Therma-Flite
The Screw Heat Exchanger Company

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Therma-Flite IC-10,000 Biosolids Drying System

Submittal Package
Part 1 of 2

For

Bowling Green Municipal Utilities
Wastewater Treatment Plant Expansion and Renovation

BGMU Project No.: S07-653
GS&P Project No.: 26064.00
TFL Project No.: 5412

TFL 5412 Submittal Contents

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A. Submittal Requirements

- Therma-Flite IC 10,000 Operational Range Table
- Compliance With Recognized Trade Association Standards & Testing Agency Standards
- Therma-Flite IC 10,000 Water Requirements
- Therma-Flite IC 10,000 Installation Instructions

Therma-Flite IC 10,000 Operational Range Table

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TFL5412 IC 10,000 Operational Range

Water Removal Capacity: 10,000 lb/hr

Hourly Feed Rate, Drying to 90%	**11,538 lb/hr**	**12,000 lb/hr**	**12,500 lb/hr**	**13,043 lb/hr**	**13,846 lb/hr**
Hourly Feed Rate, Drying to 75%	**13,968 lb/hr**	**14,167 lb/hr**	**14,386 lb/hr**	**14,630 lb/hr**	**15,000 lb/hr**
% Solids Infeed (Minimum to 14%)	**12%**	**15%**	**18%**	**21%**	**25%**

Design Data:

Processing Rate: 24 Dry Ton / Day (24 Hour Operation)
Bulk Density: 115 lb / cu. Ft (wet)
Solids Inlet Content: 18%
H2O Inlet Content: 82%
H2O Outlet Content: 10%
Product Heated Temp: 212 °F
Thermal Fluid Temp: 525 °F
Thermal Fluid Volume: Screw: 185 Gallons Each
Housing: 300 Gallons

Compliance With Recognized Trade Association Standards & Testing Agency Standards

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Fabrication Standards Compliance
TFL5412 - IC 10,000
Bowling Green, Kentucky

The fabrication of this Therma-Flite Bio-Solids Dryer is performed following the most current revisions of applicable standards recommended by the American Society of Mechanical Engineers (ASME), the American National Standards Institute (ANSI), the American Society of Testing and Materials (ASTM), and the American Welding Society (AWS).

All parts of this Therma-Flite Bio-Solids Dryer that can be defined as pressure vessels are designed and fabricated following the rules of the ASME Boiler & Pressure Vessel Code, Section VIII, Division, I, of the most current revision, as well as any additional ANSI and ASTM standards referenced therein. Final assembly pressure vessel components shall be tested and inspected to be in compliance with ASME Boiler & Pressure Vessel Code, Section VIII, Division, I, 2007, of the most current revision.

All components that are tested and found compliant with ASME Boiler & Pressure Vessel Code, Section VIII, Division, I are assigned and identified by an AMSE name that is permanently secured to that component.

All applicable process piping shall be designed and implemented per ASME 31.3.

All parts of this Therma-Flite Bio-Solids Dryer that are outside of the pressure vessel are fabricated following the AWS standards defined in AWS D1.1for Carbon Steel fabrications, and AWS D1.6 for Stainless Steel fabrications. Any additional ANSI and ASTM standards referenced therein are also followed.

Therma-Flite IC 10,000 Water Requirements

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TFL5412-IC10000 Water Requirements (assume 78F Summer Wet Bulb)

Cooling Scru:

The cooling screw requires 26.5gpm of 78F non contact cooling water. The discharge from the drier into the cooling screw is at *272F (maximum case)* and the discharge temperature of the solids from the cooling screw is 122F. The hourly heat load is 250# of water at Cp 1 plus 2250# of solids at a Cp 0.28Btu/#/F X 150F = 132,000Btu/hr. The cooling capacity of the non contact cooling water is 8.3#/gallon X (88F-78F) = 83Btu/gallon. (132,000Btu/hr)/ (60min/hr) = 2200Btu/min. 2200Btu/min/(83btu/gallon) = 26.5gpm of non contact cooling water.

Heat Load:	132,000 Btu/hr
	Cooling Water @ 78F
	88F Return Temp.
GPM Required:	*Approx 30 GPM (worst case)*

Scrubber / Condenser:

The process water required for direct contact condensation of water vapor and particulate scrubbing is 412gpm at 78F. The particulate loading is assumed as worst case of 100#/hr. The water vapor load is 10000#/hr. The cooling load per pound of water vapor is 970Btu latent heat plus 13 Btu of super heat (from the 240F vent) plus 82Btu sub cooling to the 130Fdischarge temperature for a total of 1065Btu/#.The total heat load from the condenser is 10, 650,000Btu/hr. The heat capacity per gallon is 8.3# X (130F-78F) = 431.6 Btu/gallon. 10,650,000/60min/hr = 177,500Btu/min. (177,500 Btu/min) / (431.6Btu/min) = 412gpm of process water. It is assumed that the approach is 20F between the outlet water and the vent gas or a vent temperature of 150F.

Heat Load:	10,650,000 Btu/hr
	Cooling Water @ 78F
GPM Required:	*Approx 420 GPM (worst case)*

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TFL5412 Bowling Green WWTP

Installation Instructions for Therma-Flite IC10000 Biosolids Drying System

1. The IC10,000 Biosolids Drying System shall be ***shipped*** in multiple components and will require field assembly.
    a. Dryer Module:
        i. The Dryer Module will be shipped complete by truck from Benicia, CA to Bowling Green, KY. This will be a permit load due to an overweight condition <130,000 lbs. The dryer module shall be lifted with (4) 6" SCH80 lifting pipes slid through the frame Ref. TFL5412-10000 GA Drawing a lift plan will be developed by the GC with the support of Therma-Flite based upon the logistics and knowledge of the construction site. The Dryer module will require a (2) crane lift to be removed from the truck. Placement of the equipment into its final location shall be determined by the GC with any support necessary from Therma-Flite.
            1. Provide all equipment offloading, temporary storage and placement.
            2. Provide labor, materials and equipment for the installation and assembly of all Therma-Flite supplied equipment and instrumentation. Supply and install all other materials or equipment required for a complete operational system.
            3. Site preparation and clearing of materials.
            4. Design and supply an appropriately sized reinforced concrete slab to handle full load of the odor control skid assembly. Provide collection and analysis of any geo-technical data as required.
            5. Supply and install all external water piping, thermal oil piping and drain piping to and from the equipment.

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6. Supply and install air ductwork to the odor control system including flexible connectors, interconnecting ducting, manual or actuated dampers, filters, insulation and piping supports.

b. Structural Support Legs:
    i. The Structural Support Legs Ref. TFL5412-00000 GA will be shipped in (4) components to be to be placed on the prepared concrete slab. The support structures will be shipped on a separate truck with other support equipment.

c. Cooling Screw:
    i. The Cooling Screw will be shipped complete by a separate truck from Benicia, CA to Bowling Green, KY. This shall be a standard flatbed load with a weight of 2500 lbs. The Cooling Screw should be lifted from the truck by rigging from support turnbuckle eye and a sling around the inlet flange. Placement of the equipment into its final location shall be determined by the GC with any support necessary from Therma-Flite.

d. Thermal Oil Piping Rack Guard
    i. The Rack Guard Ref. TFL5412-00000 GA will arrive in (2) pieces to be bolted together during installation. The piping rack is designed to support the supply and return headers for the Thermal Oil System and provide personnel protection.

e. Thermal Oil Piping
    i. The Thermal Oil Piping will be supplied loose and will require assembly. All gaskets and hardware will be provided. C.I. Adjustable epoxy anchor pipe supports will be provided for installation spacing of 6'-0".
    ii. The Thermal Oil Piping will be shipped insulated except for flange connections and pipe support locations.
    iii. The GC shall be responsible for final thermal installation to meet OSHA personnel protection on all thermal fluid piping.

f. Scrubber / Condenser

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i. The Scrubber / Condenser will be shipped complete on a common truck with the Cooling Screw and Thermal Piping from Benicia, CA to Bowling Green, KY. This shall be a standard flatbed load with a weight of 1200 lbs. All hardware and gaskets shall be supplied for field assembly.

g. Control Panel:
   i. The Control Panel will arrive on a pallet on a common truck with the rest of the support equipment. Standard methods of offloading can be practiced.

h. SK450 BIOREM BioFilter:
   i. The BioFilter will be shipped complete on a separate truck from Victor, NY to Bowling Green, KY. Reference BIOREM O&M Manual.
      1. Provide all equipment offloading, temporary storage and placement.
      2. Provide labor, materials and equipment for the installation and assembly of all BIOREM® supplied equipment and instrumentation. Supply and install all other materials or equipment required for a complete operational system.
      3. Site preparation and clearing of materials.
      4. Design and supply an appropriately sized reinforced concrete slab to handle full load of the odor control skid assembly. Provide collection and analysis of any geo-technical data as required.
      5. Supply and install all external water piping and drain piping to and from the vessel, water box and other fluid equipment including heat tracing, insulation, piping supports, drainage traps where necessary and / or UV protective paint.
      6. Supply and install air ductwork to the odor control system including exhaust stack, flexible connectors, interconnecting ducting, manual or actuated dampers, filters, insulation and piping supports, unless otherwise indicated above.

i. Fulton Thermal Fluid Heater FT-1200 .

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i. The Fulton Thermal Heater will be shipped in (3) separate modules on a truck from Pulaski, NY to Bowling Green, KY. Reference Fulton Thermal O&M Manual.

ii. The Main Heater Skid can be offloaded with an adequately sized forklift capable of lifting the <35,000 lb skid assembly. The Pump Skid can be offloaded with an adequately sized forklift capable of lifting the <8,000 lb skid assembly. The Expansion Tank Assembly can be offloaded with an adequately sized forklift capable of lifting the <8,000 lb skid assembly.

1. Provide all equipment offloading, temporary storage and placement.
2. Provide labor, materials and equipment for the installation and assembly of all Fulton Thermal Corp. supplied equipment and instrumentation. Supply and install all other materials or equipment required for a complete operational system.
3. Site preparation and clearing of materials.
4. Design and supply an appropriately sized reinforced concrete slab to handle full load of the odor control skid assembly. Provide collection and analysis of any geo-technical data as required.
5. Supply and install all external piping and drain piping to and from the equipment.
6. Supply and install ductwork to including exhaust stack, combustion air ducting, interconnecting ducting, manual or actuated dampers, filters, insulation and piping supports.

2. The IC10,000 **Placement** Sequence:

a. (4) Support Structures shall be placed on an appropriately sized reinforced concrete slab to handle full load of the Dryer System. Anchor locations can be determined from Ref. TFL5412-00000 and should be verified level and location to within 1/8” inch and 1/16” in 20’-0”. Recommended anchor system is Hilti HY150.

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i. Proper placement of the support structures is essential. Correct placement is the first step to trouble free installation, operation and maintenance.
ii. Authorities with jurisdictional over any national or local codes which might be applicable should be consulted before installation is made.

b. Dryer Module shall be placed on the support structures and bolted to the supports structure with provided hardware. Final leveling and grouting needs to take place before attaching any support components.
    i. The Dryer Module can be lifted utilizing the (2) Lifting Tubes located at each end of the equipment. This will require a (4) point pick. If means of lifting are not available, rollers should be placed beneath the frame and guided into position. The Dryer Module must be lifted onto the support structure – consult Therma-Flite, Inc. for installations that cannot utilize standard lifting equipment.
c. Cooling Screw shall be placed under the drive end of the Dryer Module, bolted to the discharge with provided gasket and hardware. The gasket requires >500F gasket sealer applied to both sides of the gasket to ensure adequate seal.
    i. The Cooling Screw is supported using a cantilever style turnbuckle system at the discharge end and a standard bolted and gasketed flange at the inlet end.
d. Scrubber / Condenser shall be placed on the vapor outlet flange and bolted with the provided gasket and hardware. The gasket requires >500F gasket sealer applied to both sides of the gasket to ensure adequate seal.
e. Thermal Oil Piping Rack shall be placed at the inlet end of the Dryer Module and anchored to the concrete slab utilizing ¾" Epoxy anchors per the dimensions Ref. TFL5412-00000. The Piping Rack will be supplied partially assembled with loose ship piping manifolds. Each flange will be marked with mating flange numbers for easy assembly. All gasket and hardware will be provided. 5/8" CI adjustable pipe supports will be required every 6'-0" per Ref TFL5412-00000.
f. Main Control Panel shall be placed and anchored per standard methods of supports for Electrical Enclosures determined by the GC.

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i. Ref. 21309-D-001, 21309-D-002, 21309-F-001, 21309-F-002

g. Connections:
   i. Ref. TFL5412-PID – A thru Y
   ii. TFL5412-00000 Dryer System GA
   iii. T99DR-1530 Fulton Thermal GA
   iv. SK450-GA-000 BIOREM BioFilter GA

3. Filling the System with Thermal Fluid
   a. Provide labor, materials and equipment for the operation of filling the system with approximatley. 1600 gallons of Paratherm Thermal Fluid. A Therma-Flite, Inc. representative should be on-site for this operation. Removing all trapped air during the filling of the system is essential for proper operation.
      i. The Thermal Fluid shall be provided in standard thermal fluid totes to be pumped into the system. The pump shall be the responsibility of the GC.
      ii. The System should always be filled from the lowest point possible.
         1. Open all Supply and Return valves in the system. Connect the discharge of the fill pump to the housing drain valve at the lowest point in the system. Open (3) vent flanges at the top of the housing. Slowly fill the housing allowing all the air to escape from the vents. Replace vent flanges on the top of the housing at the first sign of oil (this will happen in sequence from inlet end to outlet).
         2. In Manual Mode: Start rotation of the screw rotors in the reverse direction at a minimum of 5 RPM.
         3. Connect the discharge of the fill pump to both rotor drain valves at the same time and start pumping while the screw rotors are rotating in the reverse direction.
         4. Continue pumping while monitoring the Thermal Oil Expansion tank at the highest point in the system. Once the low level switch has been satisfied in the fluid expansion tank, turn off the fill pump.

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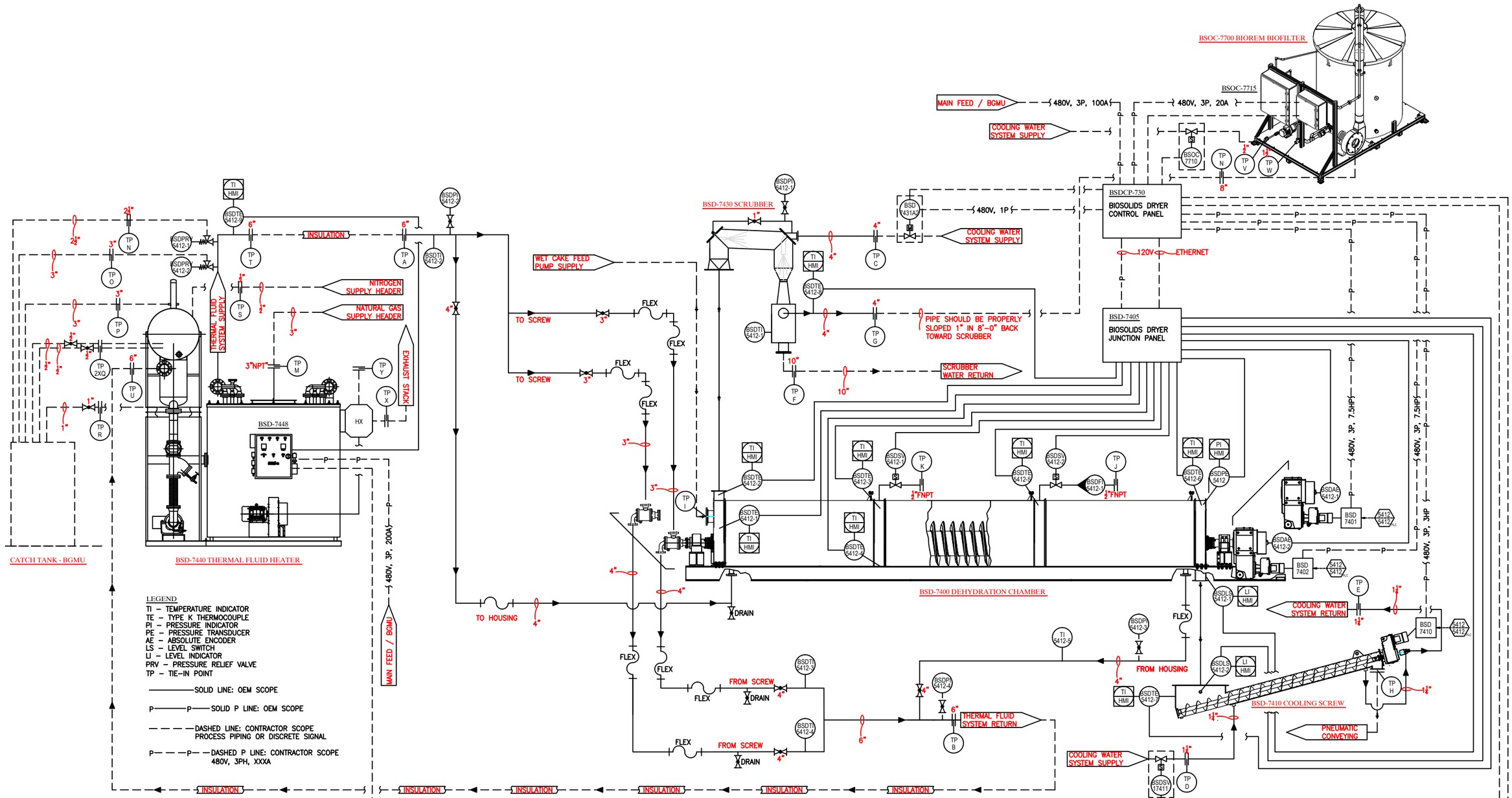
5. Start the Fulton Thermal Oil Pump and continue to circulate the oil with the screws rotating in reverse. The level in the expansion tank may drop and the low level switch may shut off the pump. If this happens, add more oil at the lowest point in the system.
6. Once every 30 minutes, shut down the Thermal Oil Supply Pump, isolate the strainer, remove and check for debris. Small amounts of pipe scale and particulate is common and must be removed.
7. Continue this operation until all air and particulate has been removed.

B. Process and Instrumentation

- Process and Instrument Diagram, Drawing No.: TFL5412-PID
- Therma-Flite Job No.: TFL5412 Instrument Index

Process and Instrument Diagram, Drawing No.: TFL5412-PID



UTILITY AND AUXILIARY TIE-IN POINTS:

- A 6" 300# FLANGE THERMAL FLUID SUPPLY
- B 6" 300# FLANGE THERMAL FLUID RETURN
- C 4" 150# FLANGE COOLING WATER SUPPLY TO SCRUBBER / CONDENSER
- D 1 1/4" FNPT COOLING WATER SUPPLY TO COOLING SCREW
- E 1 1/4" FNPT COOLING WATER RETURN TO COOLING SCREW
- F 10" 150# FLANGE CONDENSATE RETURN FROM SCRUBBER / CONDENSER
- G 4" 150# FLANGE VENT LINE TO BIO–FILTER
- H 12" X 12" CUSTOM FLANGE FROM COOLING SCREW
- I 12" 150# FLANGE WET CAKE INLET
- J 1/2" FNPT NITROGEN PURGE CONNECTION
- K 1/2" FNPT WATER SPRAY CONNECTION
- L JUNCTION – 30"X30"X8", NEMA 4X, STAINLESS
- M 3" MPNT NATURAL GAS SUPPLY
- N 2 1/2" 150# FLANGE PRESSURE RELIEF
- O 3" 150# FLANGE PRESSURE RELIEF
- P 3" 300# FLANGE VENT
- Q 1/2" MNPT HIGH/LOW CHECK
- R 1" 150# DRAIN
- S 1/2" FNPT NITROGEN PURGE
- T 6" 300# FLANGE THERMAL FLUID SUPPLY
- U 6" 300# FLANGE THERMAL FLUID RETURN
- V 1/2" SOC WATER SUPPLY
- W 1 1/2" DRAIN (P–TRAP REQUIRED)
- X 26" DIA. VERTICAL STACK CONNECTION
- Y 13 1/8" X 33 1/4" AIR INLET CONN.

REFERENCES	DRAWING NUMBER	TITLE

THIS DRAWING IS FURNISHED FOR THE SOLE USE OF THE INTENDED RECIPIENT AND ITS ACCEPTANCE CONSTITUTES AN AGREEMENT THAT IT WILL NOT BE PUBLISHED, REPRODUCED, DISTRIBUTED OR DISCLOSED TO ANY OTHER PARTY UNLESS AUTHORIZED BY THERMA–FLITE. ALL ITEMS, INCLUDING EQUIPMENT, STRUCTURES AND ACCESSORIES INDICATED ON THIS DRAWING ARE TO BE FURNISHED BY THERMA–FLITE ONLY AS SPECIFICALLY STATED HEREON OR IN A WRITTEN AGREEMENT BY US REFERRING HERETO.

REVISIONS	No.	MADE BY	CHECKED BY	DATE	DESCRIPTION
	0	CJ	RDN	01/11/10	APPROVAL SUBMITTAL

JOB No.:	TFL5412
DRAWN BY:	RDN
TRACED BY:	
CHECKED BY:	
APPROVED BY:	BRB
DATE	01/11/10

PROCESS AND INSTRUMENT DIAGRAM
IC10,000
"BIO-SCRU" DRYER
FOR
BGMU – WWTP

CUSTOMER: BGMU – WWTP

Therma-Flite
The Screw Heat Exchange Company
P.O.Box 847
848 Jackson Street,
Benicia, CA 94510
Telephone: (707) 747-0940
Fax: (707) 747-0951

SCALE:	DWG. No.:	REV:
NTS	TFL5412–PID	0

Therma-Flite Job No.: TFL5412 Instrument Index

Therma-Flite
The Screw Heat Exchanger Company

INSTRUMENT INDEX

JOB #: TFL5412

REV	TAG NUMBER	SERVICE DESCRIPTION	P&ID No.	DEVICE TYPE	MANUFACTURER	MODEL NO.	CALIBRATED RANGE	LOCATION DWG.	REMARKS
O	BSDTE-5412-1	PROCESS VENT TO SCRUBBER	TFL5412-PID	TE	OMEGA ENG.	NB1-CASS-14U-XX	TYPE K	TFL5412-00000	
O	BSDTE-5412-2	PRODUCT INLET ZONE TEMPERATURE	TFL5412-PID	TE	OMEGA ENG.	NB1-CASS-14U-XX	TYPE K	TFL5412-00000	
O	BSDTE-5412-3	PROCESS VAPOR ZONE 2 TEMPERATURE	TFL5412-PID	TE	OMEGA ENG.	NB1-CASS-14U-XX	TYPE K	TFL5412-00000	
O	BSDTE-5412-4	MATERIAL TEMP ZONE 2 TEMPERATURE	TFL5412-PID	TE	OMEGA ENG.	NB1-CASS-14U-XX	TYPE K	TFL5412-00000	
O	BSDTE-5412-5	PROCESS VAPOR ZONE 3 TEMPERATURE	TFL5412-PID	TE	OMEGA ENG.	NB1-CASS-14U-XX	TYPE K	TFL5412-00000	
O	BSDTE-5412-6	PROCESS VAPOR DISCHARGE TEMPERATURE	TFL5412-PID	TE	OMEGA ENG.	NB1-CASS-14U-XX	TYPE K	TFL5412-00000	
O	BSDTE-5412-7	MATERIAL DISCHARGE TEMPERATURE	TFL5412-PID	TE	OMEGA ENG.	NB1-CASS-14U-XX	TYPE K	TFL5412-00000	
O	BSDTE-5412-8	PROCESS VENT FROM SCRUBBER	TFL5412-PID	TE	OMEGA ENG.	NB1-CASS-14U-XX	TYPE K	TFL5412-00000	
O	BSDPE-5412	PRODUCT CHAMBER PRESSURE	TFL5412-PID	PE	DWYER	645-10	-0.5 TO 0.5 PSI	TFL5412-00000	
O	BSDAE-5412-1	DRYER LH ROTOR POSITION	TFL5412-PID	AE	BEI INDUSTRIES	HS35F-100-R2-SS	NA	TFL5412-00000	
O	BSDAE-5412-2	DRYER RH ROTOR POSITION	TFL5412-PID	AE	BEI INDUSTRIES	HS35F-100-R2-SS	NA	TFL5412-00000	
O	BSDLS-5412-1	MATERIAL SEAL LEVEL LOW	TFL5412-PID	LS	BINDICATOR	LP3-1-A-1-G-A-10-0	SPDT	TFL5412-00000	
O	BSDLS-5412-2	MATERIAL SEAL LEVEL CONTROL	TFL5412-PID	LS	BINDICATOR	LP3-1-A-1-G-A-10-0	SPDT	TFL5412-00000	
O	BSDSV-5412-1	SOLENOID VALVE - STARTUP AND SHUTDOWN WATER SPRAY	TFL5412-PID	SV	ASCO	EF8210GO94MO	-----	TFL5412-00000	
O	BSDSV-5412-2	SOLENOID VALVE - NITROGEN PURGE	TFL5412-PID	SV	ASCO	EF8210GO94MO	-----	TFL5412-00000	
O	BSDTI-5412-1	SCRUBBER WATER RETURN TEMPERATURE	TFL5412-PID	TI	ASHCROFT	30-CI-60-R-040-0/200F	0/200F	TFL5412-00000	
O	BSDTI-5412-2	THERMAL FLUID SUPPLY HEADER TEMPERATURE	TFL5412-PID	TI	ASHCROFT	30-CI-60-L-040-50/550F	50/550F	TFL5412-00000	
O	BSDTI-5412-3	RH ROTOR THERMAL FLUID RETURN TEMPERATURE	TFL5412-PID	TI	ASHCROFT	30-CI-60-L-040-50/550F	50/550F	TFL5412-00000	
O	BSDTI-5412-4	LH ROTOR THERMAL FLUID RETURN TEMPERATURE	TFL5412-PID	TI	ASHCROFT	30-CI-60-L-040-50/550F	50/550F	TFL5412-00000	
O	BSDTI-5412-5	HOUSING THERMAL FLUID RETURN TEMPERATURE	TFL5412-PID	TI	ASHCROFT	30-CI-60-L-040-50/550F	50/550F	TFL5412-00000	
O	BSDPI-5412-1	SCRUBBER CONDENSER SUPERHEAT NOZZLE PRESSURE	TFL5412-PID	PI	WEKSLER	BA43YPE4LW	0-60 PSI	TFL5412-00000	
O	BSDPI-5412-2	THERMAL FLUID SUPPLY PRESSURE	TFL5412-PID	PI	WEKSLER	BA43YPE4LW	0-60 PSI	TFL5412-00000	
O	BSDPI-5412-3	THERMAL FLUID RETURN HEADER PRESSURE	TFL5412-PID	PI	WEKSLER	BA43YPE4LW	0-60 PSI	TFL5412-00000	
O	BSDPRV-5412-1	PRESSURE RELIEF VALVE - THERMAL FLUID SUPPLY	TFL5412-PID	PRV	-----	------	-----	FULTON TBD	
O	BSDPRV-5412-1	PRESSURE RELIEF VALVE - THERMAL FLUID SUPPLY	TFL5412-PID	PRV	------	--------	-----	FULTON TBD	
O	BSDFI-5412-1	NITROGEN ROTOMETER - FLOW INDICATOR	TFL5412-PID	FI	DWYER	RMC-108-CPF	180 1800 CFH	TFL5412-00000	

C. General Arrangement Drawings

- TFL5412-00000-D-Sheet 1 Of 2, IC 10,000 General Arrangement Drawing
- TFL5412-00000-D-Sheet 2 Of 2, IC 10,000 General Arrangement Drawing

- TFL5412-10000-D-Sheet 1 Of 3, IC 10,000 General Arrangement Drawing
- TFL5412-10000-D-Sheet 2 Of 3, IC 10,000 Recommended Platform
- TFL5412-10000-D-Sheet 3 Of 3, IC 10,000 Foundation Loading / Thermal Expansion

TFL5412-00000-D-SHEET 1 OF 2 , IC 10,000 General Arrangement Drawing

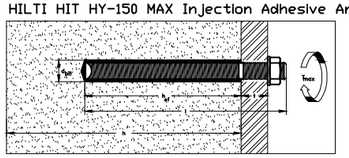
HY 150 MAX Installation Specification Table for HAS Rods

Details	Rod Size	3/4 (19.)	1-1/4 (31.8)
d_{bit} bit diameter		13/16	1-3/8
$h_{ef} = h_{nom}$ standard embedment		6-3/4 (172)	11-1/4 (286)
T_{inst} max. tightening torque — All HAS Threaded Rods	$h_{ef} \geq h_{min}$	150 (203)	400 (540)
	$h_{ef} < h_{min}$	105 (142)	280 (375)
h minimum base material thickness	$h_{ef} = h_{min}$	8-3/4 (222)	14-1/4 (362)
	$h_{ef} > h_{min}$	1.0 h_{ef} 2 (51)	1.0 h_{ef} 3 (76)

Final Cure Time Table (Approximate)

Approx. Curing Time	Base Material Temperature
20 Minutes	104°F/40°C
25 Minutes	86°F/30°C
30 Minutes	68°F/20°C
1 Hour	50°F/10°C
2 Hours	32°F/0°C
4 Hours	23°F/-5°C
12 Hours	14°F/-10°C

HILTI HIT HY-150 MAX Injection Adhesive Anchor

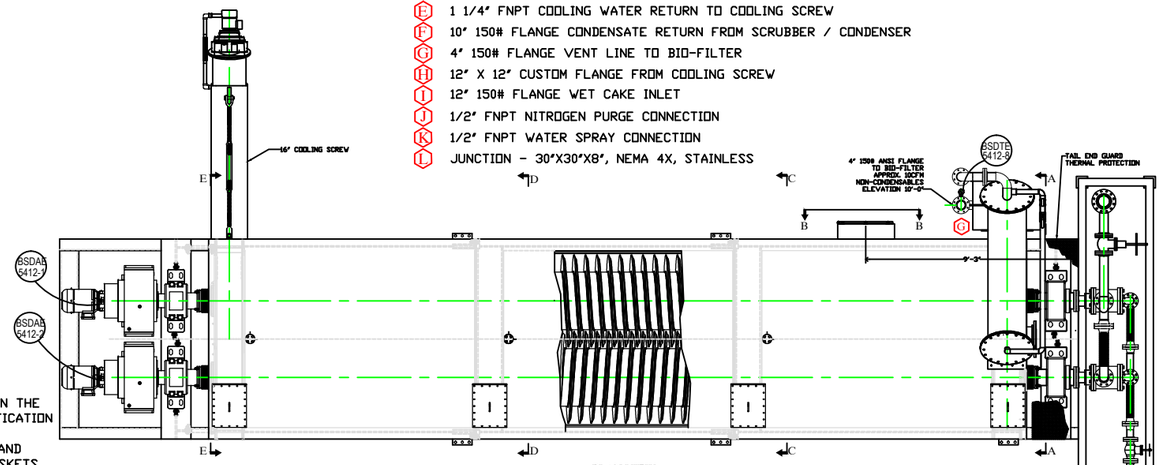


INSTALLATION NOTES:

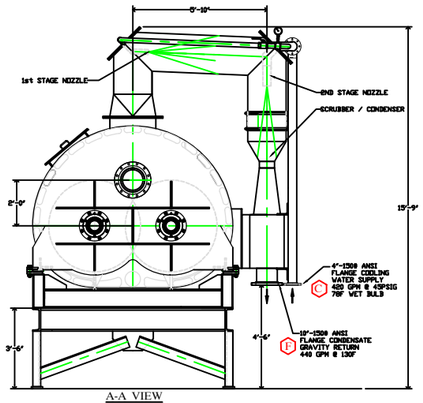
1. THE IC10000 SYSTEM SHALL BE SHIPPED IN SEPARATE COMPONENTS:
   - DEHYDRATION CHAMBER
   - COOLING SCREW
   - STRUCTURAL SUPPORTS
   - SCRUBBER / CONDENSER
   - PIPING RACK / LOOSE SHIP PIPING COMPONENTS
   - ALL REQUIRED GASKETS AND HARDWARE FOR FIELD ASSEMBLY
2. THE DEHYDRATION CHAMBER AND SUPPORT STRUCTURES SHALL BE ERECTED FIRST ON THE 10" CONCRETE PAD PER BGMU DWG# XXX AND ANCHORED PER TFL5412 GUIDE SPECIFICATION THE MACHINE SHALL BE LEVELED (2 PLANE) 1/16" IN 20'-0" BEFORE GROUTING.
3. THE REMAINNG COMPONENTS SHALL BE ERECTED FOLLOWING THE FINAL PLACEMENT AND ANCHORING OF THE DEHYDRATION CHAMBER. EACH COMPONENT IS PROVIDED WITH GASKETS AND HARDWARE REQUIRED FOR PLACEMENT AND BOLTING.
4. GASKETS: ALL GASKET SHALL BE INSTALLED WITH >500F SILICON GASKET FORMING COMPOUND TO BOTH SIDES OF THE GASKET TO ENSURE PROPER SEALING BETWEEN EACH COMPONENT.
5. TORQUE: ALL HARDWARE SHALL BE TORQUED BASED UPON INDUSTRY STANDARD FOR BOLT DIA.

UTILITY AND AUXILIARY CONNECTIONS POINTS:

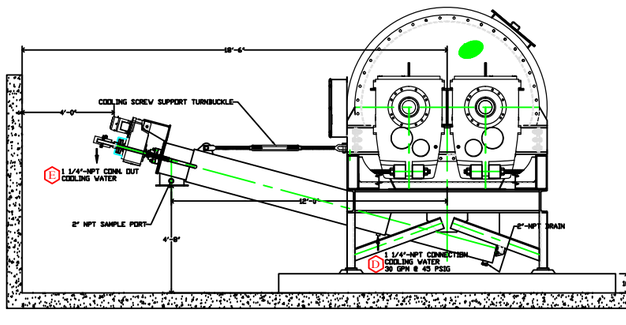
- (A) 6" 300# FLANGE THERMAL FLUID SUPPLY
- (B) 6" 300# FLANGE THERMAL FLUID RETURN
- (C) 4" 150# FLANGE COOLING WATER SUPPLY TO SCRUBBER / CONDENSER
- (D) 1 1/4" FNPT COOLING WATER SUPPLY TO COOLING SCREW
- (E) 1 1/4" FNPT COOLING WATER RETURN TO COOLING SCREW
- (F) 10" 150# FLANGE CONDENSATE RETURN FROM SCRUBBER / CONDENSER
- (G) 4" 150# FLANGE VENT LINE TO BIO-FILTER
- (H) 12" X 12" CUSTOM FLANGE FROM COOLING SCREW
- (I) 12" 150# FLANGE WET CAKE INLET
- (J) 1/2" FNPT NITROGEN PURGE CONNECTION
- (K) 1/2" FNPT WATER SPRAY CONNECTION
- (L) JUNCTION - 30"X30"X8", NEMA 4X, STAINLESS



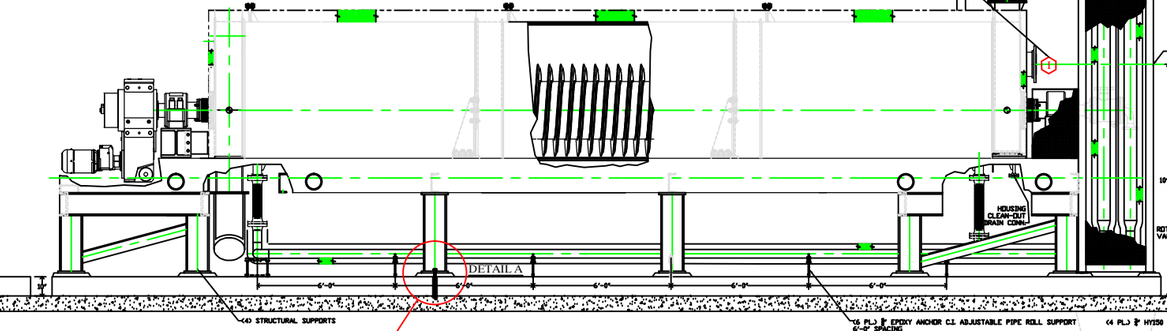
PLAN VIEW



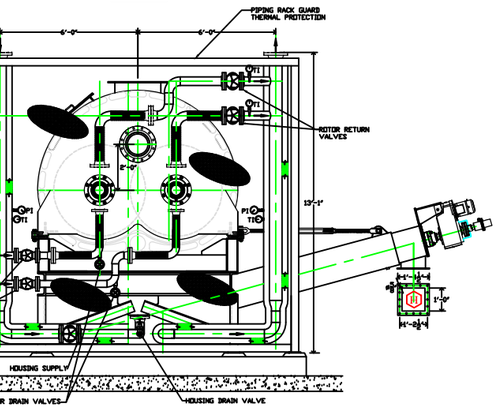
A-A VIEW



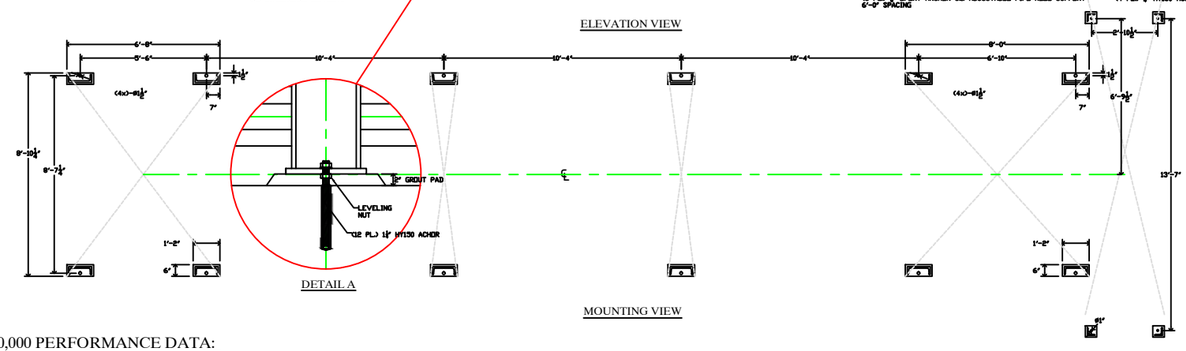
DRIVE END VIEW



ELEVATION VIEW

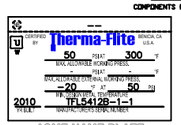


TAIL END VIEW
COMPONENTS REMOVED FOR CLARITY



DETAIL A

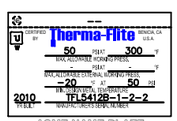
MOUNTING VIEW



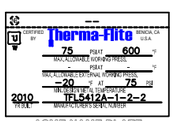
(COOLER HOUSING)

(DRYER HOUSING)

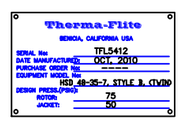
(DRYER RH.ROTOR)



(COOLER ROTOR)



(DRYER LH. ROTOR)



DESIGN AND CONSTRUCTION NOTES:

1. DESIGN AND CONSTRUCTION PER ASME CODE, SECTION VIII, DIVISION I, 2007, JULY 09 ADDENDA. "NB" & "U" STAMP REQUIRED.
2. WELDING PROCEDURE PER ASME CODE SECTION IX, 2007, JULY 09 ADDENDA.
3. MILL CERTIFICATES REQUIRED FOR ALL MATERIALS.
4. NDE PER TFL QUALITY CONTROL MANUAL.
5. IMPACT TEST EXEMPT PER UG-20.
6. DESIGN PRESSURE:
   SCREW ROTOR: 75 PSI.
   JACKETED HOUSING: 50 PSI.
7. HYDRO-TEST PRESSURE:
   SCREW ROTOR: 114 PSI
   JACKETED HOUSING: 76 PSI

IC10,000 DESIGN DATA:

PROCESSING RATE:	24 DRY TON/DAY (24HOUR OPERATION)
BULK DENSITY):	115 LB/CU.FT (WET)
SOLIDS INLET CONTENT:	18%
H20 INLET CONTENT:	82%
H20 OUTLET CONTENT:	10%
PRODUCT HEATED TEMP:	212 F
THERMAL FLUID TEMP:	525 F
THERMAL FLUID VOLUME:	SCREW---185 GAL./EACH HOUSING---300 GAL.

IC10,000 PERFORMANCE DATA:

WATER REMOVAL CAPACITY: 10000 LB/HR

HOURLY FEED RATE DRYING TO 90%	11,538 LB/HR	12,000 LB/HR	12,500 LB/HR	13,043 LB/HR	13,846 LB/HR
HOURLY FEED RATE DRYING TO 75%	13,968 LB/HR	14,167 LB/HR	14,386 LB/HR	14,630 LB/HR	15,00 LB/HR
% SOLIDS INFEED (MINIMUM 14%)	12%	15%	18%	21%	25%

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No.	MADE BY	CHECKED BY	DATE	DESCRIPTION
3	RDN		2/1/10	RELEASED FOR INFORMATION ONLY
2	RDN		2/18/10	COOLING SCREW MODIFICATION
1	RDN		3/8/10	RELEASED FOR APPROVAL

JOB No:	TFL5412
DRAWN BY:	CJ 12/03/09
CHECKED BY:	RDN 12/03/09
APPROVED BY:	BRB 12/03/09

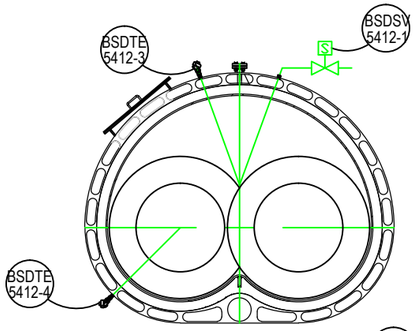
GENERAL ARRANGEMENT DRAWING OF "IC10,000" DRYER MODULE FOR BOWLING GREEN MUNICIPAL UTILITIES

CUSTOMER: BGMU
PROJECT No: S07-653

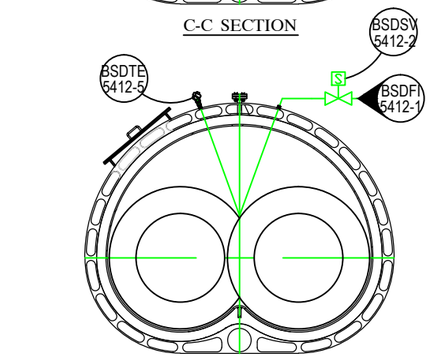
Therma-Flite
The Screw Heat Exchange Company
P.O.Box 847
889 Jackson Street,
Benicia, CA 94510
Telephone: (707) 747-5949
Fax: (707) 747-5951

SHEET: 1 OF 2 | DWG. No: TFL5412-00000 | R2

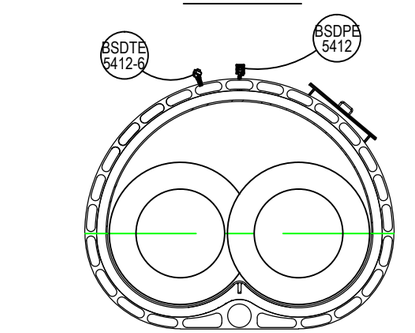
TFL5412-00000-D-SHEET 2 OF 2 , IC 10,000 General Arrangement Drawing



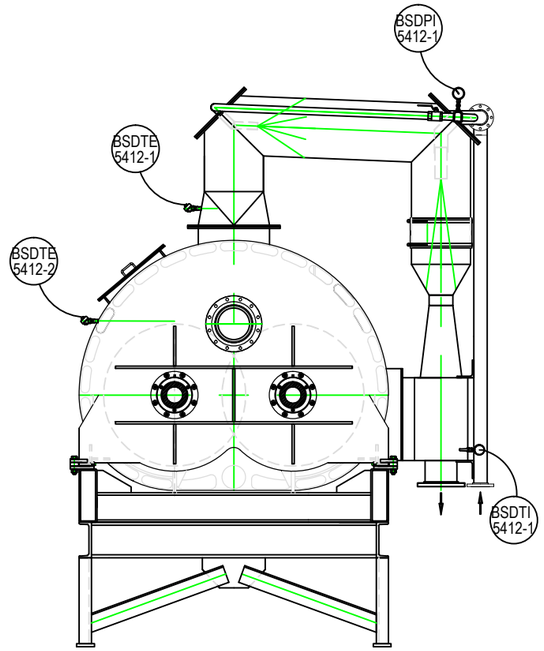
C-C SECTION

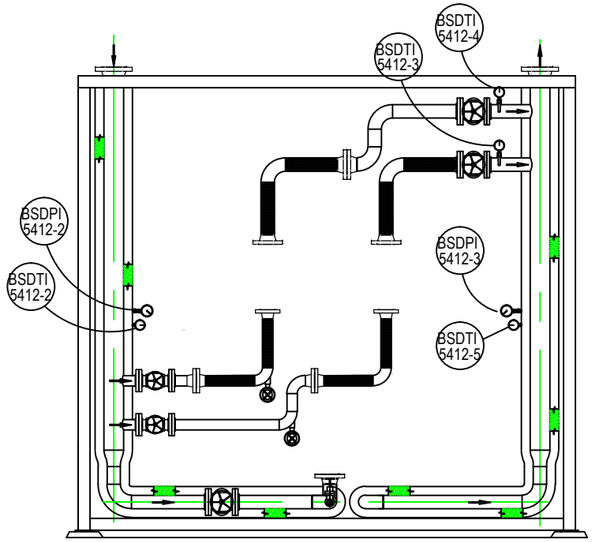


D-D SECTION

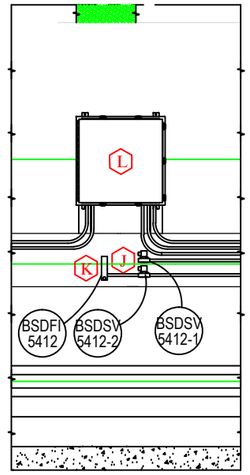


E-E SECTION
COOLING SCRU NOT SHOWN



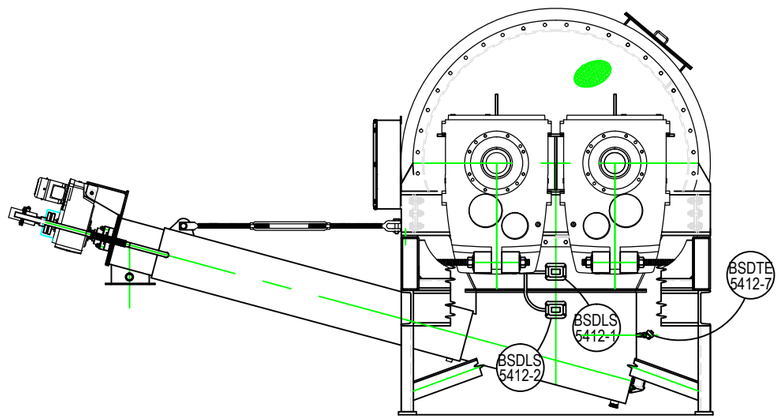


NOTE: ALL VALVES ARE "VELAN" CAST CARBON STEEL GATE VALVES.



B-B VIEW

NOTE: ALL INSTRUMENTATION SHALL BE FACTORY PREWIRED TO THE JUNCTION ENCLOSURE L. REFERENCE JUNCTION ENCLOSURE DRAWING #XXX.



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REVISIONS	No.	MADE BY	CHECKED BY	DATE	DESCRIPTION
	1	RDN		2/1/10	RELEASED FOR INFORMATION ONLY
	2	RDN		2/18/9	COOLING SCREW MODIFICATION
	3	RDN		3/8/19	RELEASED FOR APPROVAL

JOB No:	TFL5412	
DRAWN BY:	CJ	12/03/09
CHECKED BY:	RDN	12/03/09
APPROVED BY:	BRB	12/03/09

DATE

GENERAL ARRANGEMENT DRAWING OF "IC10,000" DRYER MODULE FOR BOWLING GREEN MUNICIPAL UTILITIES

CUSTOMER: BGMU

PROJECT No: S07-653

Therma-Flite
The Screw Heat Exchange Company
P.O.Box 847
849 Jackson Street,
Benicia, CA 94510
Telephone: (707) 747-5949
Fax: (707) 747-5951

SHEET: 2 OF 2 | DWG. No: TFL5412-00000 | R2

TFL5412-10000-D-SHEET 1 OF 3 , IC 10,000 Dryer Module

DESIGN AND CONSTRUCTION NOTES:

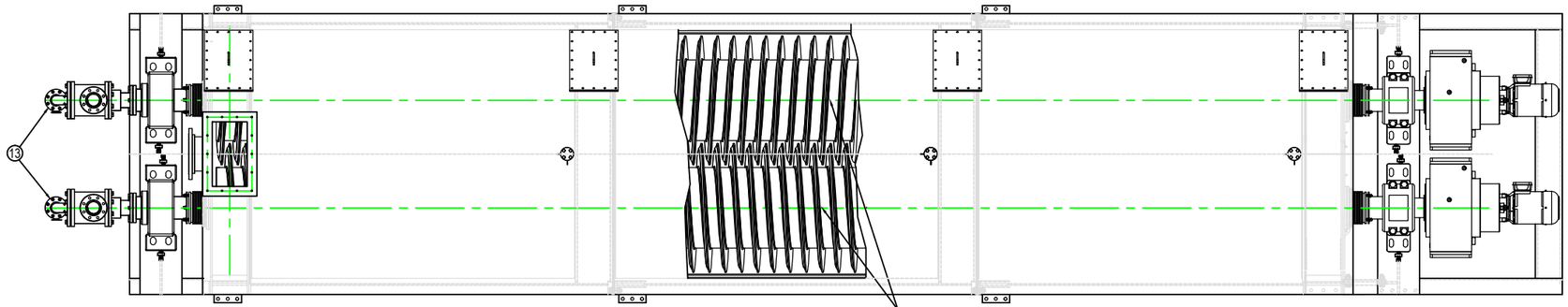
1. DESIGN AND CONSTRUCTION PER ASME CODE, SECTION VIII, DIVISION I, 2007, JULY 09 ADDENDA. 'NB' & 'U' STAMP REQUIRED.
2. WELDING PROCEDURE PER ASME CODE SECTION IX, 2007, JULY 09 ADDENDA.
3. MILL CERTIFICATES REQUIRED FOR ALL MATERIALS.
4. NDE PER TFL QUALITY CONTROL MANUAL.
5. IMPACT TEST EXEMPT PER UG-20.
6. DESIGN PRESSURE:
   SCREW ROTOR: 75 PSI.
   JACKETED HOUSING: 50 PSI.
7. HYDRO-TEST PRESSURE:
   SCREW ROTOR: 114 PSI
   JACKETED HOUSING: 76 PSI

IC10,000 DESIGN DATA:

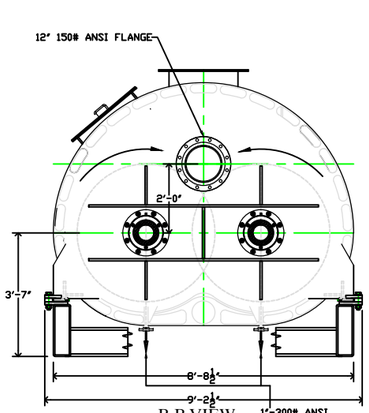
PROCESSING RATE:	24 DRY TON/DAY (24HOUR OPERATION)
BULK DENSITY:	63 LB/CU.FT (WET)
SOLIDS INLET CONTENT:	18%
H20 INLET CONTENT:	82%
H20 OUTLET CONTENT:	10%
PRODUCT HEATED TEMP:	212 F
THERMAL FLUID TEMP:	525 F
THERMAL FLUID VOLUME:	SCREW---185 GAL./EACH HOUSING---300 GAL.

REF. DWG.	ITEM	QTY	DESCRIPTION	MATERIAL
	11	2	PILLOW BLOCK BEARING, 'MIETHER'-#SAF22338, (8 3/8"BORE) (DRIVE END)	--
	12	2	PILLOW BLOCK BEARING, 'DODGE' 8" SOLID LUBE (TAIL END)	--
	13	2	ROTARY JOINT, KADANT JOHNSON 5" ELSN, M=4", P=3"	--
	14	2	SHAFT MOUNT GEAR REDUCER, 'NORD'-#SK11382/52AZSHG,	--
			VL-132S/4 CUS, 7.5 HP, 1154.35 RATIO	--
	15	2	ENCODER, BEI HS35F-100-R2-SS	304SS
	16	2	ACCESS COVER,	--

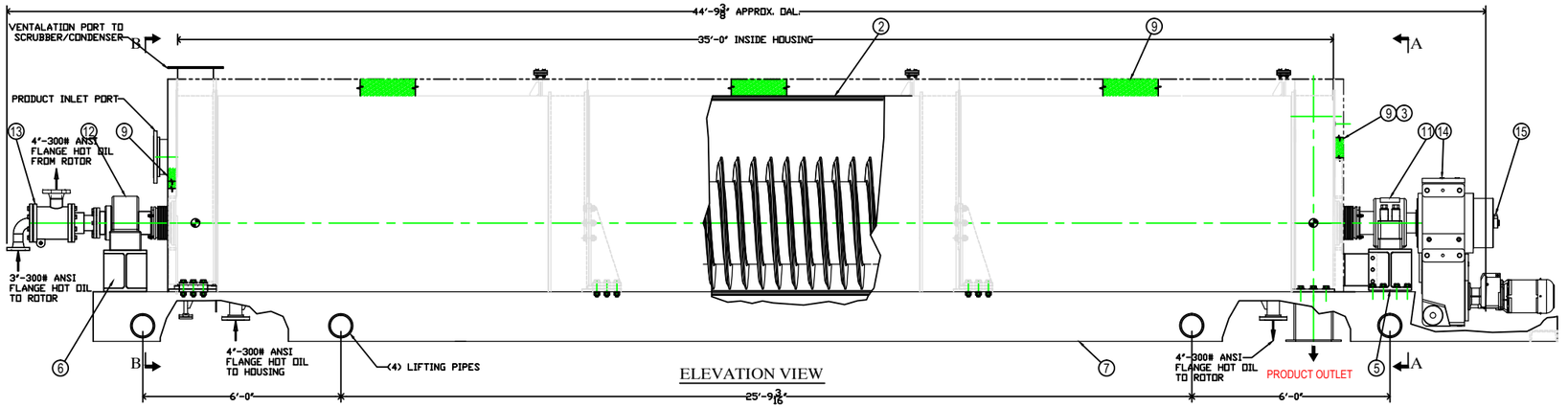
REF. DWG.	ITEM	QTY	DESCRIPTION	MATERIAL
	1	2	ROTORS, 48"OD. X V'PITCH W/30"STEM PIPE, RH. & LH. EACH.	SA-240-304/SA-182-304
	2	1	HOUSING,	SA-240-316L/CS
	3	1	REMOVABLE END PLATE,	SA-240-316L
	4	4	SHAFT RIDER SEAL,	--
	5	1	BEARING SUPPORT, (DRIVE END)	MILD STEEL
	6	1	BEARING SUPPORT, (TAIL END)	MILD STEEL
	7	1	SUPPORT SKID,	MILD STEEL
	8	2	4"PIPE CONN. JOINT,	SA-312-316L
	9	LOT	INSULATION AND SS. OUTER FLASHING,	304SS
	10	LOT	1/8"THK. GASKET,	--



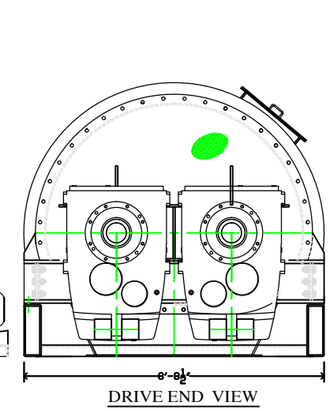
PLAN VIEW



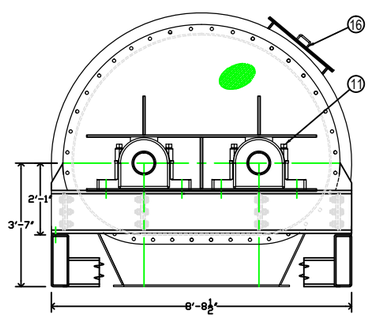
B-B VIEW



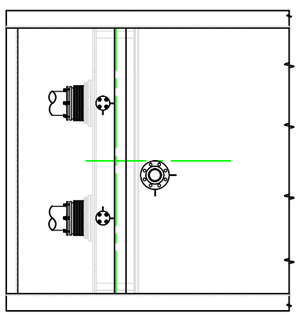
ELEVATION VIEW



DRIVE END VIEW

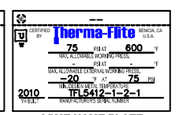


A-A VIEW

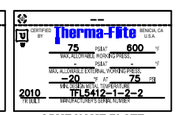


BOTTOM VIEW

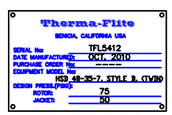
ASME NAME PLATE (HOUSING)



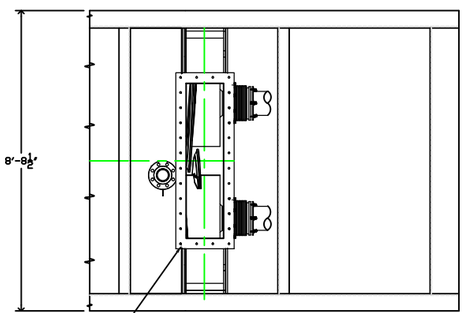
ASME NAME PLATE (RH.ROTOR)



ASME NAME PLATE (LH. ROTOR)



EQUIP. NAME PLATE



BOTTOM VIEW

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NO.	MADE BY	CHECKED BY	DATE	DESCRIPTION
3	RDN		1/31/10	ISSUED FOR INFORMATION
2	RDN		2/1/10	INLET FLANGE ELEVATION / SUPPORT
1	RDN		3/8/10	CHANGE REMOVABLE END PLATE

JOB No:	TFL5412
DRAWN BY:	CJ 12/03/09
CHECKED BY:	RDN 12/03/09
APPROVED BY:	BRB 12/03/09

GENERAL ARRANGEMENT DRAWING OF "IC10,000" DRYER MODULE FOR BOWLING GREEN MUNICIPAL UTILITIES

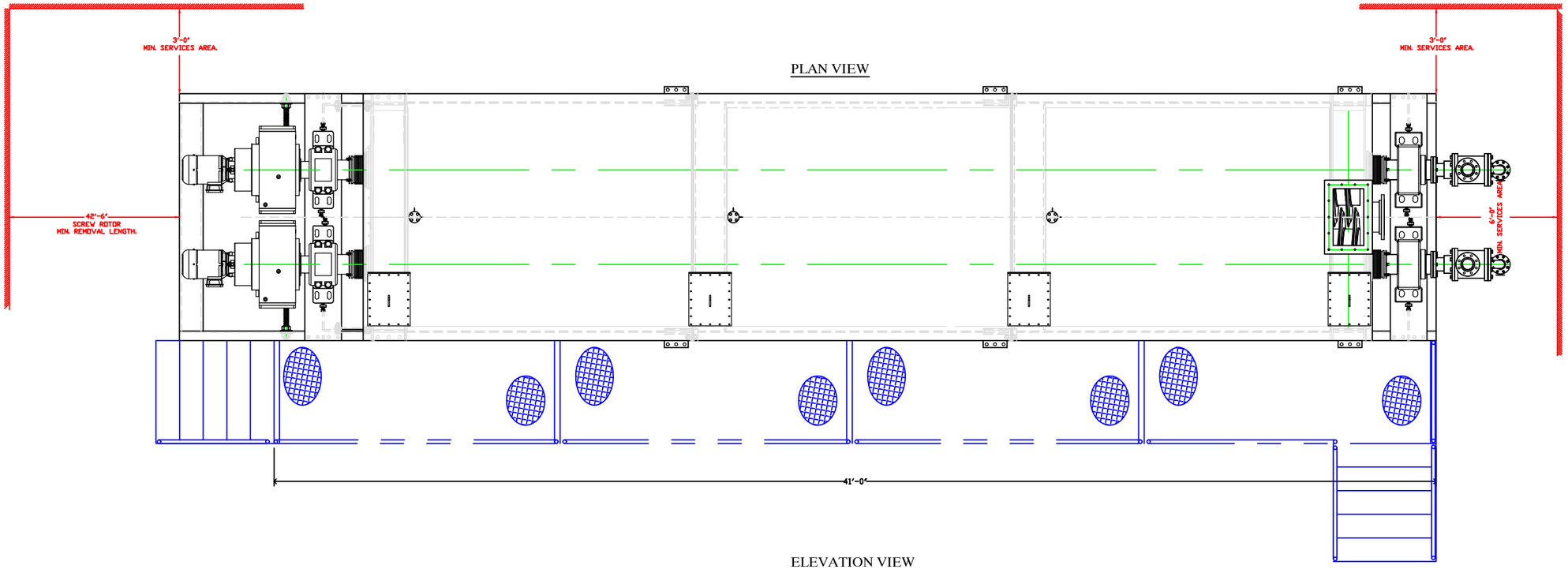
CUSTOMER: BGMU
PROJECT No: S07-653

Therma-Flite
The Screw Heat Exchange Company
P.O.Box 847
849 Jackson Street,
Benicia, CA 94510
Telephone: (707) 747-5949
Fax: (707) 747-5951

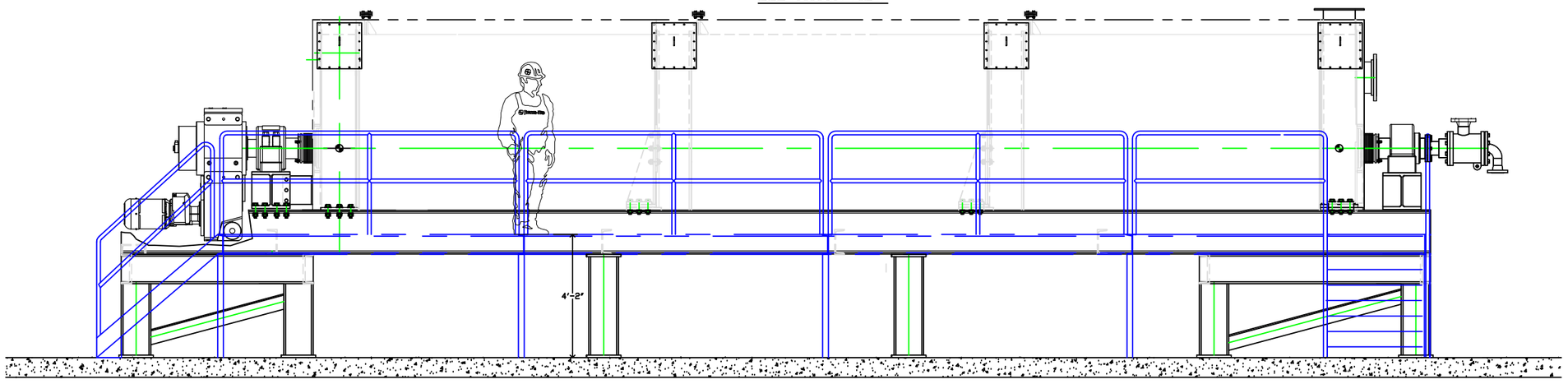
SHEET: 1 OF 3 DWG. No: TFL5412-10000 REV 0

TFL5412-10000-D-SHEET 2 OF 3 , IC 10,000 Recommended Platform

PLAN VIEW



ELEVATION VIEW



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REVISIONS	No.	MADE BY	CHECKED BY	DATE	DESCRIPTION
	1	RDN		1/8/10	ISSUED FOR INFORMATION ONLY
	2	RDN		2/1/10	PLATFORM RECOMMENDATION CHANGES
	3	RDN		3/8/10	CHANGE REMOVABLE ENDPLATE

JOB No.: TFL5412
DRAWN BY: RDN
CHECKED BY:
APPROVED BY:
DATE: 1/05/10

RECOMMENDED PLATFORM - WALKWAY AND SERVICE ACCESS
"IC10,000" DRYER MODULE
FOR
BOWLING GREEN MUNICIPAL UTILITIES

CUSTOMER: BGMU
PROJECT No: S07653

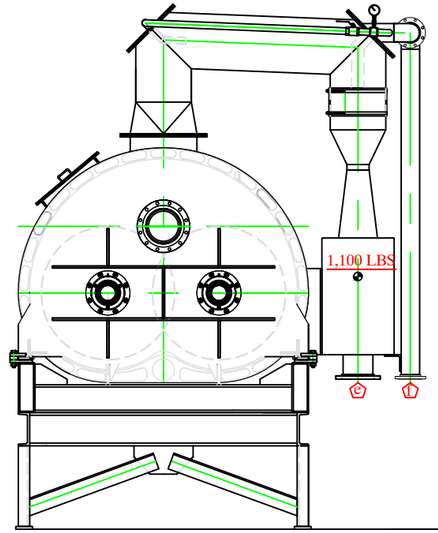
Therma-Flite
The Screw Heat Exchange Company
P.O.Box 847
849 Jackson Street,
Benicia, CA 94510
Telephone: (707) 747-5949
Fax: (707) 747-5951

SHEET: 2 OF 3
DWG. No.: TFL5412-10000
REV: 0

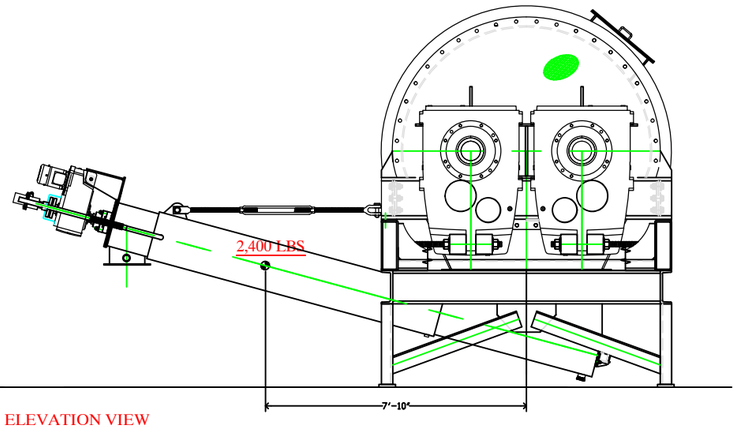
TFL5412-10000-D-SHEET 3 OF 3 , IC 10,000 Foundation Loading / Thermal Expansion

FOOT	FOUNDATION LOADING (Z DIRECTION)
A	APPROX. 15,240 LBS
B	APPROX. 15,240 LBS
C	APPROX. 15,240 LBS
D	APPROX. 15,240 LBS
E	APPROX. 15,250 LBS
F	APPROX. 15,250 LBS
G	APPROX. 15,970 LBS
H	APPROX. 15,970 LBS
I	APPROX. 2,000 LBS
J	APPROX. 2,000 LBS
K	APPROX. 2,000 LBS
L	APPROX. 2,000 LBS

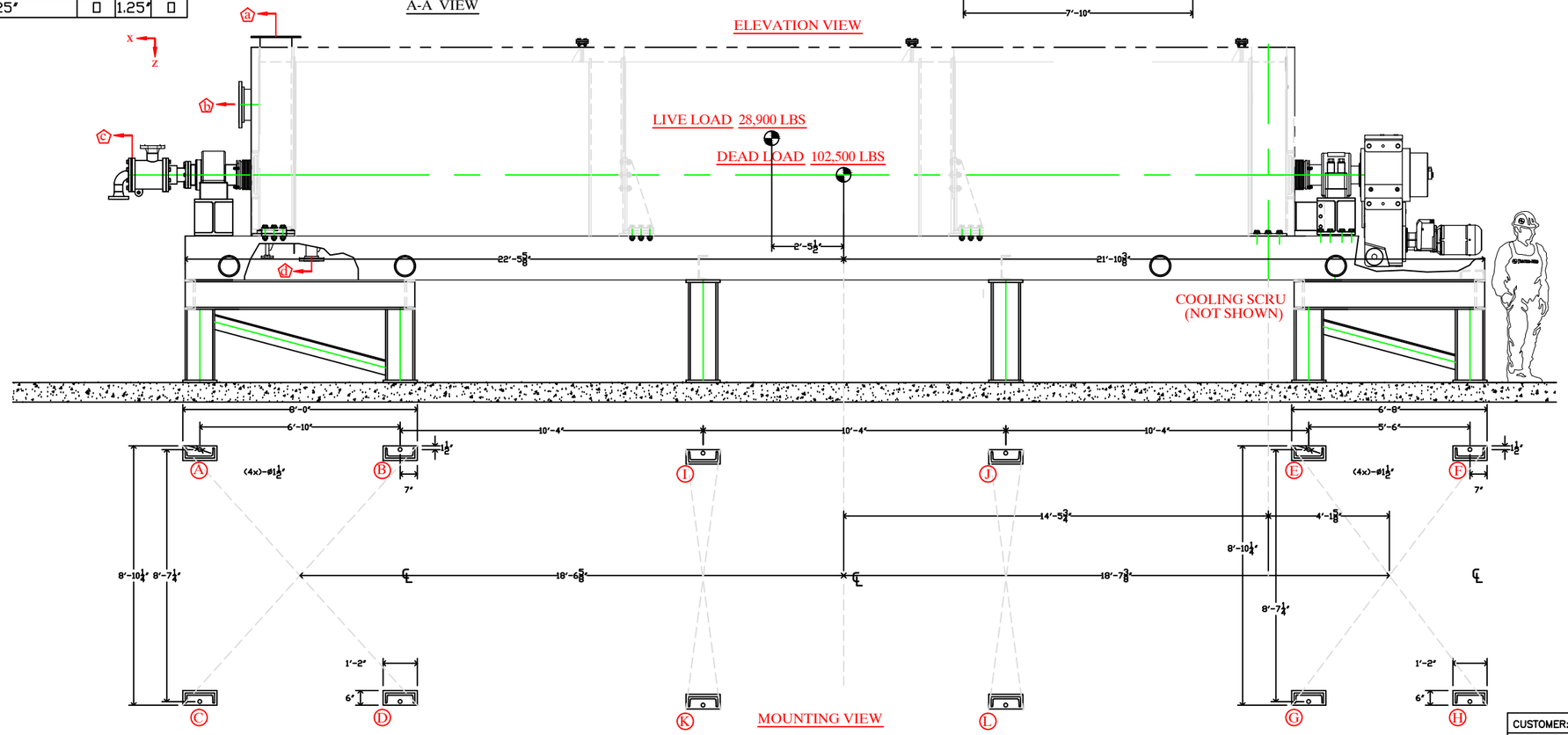
NOZZLE	THERMAL EXPANSION	X	Y	Z
a	APPROX. 1.25"	1.25"	0	0
b	APPROX. 1.375"	1.38"	0	0
c	APPROX. 1.5"	1.5"	0	0
d	APPROX. 1.125"	1.13"	0	0
d	APPROX. 1.125"	0	1.25"	0
d	APPROX. 1.125"	0	1.25"	0



A-A VIEW



ELEVATION VIEW



MOUNTING VIEW

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No.	MADE BY	CHECKED BY	DATE	DESCRIPTION
0	RDN		1/28/10	ISSUED FOR INFORMATION ONLY
1	RDN		2/1/10	REVISED WEIGHT DISTRIBUTION / EXPANSION
2	RDN		5/6/10	CHANGE REMOVABLE ENDPLATE / ADD LIVE LOADS

JOB No:	TFL5412
DRAWN BY:	RDN
CHECKED BY:	
APPROVED BY:	
DATE	1/05/10

FOUNDATION LOADING / THERMAL EXPANSION
"BIO-SCRU" DRYER MODULE
FOR
BOWLING GREEN MUNICIPAL UTILITIES

CUSTOMER: BGMU
PROJECT No: S07-653

Therma-Flite
The Screw Heat Exchange Company
P.O.Box 847
849 Jackson Street,
Benicia, CA 94510
Telephone: (707) 747-5949
Fax: (707) 747-5951

SHEET: 3 OF 3 DWG. No: TFL5412-10000 REV 2

D. IC 10,000 Bio-Solids Dryer

- Performance Specification: BSD-7400 BioScru IC 10,000 Dryer
- Therma-Flite IC 10,000 Spare Parts List
- Rotary Joint, Kadant Johnson, 4" 2800 ELSJ
    - 2800 ELSJARFYQ-HO 4" Rotary Joint Installation & Maintenance Manual
    - Kadant Johnson Drawing No.: AB10955RA
- Solid Lube Bearing, Dodge, 6", HY 700
    - Solid Lube Bearing Instruction Manual 3049-609
    - Dodge Drawing 034843
    - Product Data Sheet
- Roller Bearing, Fixed, Miether, SAF 22326
    - Miether Assembly, Lubrication & Maintenance Manual
    - Miether Sizing & Order Guide
- Biosolids Dryer Rotor Position Indicator
    - BEI Industrial Encoders, HS35F-100--SS Absolute Encoder Product Ordering & Data Sheet
- Temperature Indicator, Ashcroft, 30-EL-60-040-0/200F
    - Installations and Maintenance Instructions
    - Bimetal Thermometers Dimensions
    - Bimetal Thermometers Specifications
    - Thermowell Selection Sheet
- Thermal Oil Valve,Velan, Cast Carbon Gate Valve
- Solenoid Valve, ASCO, EF8210GO94MO
    - ASCO EF8210GO94MO Ordering Information
    - ASCO General Service Solenoid Valves Product Data
    - Installation & Maintenance Instructions
- Gearmotor, Nord SK 11382/52 AZ SH -132S/4
    - Nord Drawing SK11382/52A-132S/4
    - Dryer Rotor Gearmotor Ordering Guide
    - SK11382 Oil Fill Quantities
    - SK 11382/52 132S/4 Gearbox Dimensions
    - SK 11382/52 132S/4 Gearmotor Specifications
    - SK 11382/52 132S/4 Motor Dimensions
    - SK 11382/52 132S/4 Shrink Disc Specifications
- Material Seal Level Indicator, Bindicator, LP3-1-A-1-G-A-10-0
    - LP-30 Pulse Point Installation, Operation, & Maintenance Manual
- Thermocouple, Type K, Omega Engineering, NB1-CASS-14U-12
    - Omega Engineering Type K Thermocouple Reference Tables
- Pressure Transducer, Dwyer, 645-10
    - Dwyer 645 Series Specifications
    - Dwyer 645 Series Installation & Operating Instructions
    - Dwyer 645 Series Dimensions
- Pressure Indicator, Weksler, BA4CYPE4LW
    - Weksler 3.5" Industrial Gauge Specifications & Order Guide
- Nitrogen Flow Indicator, Dwyer, RMC-108-CPF
    - Dwyer RM Rate Master Flowmeter Installation & Operating Instructions

Performance Specification: BSD-7400 BioScru IC 10,000 Dryer

1-877-BIO-SLDS
P 707-747-5949
F 707-747-5951

TFL5412 PERFORMANCE SPECIFICATION

BSD-7400 BIOSCRU IC10000 DRYER

Capacity:

Evaporation Rate:	10,000 lb/hr H20

Thermal Fluid:

Flow Rate:	800 GPM
MFG / Type:	Paratherm-NF
Maximum Operating Temp:	535F

Power:

Qty 2:	
NORD Gear Motor / VFD Driven:	480V / 3PH / 11FLA
Model No:	SK11382/52AZSHG – 7.5HP – 1154.35:1 RATIO

Material of Construction:

Screw Rotor:	316SS
Housing (in contact w/ product):	316SS
Support Structures:	CARBON STEEL

Paint Specification:

NORD Gearmotor	MFG Standard
Bearings	MFG Standard
Rotary Joint:	MFG Standard
Support Structures:	Dimetcote9H/PSX892HS

Manufacture:

Designed and Manufactured by Therma-Flite, Inc.

Therma-Flite
The Screw Heat Exchanger Company

P.O. Box 847
849 Jackson St.
Benicia, CA 94510
P (707) 747-5949
F (707) 747-5951
www.therma-flite.com

TFL5412 SPARE PARTS LIST

Spare Parts List: Bowling Green IC 10,000

Start Up Materials:
Note: Materials Not Used During Start-Up, Such As Excess Thermal Heating Fluid, Are To Be Saved And Used As Required As A Two-Year Consumable Or Spare Parts.

- 1600 Gallons Thermal Heating Fluid
    - Fulton FT-1200-C Thermal Fluid Heater & Expansion Tank, 2 Rotors, Housing
- Shaft Rider Seal Replacement Packing Material
- Bearing Grease
- Rotary Joint
- Gasket Kit For Flanges And Covers

Two Year Consumables:

- Roll Of Packing For All Four (4) Shaft Rider Seals
- ~55 Gallons Of Thermal Heating Fluid
- Scrubber Nozzle
- Bearing Grease

Recommended Two Year Spare Parts:

- Roll Of Packing For All Shaft Rider Seals
- Bearing Grease
- Drive End Bearing
- Tail End Bearing
- End Plate Gasket
- Rotary Joint Rebuild Kit

Recommended Five Year Spare Parts:

- Gasket Kits – Whole Machine
    - Shaft Rider Seal Gaskets, Drive End & Tail End
- 1 Replacement Drive End Bearing & Tail End Bearing
- Nord Gearmotor
- Rotary Joints

Rotary Joint, Kadant Johnson, 5” 2950 ELS, M=4”, P=3”, S=3”

- Rotary Joint Installation & Maintenance Manual
- Kadant Johnson Drawing No. AB10779

KĀDANT
AN ACCENT ON INNOVATION

Installation and Maintenance Manual

ELSJ Rotary Joint

March 2010

Therma-Flite

Benicia, California

Kadant Johnson Inc., 805 Wood Street, Three Rivers, MI 49093 USA
269-278-1715 fax: 269-279-5980 www.kadant.com

General Guidelines for Using Rotary Joints Used with Thermal Oil

NOTE: Please follow your company's safety procedures whenever working on Kadant Johnson rotary joints and read all of the instructions completely before proceeding.

Please refer to the assembly drawings supplied with your Kadant Johnson rotary joint for part identification. If you have any questions, please contact your Representative or Kadant Johnson.

Rotary joints used with heat transfer oils require special attention during repair to ensure leak free operation.

Heat transfer oils tend to “coke” at high temperatures and deposit material which settles in the joint. Due to this, the joint should be disassembled and cleaned on a regular basis as noted in Table 1. Care must be exercised to prevent marring the sealing surfaces when cleaning. When ordering new replacement parts, always specify on your order “HOT OIL SERVICE” and indicate the maximum operating temperature.

Piping strains can force the joint out of alignment and result in leakage. Two pieces of flexible metal hose, installed perpendicular (90°) to each other, should be used at each inlet and outlet connection of the rotary joint. They should be properly supported so that piping loads are not applied directly to the joint. If a traveling loop is used, be sure to follow the recommendations of the hose manufacturer for length and proper installation, or contact Kadant Johnson.

PROCEDURES FOR STARTING NEW HOT OIL SYSTEMS

If the rotary joint begins leaking soon after its installation, disassemble and inspect the carbon seal rings for scratches or swirl marks on the flat or concave surface. These marks indicate particles are present in the oil and finer filtering mesh is required.

In order to ensure leak free service at start-up of new equipment, it is recommended that the circulating system be flushed and include a filter capable of retaining all metallic and non-metallic foreign material that may be present in the system as they can damage the seal face.

A means of filtration should be installed before each rotary joint. The filter should remove particles 40 – 60 microns or smaller in size. Pressure gauges should be mounted up and down stream of the filter to monitor the condition of the filter element.

STEP 1.
It is highly recommended to keep the system clean. All piping should be thoroughly cleaned during construction. Cover all open piping stubs and other ports so that construction debris does not contaminate system. Make sure system is free of welding slag, metallic particles and pipe sealers.

STEP 2.
Remove filter cartridges to accomodate the rinsing process.

STEP 3.
Bypass the rotary joint(s) so debris is not flushed into it.

STEP 4.
Flush roll(s) separately from rest of the system.

STEP 5.
Fill the system with a flushing solvent recommended by the manufacturer of the heat transfer fluid.

STEP 6.
Force the solvent through the system either by running the pump, by compressed air, or gravity flow. If possible, heat the flushing solvent. This will expand the piping allowing some additional debris left over from the welding to break free. Do not exceed the recommended temperature range of the flushing fluid.

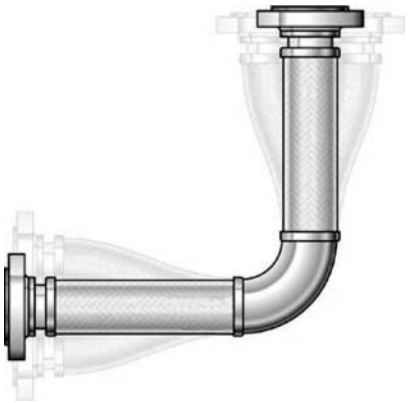
STEP 7.
Continue to rinse the system until the flushing solvent is clean.

STEP 8.
Drain all the flushing solvent from the system.

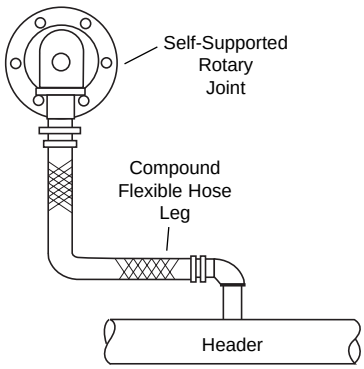
STEP 9.
Install the system filter cartridges.

STEP 10.
Install the Kadant Johnson rotary joint(s).

STEP 11.
Fill system with the heat transfer fluid.



Compound Hose



Flexible Metal Hose

STEP 12.
Run system according to the manufacturer's recommendations.

STEP 13.
Check system for leaks and repair as necessary.

It is very important to maintain a clean system. The major cause of premature rotary joint failure is debris in the system. If an older system is being used, it is important to keep the piping, rolls, and rotary joints clean while service is being performed. Adequate filters must be installed in all systems.

CARBON SEAL RING REPLACEMENT

Kadant Johnson recommends replacing the nipple, wear plate, seal ring, guides, and spring when rebuilding the joint. When ordering replacement parts, they must be specified for hot oil service. They will be factory lapped and no further lapping will be required.

When field repair is being performed, thoroughly clean all components. Replace any damaged or worn parts.

Since the carbon seal ring is being used to seal a very low viscosity fluid, the seal ring, nipple and wear plate must be properly lapped using the following guidelines.

To lap the spherical surface, mount the steel nipple tube in a lathe with its spherical collar facing toward the tailstock end of the machine. Apply a light coating of 250 to 350 grit lapping compound to the spherical surface (figure 1). Rotating the tube at 50–100 RPM, hold the carbon seal ring against the rotating collar (figure 2). Since the carbon will tend to dry out the lapping compound, thin the compound with mineral spirits or use water if it is a water-based lapping compound. The lapped surfaces will develop a dull matte finish when sufficiently lapped. The surface finish should be 20 Ra or less. Clean all lapping compound from sealing surfaces.

Using a lapping plate, lap the flat surface of the seal ring (figure 3) and wear plate (figure 4). These surfaces should be flat to three light bands or less with a polished appearance. The surface finish on both the wear plate and the seal ring needs to be 20 Ra or less.

If metal wear surfaces are scratched, pitted or otherwise damaged, Kadant Johnson recommends replacement of the damaged parts. CAUTION: Do not attempt to machine the surfaces, as it may change the safe working pressure rating of the product.

Recommended Cleaning and Inspection Schedule

Operating Temperature Hot Oil	Months
100° – 300°F (38° – 149°C)	12
301° – 450°F (150° – 232°C)	6
451° – 650°F (233° – 343°C)	3

Table 1

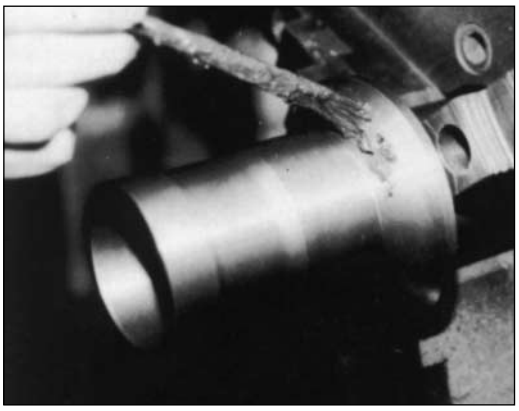


Figure 1

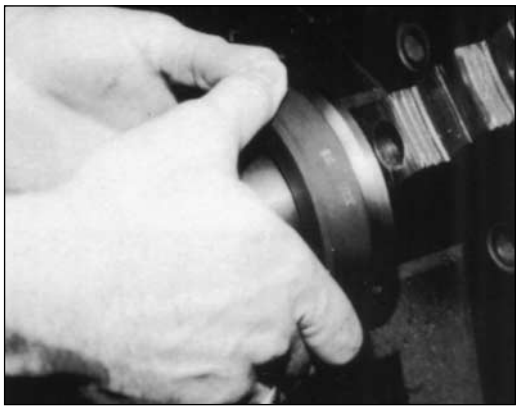


Figure 2

Figure 3

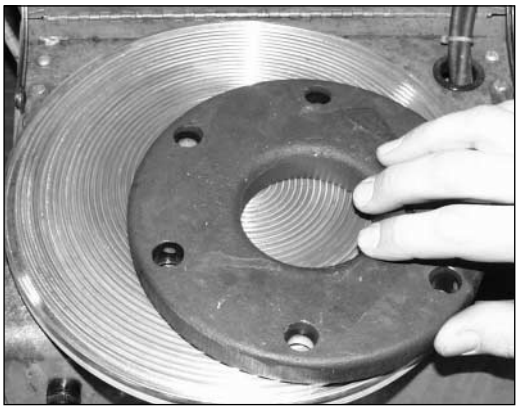


Figure 4

The Kadant Johnson Warranty

Kadant Johnson products are built to a high standard of quality. Performance is what you desire: that is what we provide. Kadant Johnson products are warranted against defects in materials and workmanship for a period of one year after date of shipment. It is expressly understood and agreed that the limit of Kadant Johnson's liability shall, at Kadant Johnson's sole option, be the repair or resupply of a like quantity of non-defective product.

KADANT JOHNSON
www.kadantjohnson.com

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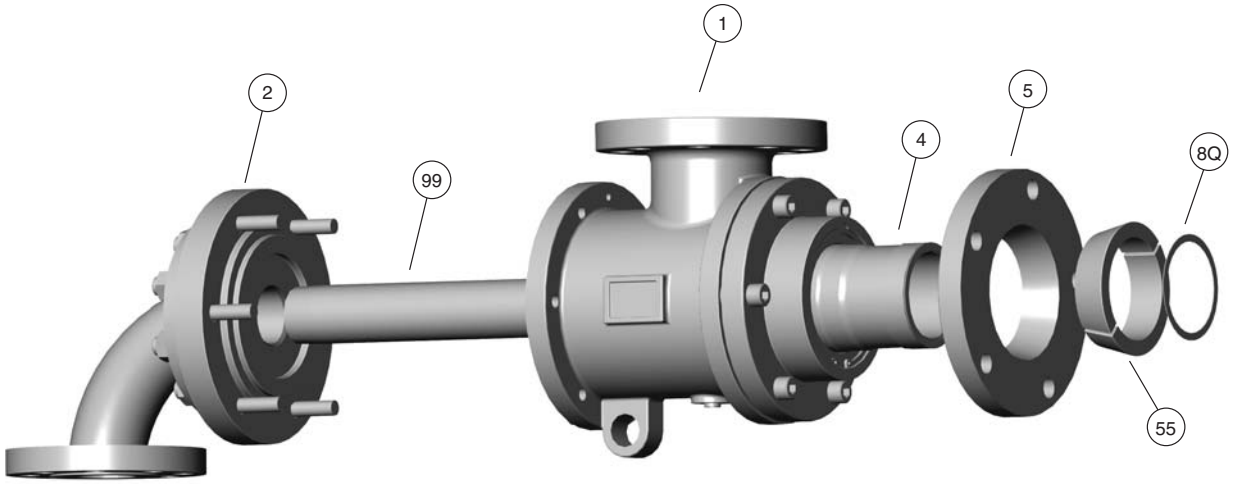
Installation Instructions for Type ELSJA Joints



Type ELSJARFQ

Please follow your company's safety procedures whenever working on Kadant Johnson Rotary Joints and read all of the instructions completely before proceeding.

Please refer to the assembly drawings supplied with your Kadant Johnson rotary joint for part identification. If you have further questions, please contact your representative or Kadant Johnson.

Tighten all fasteners in a star pattern. See joint assembly drawing for torque specifications.

STEP 1.
Check to make sure that all debris has been removed from the piping and roll before installing joint. This will eliminate seal ring scoring and damage to internal joint parts which could cause unnecessary downtime and maintenance.

STEP 2.
Thread horizontal pipe (99) into the rotary joint head (2).

NOTE: The horizontal pipe must be straight and true. This will prevent the pipe from breaking and excessive pipe wear.

STEP 3. For quick release style connections to your journal:

Place a new copper gasket (8Q) into the recess of the journal flange. Slide the quick release nipple flange (5) over the rotary joint nipple (4) with its taper facing outward. Place the two split taper wedges (55) into the recess of the nipple tube and slide the quick release flange over them to hold in place. Lift the joint up and slide the nipple (4) into the journal flange recess and secure to the studs with nuts provided, tightening evenly. Note that the quick release nipple flange (5) will not seat tightly against the face of the journal flange. When tight, there will be 1/8˝ to 3/16˝ (3 to 5 mm) space between the two flanges. Measure the gap to make sure it is even.

If the rotary joint has a threaded nipple (4) connection for attachment to your roll, simply thread it into the journal/flange.

STEP 4.
Connect piping to joint using Kadant Johnson flexible metal hose. The hose(s) should be long enough so there is no binding or tension that will move the joint off the journal centerline of the roll. The joint must be free to move outward to compensate for seal ring wear. See recommended minimum hose length chart in this instruction sheet – Table 2.

NOTE: Connect the hose as close to the joint as possible. Minimize the use of fittings and pipe, as this increased weight can affect the performance of the joint. Provide suitable support for the pipe and fitting beyond the hose.

STEP 5.
Install anti-rotation rod in the anti-rotation rod hole using Schedule 80 pipe. See assembly drawing for recommended sizes for anti-rotation rod. It is recommended that not more than two joints be joined with one anti-rotation rod. Secure the rod in the anti-rotation rod hole of one joint using cotter pins and let the rod float in the anti-rotation rod hole of the second joint. This will absorb the torque generated by the joint and prevent premature hose failure by reducing stresses.

NOTE: Never apply oil or grease to Kadant Johnson joints. The saturated steam, condensate, or liquid passing through it is the only lubrication required for the carbon-graphite parts.

NOTE: Minimize running Kadant Johnson joints dry. Excessive seal wear may occur.

PROCEDURE FOR DETERMINING SEAL RING WEAR

Check the rotary joint regularly to determine seal ring wear. Should the seal ring wear away completely, the metal nipple can wear into the joint body, and eventually through it. This will result in a significant leak and create a hazardous condition. Lack of attention may require replacement of the entire joint instead of just the seal ring. See Table 1 for allowable seal wear.

STEP 1.
Reference the shoulder that has been machined into the joint nipple.

STEP 2.
As the seal ring begins to wear, the joint automatically (due to pressure) moves away from the cylinder journal end.

STEP 3.
As this movement takes place, the shoulder on the joint's nipple begins to expose itself.

STEP 4.
See Table 1 and determine the seal wear allowable for your joint size.

STEP 5.
When the machined shoulder on the nipple is visible to the dimension in Step 4, the seal ring should be replaced.

TABLE 1

MAXIMUM SEAL RING WEAR

Joint Size	Seal Wear	
2″	5/16″	mm
2-1/2″	3/8″	10 mm
3″	7/16″	11 mm
3-1/2″	7/16″	11 mm
4″	9/16″	14 mm
5″	9/16″	14 mm
6″	7/16″	11 mm
7-1/2″	11/16″	18 mm
8″	13/16″	21 mm
10″	1″	25 mm
12″	1″	25 mm

TABLE 2

RECOMMENDED MINIMUM HOSE LENGTHS

Hose Size	Minimum Length	
1″	15″	380 mm
1-1/4″	18″	450 mm
1-1/2″	18″	450 mm
2″	21″	530 mm
2-1/2″	24″	610 mm
3″	27″	690 mm
4″	28″	700 mm
5″	30″	750 mm
6″	33″	850 mm
8″	36″	900 mm

Dimensions and specifications are for reference only and subject to change. Certified drawings are available on request. Please refer to Kadant Johnson Drawing Number A37640 for torque specifications.

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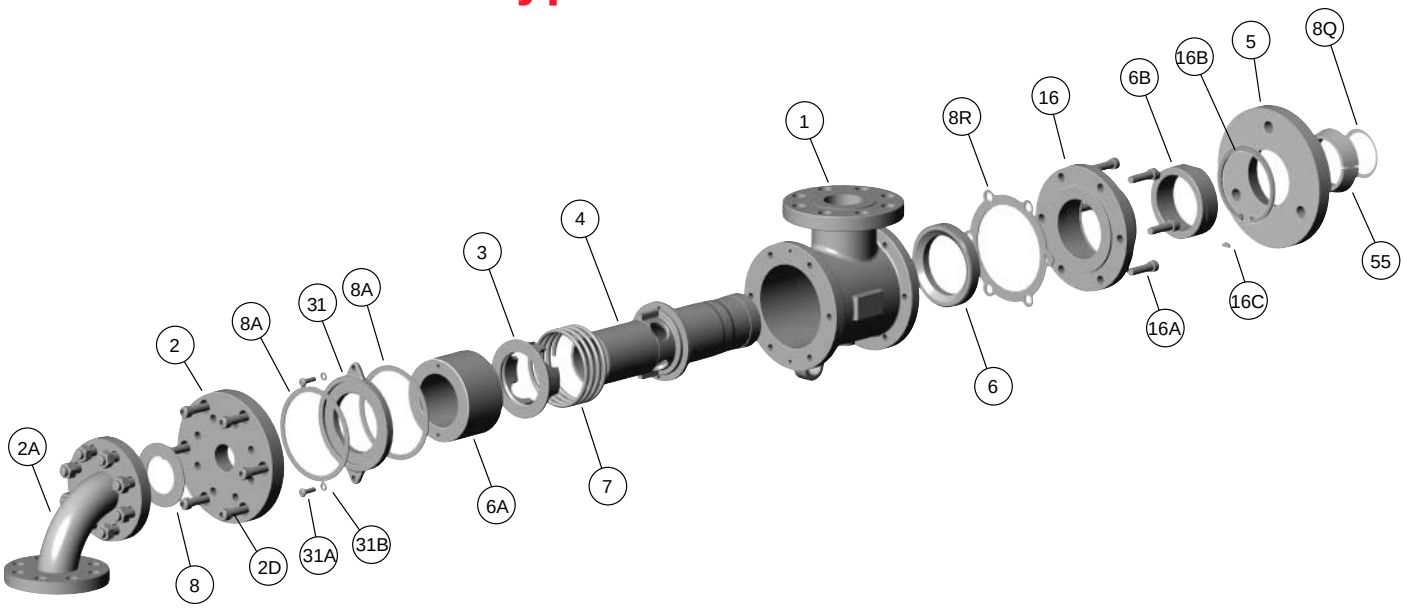
Disassembly and Repair of Type ELSJA Joints



Type ELSJARFQ

REPAIR KITS ARE AVAILABLE CONSISTING OF:

Item #	Qty	Description
6	1	Carbon Seal Ring
6A	1	Front Carbon Guide
6B	1	Rear Carbon Guide
8A	2	Ring Gasket
8R	1	Full Face Gasket
16B	1	Retaining Ring

NOTE: For applications using thermal oil, see “Special Instructions For Rebuilding Kadant Johnson Rotary Joints Used on Heat Transfer Oils”. This sheet offers additional information on seal ring, nipple and wear plate preparation (lapping) that is recommended for thermal oil service.

Please follow your company's safety procedures whenever working on Kadant Johnson Rotary Joints and read all of the instructions completely before proceeding.

Please refer to the assembly drawings supplied with your Kadant Johnson Rotary Joint for part identification. If you have further questions, please contact your Representative or Kadant Johnson.

REMOVAL:

STEP 1.
Close the inlet and outlet valves and allow the joint to cool. Disconnect piping from the joint, remove anti-rotation rod and restraining yoke (if used).

STEP 2.
Uncouple the nipple (4) from the journal flange. For threaded nipple joints, unscrew nipple from journal. For joints with quick release nipples, remove hex nuts from the studs at the nipple flange (5). Slide nipple flange away from journal to expose two split taper wedges (55). Remove wedges.

STEP 3.
Slide joint away from the machine to expose horizontal pipe. Using pipe wrench, unscrew the horizontal pipe from the joint head (2), and slide the joint off the pipe. A copper gasket (8Q), located in the journal adapter, should be removed and discarded. The joint is now ready to be serviced.

SERVICING THE JOINT:

STEP 4.
Remove head (2) by removing the bolts (2D).

STEP 5.
Loosen and remove the two round head screws (31A) freeing assembly plate (31). Caution: There may be spring tension behind the assembly plate.

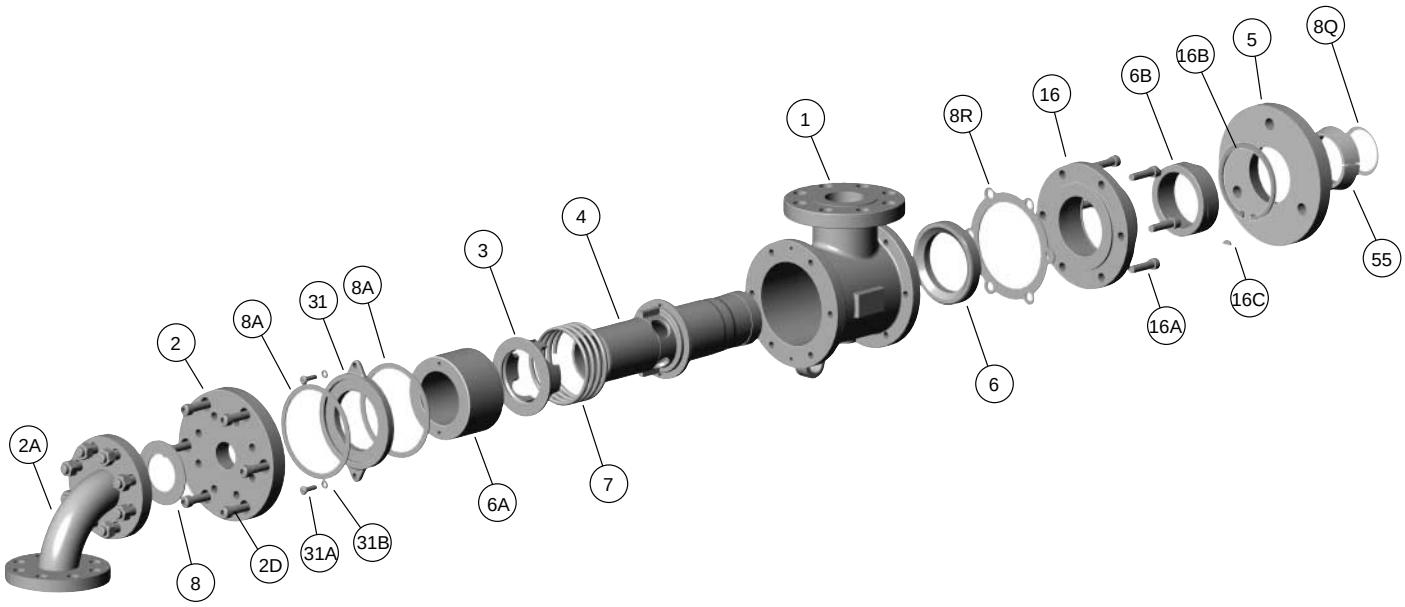
STEP 6.
Lift off the assembly plate and remove the remaining parts in the following order: front carbon guide (6A), nipple (4) with spring shoulder (3) and spring (7), and seal ring (6).

STEP 7.
Separate the wear plate (16) from the body (1) by removing the bolts (16A). Inspect the flat surface of the wear plate where the seal ring runs against it. If this surface is scratched or grooved, replace the wear plate. If the wear plate is in serviceable condition, replace the rear guide (6B) by removing the retainer ring (16B) freeing the rear carbon guide. If equipped with a woodruff key (16C), discard. This part is no longer required.

STEP 8.
Clean all gasket surfaces.

STEP 9.
Slide the spring shoulder (3) and spring (7) off the nipple (4).

STEP 10.
Inspect the nipple's sealing and bearing surfaces for scratches, grooves or pits. Inspect the drive keys. If there is deterioration in these areas, replace the nipple.



Type ELSJARFQ

STEP 11.
Install a new rear carbon guide (6B) into the wear plate (16). Install the retainer ring (16B) into the groove to secure the rear carbon guide. Install the wear plate onto the body (1) using a new gasket (8R). Secure wear plate with bolts (16A) using a star pattern for a tightening sequence. Please see Kadant Johnson Drawing A37640 for torque specifications.

STEP 12.
Turn the rotary joint housing upright and install a new carbon seal ring (6), flat side down, concave side facing outward. Caution: seal rings are hard but brittle. Please handle with care.

STEP 13.
Reinstall nipple (4) back into the body through the rear guide (6B), followed by the spring (7).

STEP 14.
Align the key on the nipple (4) with the key-way on the spring shoulder (3) and slide the spring shoulder onto the nipple.

STEP 15.
Set the front guide (6A) over the nipple next. The two pinholes should face outward.

STEP 16.
Set gasket (8A) on the end of the body.

STEP 17.
While aligning the two pins with the holes in the front guide, push down on the assembly plate and secure with the round head screws (31A) and lock washers (31B). Keys and keyways, pins and pinholes, should align. Reinstall head (2) with elbow (2A) attached with a new gasket (8A) and tighten bolts (2D) using a star pattern. Please see Kadant Johnson Drawing A37640 for torque specifications.

STEP 18.
Thread horizontal pipe into the joint head and tighten with a pipe wrench.

REINSTALLATION:

STEP 19.
Prior to installing the rotary joint on the machine, place a new metal gasket (8Q) into the recess of the journal.

STEP 20.
Reinstall 'Q' nipple flange (5) over nipple (4).

STEP 21.
Place the two tapered split wedges (55) into the recess of nipple (4) and secure by sliding the 'Q' nipple flange over the wedges.

STEP 22.
Slide the rotary joint into the recess of the journal flange and engage ‘Q' nipple flange (5) over the studs. Secure by evenly tightening the jam nuts.

Note that this flange will not fit tightly against the journal. There should be a space between the flanges. Make certain this gap is equal around the circumference of the ‘Q' nipple flange.

STEP 23.
Reconnect the piping and joint is now ready for service.

Dimensions are for reference only and subject to change. Certified drawings are available on request. Please refer to Kadant Johnson Drawing Number A37640 for torque specifications.

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Safety Instructions

CAUTION. Please read these instructions before installing, maintaining, or operating the rotary joint.

GENERAL PRECAUTIONS

Rotary joints contain fluids and vapors that can be at high pressure and high temperature. Installation, maintenance, or operation can cause injuries if the instructions provided with the equipment are not followed.

When installing, maintaining, or operating rotary joints, approved safety glasses with side shields and safety shoes should be worn to prevent injuries to eyes and feet.

When handling rotary joints that have been in service, gloves should be worn for protection against touching hot surfaces. Gloves also protect against cuts from machined or worn surfaces. Rubber gloves offer protection against contamination from heat transfer fluids.

Fluids (including lubricants) and vapors leaking from or contained in the rotary joint may be hot and harmful to the health of personnel. Do not touch or breathe any escaping fluid or vapor. Follow the available Material Safety Data Sheet recommendations for safe handling and disposal.

Rotary joints should not be operated until the appropriate pressure and temperature interlocks, guards, and other safety devices have been installed to protect the rotary joint, personnel, and the associated pressure equipment.

Before removing, disassembling, or loosening a rotary joint, check to be sure that the pressure has been properly vented from the pressure equipment to which it is attached.

Rotary joints contain mechanical spring forces when they are assembled. When disassembling a rotary joint for installation or maintenance, be sure that these forces are properly contained, following the instructions provided with the equipment.

EQUIPMENT HANDLING

Rotary joints can be very heavy, particularly when there are hoses, sight flow indicators, and other auxiliary equipment attached to them. Be sure that the rotary joint is properly and securely supported before loosing any mounting fittings.

Rotary joints are sealed with carbon or carbon graphite seal material. These seals can be broken if the rotary joint is dropped or experiences similar impact forces. If the seal ring is broken, leakage will occur when the unit is placed into service. The seal ring could fail completely, allowing a sudden and uncontrolled release of the contained fluid or vapor.

Rotary joints should be handled with care and stored where they will be not be subjected to impact forces.

Joints that have undergone questionable impacts should not be placed into service without the inspection by a qualified technician.

EQUIPMENT INSTALLATION

Rotary joints should be installed and maintained according to the installation and maintenance instructions supplied with the equipment.

The assembly and disassembly instructions provide step by step installation and maintenance instructions. If there are any questions, consult the Customer Service Representative of the manufacturer.

Rotary joints are connected to the supply and drainage piping through flexible (rubber or metal braided) hoses. If these hoses are not properly installed, leakage may occur either past the hose connections or through the seal faces of the rotary joint.

In most installations, two flexible hoses are required to insure that excessive forces are not applied to the rotary joint through thermal expansion, weight, or equipment movement. Follow the instructions supplied with the equipment for proper piping designs and guidelines for installation.

The weight of the external piping (hoses, headers, brackets, and braces) should not be applied to the rotary joint. This weight should be relieved by appropriate supports extending from external framing to these components.

Rotary joints have threaded and flanged fittings that correspond to industry standards. Connecting piping should use fittings of equal or higher ratings.

SAFETY DEVICES

Appropriate temperature and pressure safety devices should protect rotary joints that are installed in vapor and fluid systems.

These devices should be set to prevent the vapor or fluid from exceeding the temperature and pressure limitations of all components in the system, with the limitations being the lowest of any individual component.

When the rotary joint is installed on an operating machine, the installation of the appropriate interlocks, guards, and other safety devices is the responsibility of the user, the equipment installer, or the supplier of the machinery, as determined by the user.

In particular, the user or his contracted system provider, should incorporate safety devices into the system to prevent the pressure from exceeding the maximum allowable pressure indicated on the equipment.

Users are advised to use temperature sensors and associated safety interlocks for those cases in which the foreseen operating temperature will be close to the maximum allowable temperature of the equipment.

ADDITIONAL SAFETY INFORMATION

For information relating to Compliance with PUWER 98, see Kadant Johnson Supplementary Safety Information sheet IS-Supplementary Safety Info. This is available for free downloading from www.kadantjohnson.com.

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Flexible Hose Piping Recommendations For Rotary Joints

Follow your company's safety procedures whenever working on Kadant Johnson products. Read all of the instructions before proceeding with installation or repair.

Please refer to the Kadant Johnson assembly drawing for part identification. Assembly drawings are available on request from Kadant Johnson.

Lubricate all fasteners with anti-seize compound. Tighten all fasteners in a star pattern. Torque specifications are listed on the product assembly drawing and are available from Kadant Johnson.

The following sketches illustrate recommended flexible hose installation for rotary joints to minimize piping loads applied to the bearings of rotary joints which directly affect the life of wearing parts.

1. Flexible metal hose should be attached directly to the joint between fixed piping and rotary joint.
2. Piping must be supported independent of the rotary joint. Do not support piping with rotary joint.
3. Flexible hose is used to minimize piping loads due to thermal expansion of piping or process equipment. Also when equipment moves or vibration is present, the flexible hose absorbs this motion with minimal effect on rotary joint.
4. These arrangements are designed to minimize hydraulic forces on the joint.

EXAMPLES OF FLEXIBLE HOSE INSTALLATIONS

Figure 1 – the vertical piece of hose allows for header expansion and misalignment of header connection relative to rotary joint connection within normal piping tolerances. Also flexible hose tolerance in length is compensated for to a reasonable amount. The horizontal leg of flexible hose allows for thermal and hydraulic expansion of vertical hose leg without exerting large forces on joint.

Figure 2 – another method is shown to provide flexibility of hose length, piping and roll movement vertical or horizontal. Generally the hose must be longer than needed for Figure 1 due to the minimum bend radius allowable, which is dependent on size and material of hose and amount of equipment movement.

Figure 3 – illustrates another recommended method using a single piece of hose which requires sufficient hose length to stay within the minimum bend radius of the specified hose size and material.

Figure 4 – recommended dual-flow arrangements.

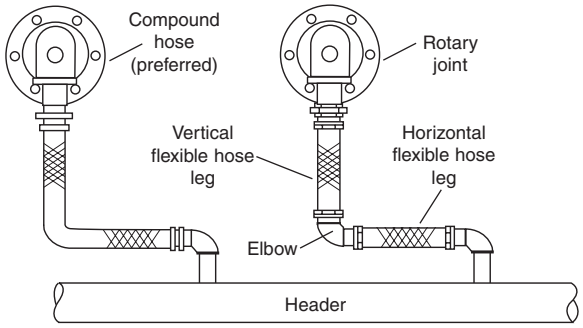


Figure 1

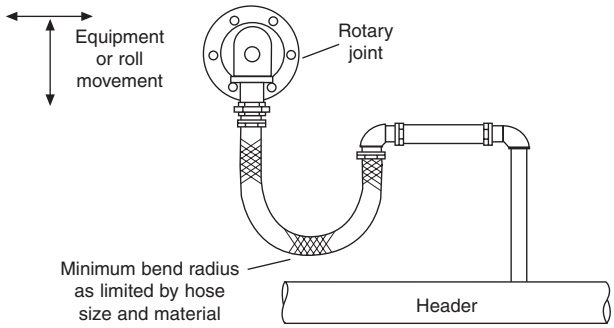


Figure 2

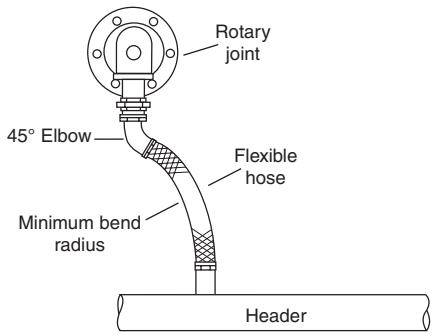


Figure 3

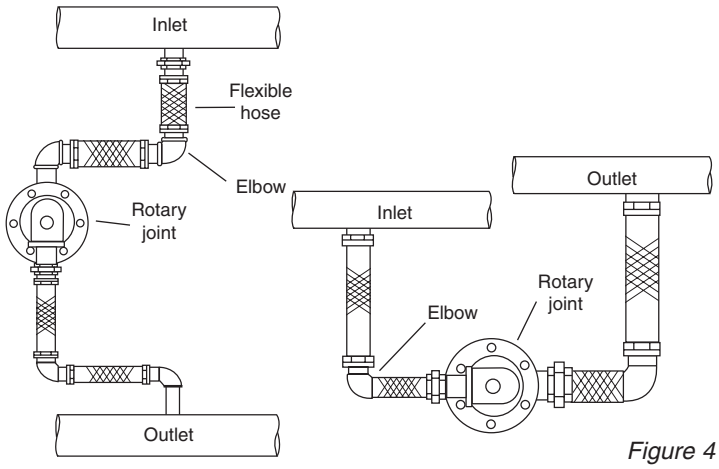
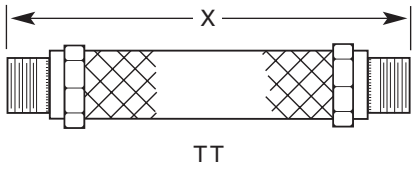


Figure 4

RECOMMENDED MINIMUM HOSE LENGTH

PIPE SIZE	MINIMUM LENGTH (X)	STATIC BEND	INTERMITTENT BEND	MAXIMUM OFFSET
1/4	8	0.87	5.5	1-15/16
3/8	10	1.12	5.5	1-7/8
1/2	10	1.50	6.0	1-1/2
3/4	12	2.12	8.0	15/16
1	15	2.75	9.0	1-5/8
1-1/4	18	3.25	10	2-1/8
1-1/2	18	3.75	12	1-15/16
2	21	5.00	15	2-1/8
2-1/2	22	7.00	14	2-7/16
3	24	8.25	17	2-9/16
4	28	11.0	22	2-15/16
5	30	11.0	28	2-1/2
6	33	16.5	33	2-5/8
8	36	21.5	43	2-7/16



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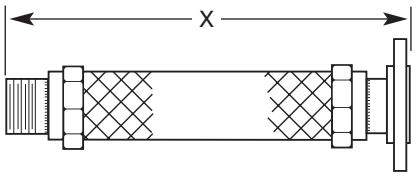

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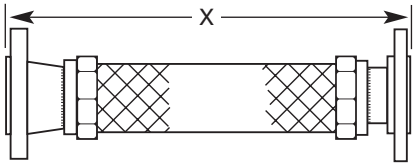

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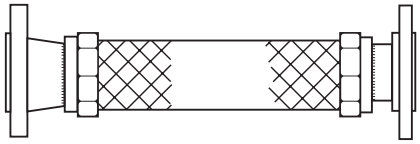
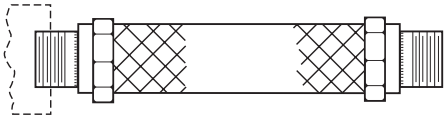


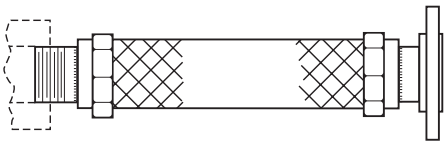
Fixed Flange One End
Lap Flange One End

Size	Maximum Pressure (psig) at:			
	400°F	500°F	600°F	650°F
1/2 x 12	150	150	150	150
3/4 x 12	150	150	150	150
1 x 15	150	150	150	150
1-1/4 x 18	150	150	150	150
1-1/2 x 18	150	150	150	150
2 x 21	150	150	150	150
2-1/2 x 22	150	150	150	150
3 x 24	150	150	150	150
4 x 28	150	150	150	150
5 x 30	150	150	150	150
6 x 33	150	150	150	150
8 x 36	150	140	135	130



Threaded Both Ends

Size	Maximum Pressure (psig) at:			
	400°F	500°F	600°F	650°F
1/4 x 12	625	600	575	560
3/8 x 12	550	525	505	490
1/2 x 12	575	550	525	510
3/4 x 12	495	465	440	430
1 x 15	440	420	405	390
1-1/4 x 18	370	350	330	320
1-1/2 x 18	340	320	300	295
2 x 21	335	325	310	300
2-1/2 x 22	330	315	305	295
3 x 24	270	255	240	235
4 x 28	190	175	170	165
5 x 30	220	205	195	190
6 x 33	195	185	175	170
8 x 36	150	140	135	130



Threaded One End
Lap Flange One End

Size	Maximum Pressure (psig) at:			
	400°F	500°F	600°F	650°F
1/2 x 12	150	150	150	150
3/4 x 12	150	150	150	150
1 x 15	150	150	150	150
1-1/4 x 18	150	150	150	150
1-1/2 x 18	150	150	150	150
2 x 21	150	150	150	150
2-1/2 x 22	150	150	150	150
3 x 24	150	150	150	150
4 x 28	150	150	150	150
5 x 30	150	150	150	150
6 x 33	150	150	150	150
8 x 36	150	140	135	130

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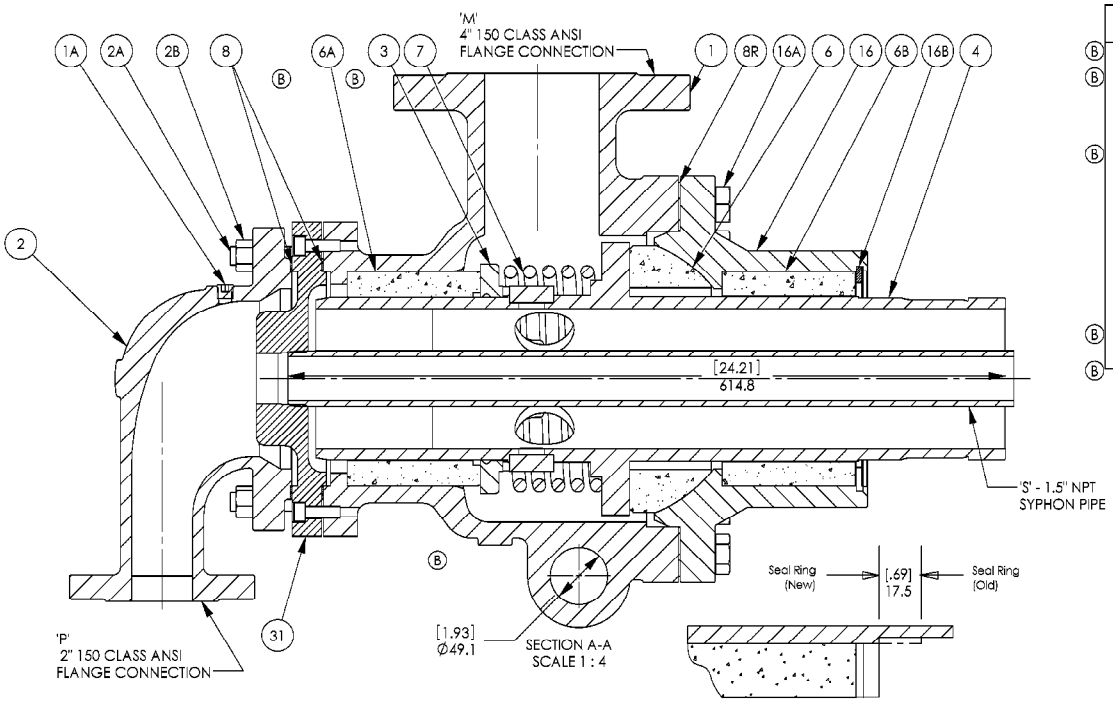
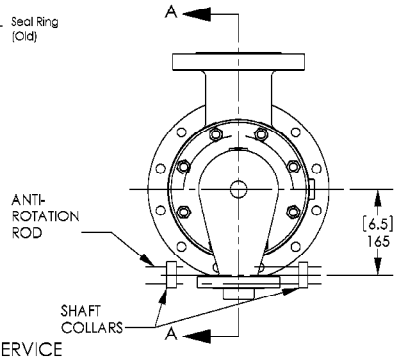
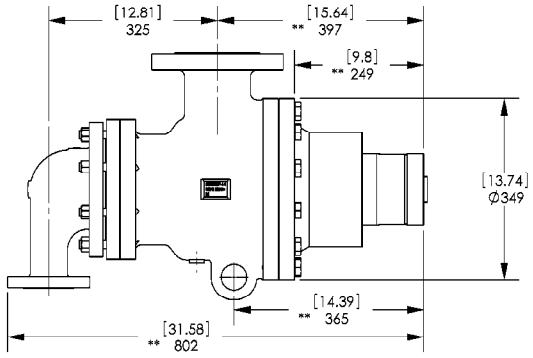
Kadant Johnson Drawing No.: AB10779







PARTS LIST

	ITEM NO.	NO. REQ'D	DESCRIPTION	PART NO.	MATERIAL	REMARKS
(B)	1	1	BODY	SNR2951NF-4-2	DUCTILE IRON	
(B)	1A	1	PIPE PLUG	CSP660-0025-01	STEEL	¼" NPT
	2	1	HEAD	SNR2952NAF-2-1	DUCTILE IRON	
	2A	8	STUD	M16 X 2 X 80	STEEL-ISO 898-1,8.8	STUD OAL 100
	2B	8	NUT	HEX M16	STEEL	
(B)	3	1	SPRING SHOULDER	SNR-29581	DUCTILE IRON	
	4	1	NIPPLE ASSEMBLY	SNR2954Q2-1	DUCTILE IRON	
	6	1	SEAL RING	SNR-2956R-AI	ANTIMONY	
	6A	1	GUIDE	SNR29510	CARB.GRAPH	
	6B	1	GUIDE	SNR29510-1	CARB.GRAPH	
	7	1	SPRING	SJ-957-HS7	STL.STN.	HEAVY 17-7PH
	8	2	GASKET	SJ758	NON-ASBESTOS	
	8R	1	GASKET	SNR2958R	NON-ASBESTOS	PER ORDER
	16	1	WEAR PLATE	SNR29516-1	DUCTILE IRON	
	16A	12	CAP SCREWS	HHS M20 X 60	STEEL-ISO 898-1,8.8	HEX HEAD
	16B	1	RETAINING RINGS	CSF231-0725-01	CARBON STEEL	
(B)	31	1	ASSEMBLY PLATE	SNR29531-1	DUCTILE IRON	
(B)	31A	2	S.H.C.S.	M10 X 1.5 X 30mm LG.	STEEL	

NOTES:
1. Plating Requirements: Plated per Spec. A97-PL-1629-01 For Steam and Water
2. Maximum Operating Pressure 20 BAR [300PSIG] (B)
   Maximum Operating Temperature 260°C [500°F]
3. Torque Items 16A to 136 N-M [100 FT-LBS], torque 2A to 81 N-M [60 FT-LBS]
   Lubricate all fasteners during installation
4. Maximum Seal Ring Wear 17.5mm[.69]
5. TORQUE RODS – See A97-16-2-24 for torque rod size. Attach with (2) shaft collars, one on each side of lug on one joint, extend rod to an adjacent joint or anchor point. Note: Do not connect more than two joints to one stop rod.
6. PIPING – Flexible Metal Hose must be of sufficient length to allow for movement of the Rotary Joint due to seal ring wear and thermal expansion. Hose must be connected directly to the Joint with suitable support provided for the piping beyond the hose. Hose must not be in compression, tension or offset when installed.
7. When ordering spare parts or complete Joint assemblies, specify 'M', 'P', 'S', and Plating Construction required. Refer to this drawing number and symbol number.
8. Consult factory for service conditions exceeding those specified above.
9. For increased joint life it is recommended that 'M' & 'P' connections be 180° apart.
10. All dimensions +/- 3mm [.12] unless specified.
11. ** Dimensions will increase a maximum of 17.5mm [.69] due to seal ring wear.

STEAM AND WATER SERVICE

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Permissible deviations on untoleranced machining dimensions as below

ISO 2768-m

Dimensions in		Tolerance in	
mm	[inch]	± mm	±[inch]
Up to 6	0.24	0.1	0.004
6-30	0.24-1.18	0.2	0.008
30-120	1.18-4.72	0.3	0.012
120-400	4.72-15.75	0.5	0.02
400-1000	15.75-39.37	0.8	0.03
1000-2000	39.37-78.75	1.2	0.05
2000-4000	78.75-157.5	2	0.08

PATTERN NO: .
REFERENCE DRAWING: .
TREATMENT: A97-PL-1629-01
ANGULAR TOLERANCE: ±0°30'
LOCATION: 111
REQ. NO: US092008-50
MATERIAL: SEE B.O.M. :US/CA
. :NL
. :CN
. :BR
DEBURR: .
DRAWN BY: EFS
CHECKED BY: FPD
DATE: OCT-7-2008
PROJECTION:
TITLE: ASSEMBLY AND PARTS LIST
5" 2950ELS
CLASS 150 ANSI FLGD. M & P, S= 1.5" PIPE

KADANT JOHNSON

SYMBOL NO: 2950ELSJARFYQ
SCALE: 1:4
PAGE: 1 OF: 1
DRAWING NO: AB10779
REV: B

V1.2

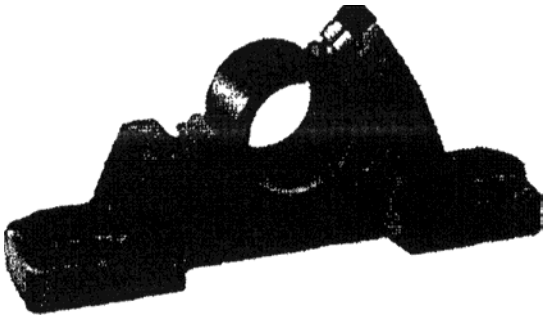
Solid Lube Bearing, Dodge, 8”, HY 700

- Solid Lube Bearing Instruction Manual 3049-609
- Dodge Drawing 034835
- Product Data Sheet

INSTRUCTION MANUAL

for

DODGE® SOLIDLUBE® BEARINGS



CAUTION
Do not lubricate bearings or shaft. Oil or grease is detrimental to the life of Solidlube bearings.

Installation and Operation

Solid Film Lubrication:
Solid film lubricating bearing material will transfer a film or coating of lubricant to the shaft as the shaft rotates. This film or coating prevents metal to metal contact between the shaft and bearing material, as the shaft actually rides upon the lubricant and not upon the bearing itself. Because it is a solid, the lubricant will not squeeze out when the shaft is not rotating. The bearing will not need additional lubrication since the solid lubricant is impregnated into the bushing material and is transferred or "worn" onto the rotating shaft at a rate determined by the rubbing speed of one material to the other and the imposed load. Since this is a "wear type" bushing, wear will be experienced under normal operating conditions.

Installation:
Shaft Preparation: The bearing journal should not be exposed to grease, oils or dirt to insure good life of the bearing. NO OIL OR GREASE SHOULD BE USED ON THE BUSHING OR SHAFT WHEN ASSEMBLING THIS BEARING. The shaft should be clean and free of burrs and nicks. The shaft should be held to a minimum amount of taper and as little eccentricity as possible so a uniformly distributed rubbing surface can be maintained. For best results, the shaft finish should be held to 10 to 20 micro-inches and hardness should be 35 Baldor Electric Company "C" or higher. Shaft tolerance should be +.0001-.002 for commercial steel shafting.

NOTE: The 1000 Series bushings may have a white film in the bore which should be wiped off with a clean cloth before assembly.

Installation of LT & LTB Pillow Block Assembly:

1. Slide the assembled pillow block on the shaft.
2. Align the pillow block on the shaft and tighten the hold-down bolts. Shim the pillow block base if necessary.

NOTE: Inner unit assemblies are installed properly at the factory. For added service the bearing inner unit may be rotated 180º while on the shaft to utilize a new bearing surface. **Caution:** Units should not be rotated 180º with the stop-pin in place, as this may restrict self-aligning capabilities.

Installation of MM & HY Pillow Block Assemblies:

1. Loosen the cap bolts being careful not to lose housing shims.
2. Slide the assembled pillow block on the shaft and position for mounting.
3. Insert hold-down bolts but do not tighten.
4. Align the bearing with the shaft using shims when necessary and tighten hold-down bolts.
5. Rotate shaft to allow the inner unit to align itself in the outer housing and tighten the bearing cap bolts.

NOTE: Inner unit assemblies are installed properly at the factory. For added service the bearing inner unit may be rotated 180º while on the shaft to utilize a new bearing surface. **Caution:** Units should not be rotated 180º with the stop-pin in place, as this may restrict self-aligning capabilities.

WARNING: Because of the possible danger to person(s) or property from accidents which may result from the improper use of products, it is important that correct procedures be followed: Products must be used in accordance with the engineering information specified in the catalog. Proper installation, maintenance and operation procedures must be observed. The instructions in the instruction manuals must be followed. Inspections should be made as necessary to assure safe operation under prevailing conditions. Proper guards and other suitable safety devices or procedures as may be desirable or as may be specified in safety codes should be provided, and are neither provided by Baldor Electric Company nor are the responsibility of Baldor Electric Company. This unit and its associated equipment must be installed, adjusted and maintained by qualified personnel who are familiar with the construction and operation of all equipment in the system and the potential hazards

involved. When risk to persons or property may be involved, a holding device must be an integral part of the driven equipment beyond the speed reducer output shaft.

Thrust Loads:

Shaft locating collars may be used for slight amounts of thrust loads only. Total collar to bearing clearance should be .010 to .020 inches or .005 to .010 inches per collar.

Running In:

To improve life expectancy from this type of bearing, a brief run-in or break-in can be performed. This may not be possible, but to obtain optimal service, it is advisable to break-in this type of bearing. The break-in should be run with a bearing mounted on its mating shaft as in service with all possible loading removed. The break-in period will build up the solid film of lubricant on the shaft to reduce potential start-up damage to the bushing.

Shaft Corrosion:

When commercial steel shafting is exposed to corrosive media, the shaft will oxidize (rust), pit, etc. The SOLIDLUBE bushing is chemically inert, but a rusty shaft will grow into the SOLIDLUBE bushing, thus eliminating clearances and restricting movement. Corrective action is to use corrosive resistant shafting such as stainless steel and/or to provide for regularly scheduled movement of the shaft.

Special Operating Conditions:

Consult factory for application assistance. Refer acid, chemical, extreme or other special conditions to Baldor Electric Company – Dodge Company. The SOLIDLUBE bearing has a high coefficient of friction which can result in stalling when many bearings run off the same drive system. Please consult Baldor Electric Company for further information.

HOLD DOWN BOLTS

Bolt Size (Inch)	Grade 2 Dry Torque (In-Lb)	Pillow Block Shaft Size (Inch)	Four Bolt Flange Shaft Size (Inch)	Two Bolt Flange Shaft Size (Inch)
3/8–16	240	3/4, 7/8, 15/16, 1	3/4	3/4
7/16–14	384	–	7/8, 15/16, 1, 1 1/8, 1 3/16	7/8, 15/16, 1, 1 1/8, 1 3/16
1/2–13	600	1 1/8, 1 3/16, 1 1/4, 1 3/8, 1 7/16, 1 1/2, 1 11/16, 1 3/4	1 1/4, 1 3/8, 1 7/16, 1 1/2, 1 11/16, 1 3/4, 1 15/16, 2	1 1/4, 1 3/8, 1 7/16, 1 1/2, 1 11/16, 1 3/4, 1 15/16, 2
5/8–11	1200	1 15/16, 2, 2 3/16, 2 7/16, 2 1/2, 3 7/16*, 3 1/2*	2 3/16, 2 7/16, 2 1/2, 3 7/16*, 3 1/2*	
3/4–10	2100	3 15/16*, 4*, 4 15/16*, 5*	2 15/16, 3, 3 15/16*, 4*	
7/8–9	2040	2 15/16, 3, 4 7/16*, 4 1/2*	4 7/16*, 4 1/2*	
1–8	3000	–	4 15/16*, 5*	

* BEARINGS WITH SPLIT HOUSINGS

HOLD DOWN BOLTS

Bolt Size (mm)	Grade 2 Dry Torque (N-m)	Pillow Block Shaft Size (mm)	Four Bolt Flange Shaft Size (mm)	Two Bolt Flange Shaft Size (mm)
10	29	20, 25	20, 25, 30	20, 25, 30
12	50	30, 35, 40, 45	35, 40, 45, 50	35, 40, 45, 50
16	124	50, 60	60	
18	175	–	70, 75	
22	322	70, 75		

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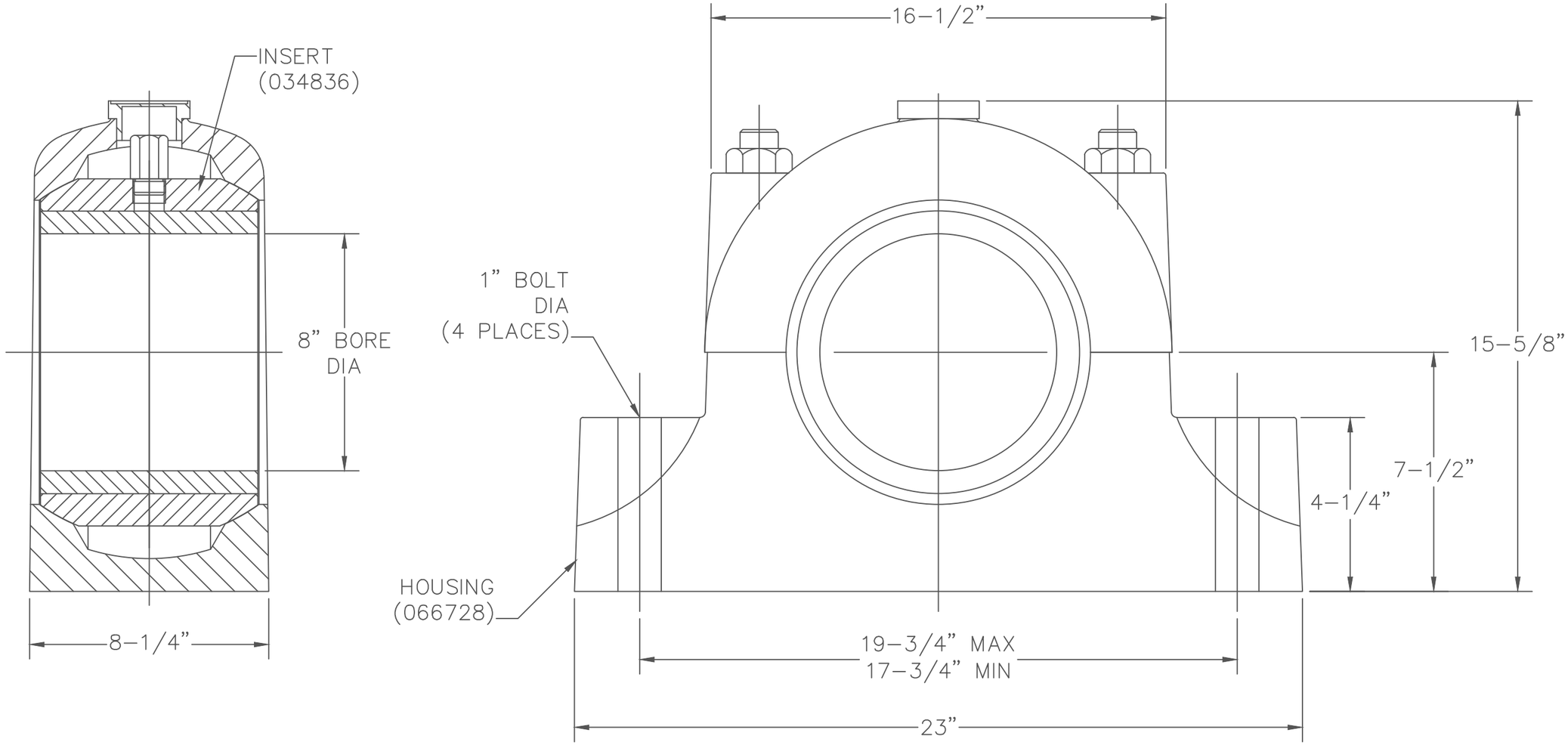
04/07 3C-K IM499954

This material is not intended to provide operational instructions. Appropriate instruction manuals and precautions should be studied prior to installation, operation or maintenance of equipment.

Dodge Drawing 034835



8" SOLIDLUBE HY700 PILLOW BLOCK

APPROVAL

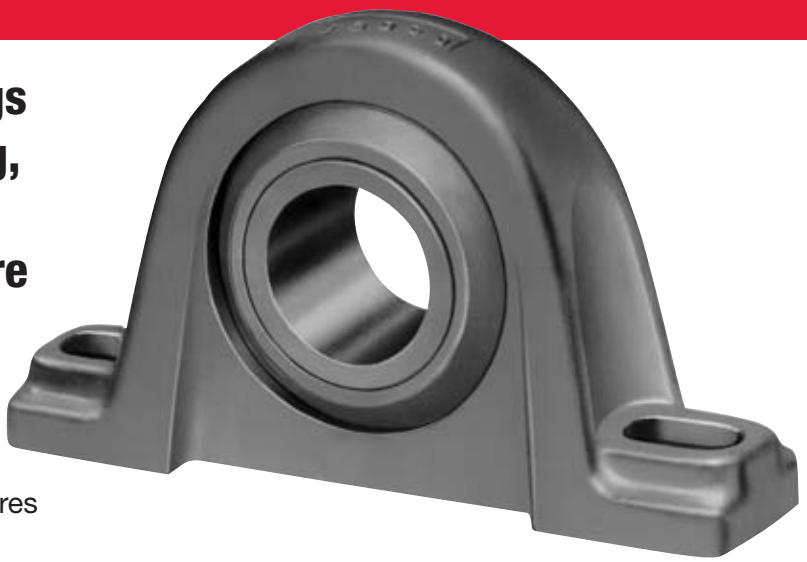
ORDER NO. ORDER# CUSTOMER ORDER NO. CUST#	APPROVED BY _APPRDBY_ DATE _DATEAPPR'D_	DIST. DIST1 DIST2
BALDOR · DODGE	DR. BY _DRWNBY DATE DWGDATE_ CK. BY _CHKBY_ APPD. BY_DWGAPP	DRAWING NO. DWG#

Dodge Solid Lube Bearing Product Data Sheet

SOLIDLUBE

BEARINGS

SOLIDLUBE sleeve bearings are statically self-aligning, non-galling, solid-film lubricating for temperature extremes.



First in the field and second to none, DODGE SOLIDLUBE is the bearing that works where others won't. In temperatures ranging from -200°F to +1000°F...under water...vacuum environments...corrosive atmospheres liquids...slow speed and limited shaft movement applications — wherever lubrication is critical.

Two series cover a wide range of temperature extremes:

700 Series: -40°F to 700°F

1000 Series: -200°F to -40°F; 250°F to 1000°F

Notes: Overlap of 250°F to 700°F – The 700 Series is less expensive but the 1000 Series will give better bearing life on a continuous 24 hour/day application. The 1000 Series should not be used in "wet" environments or in the temperature range of -40°F to 250°F.

The 700 Series and 1000 Series SOLIDLUBE Bearings are not to be used above 700°F and 1000°F respectively.

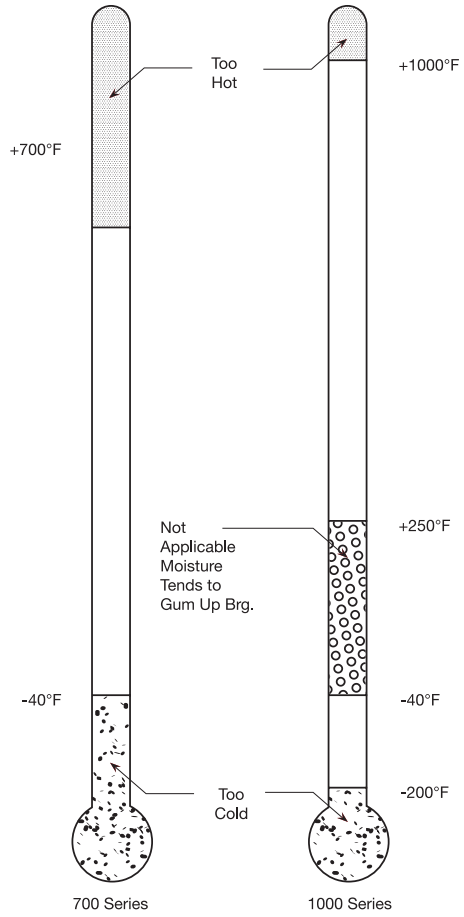
Self-Lubricated:

- Lubrication is provided from the bearing's own solid sleeve material and requires no additional lubrication of any type

Note: Oils and greases are detrimental to the life of the bushings and should not be used.

Self-Aligning:

- Ball and socket arrangement between the housing I.D. and the O.D. of the bearing insert provides self-alignment
- Anti-rotation pin locks the insert in place
- Bearing is self aligning up to ±2°



SOLIDLUBE Bearing Operating Temperature

BALDOR®

HOUSING CONFIGURATIONS:

- Pillow Blocks
- 4-Bolt Flange Units
- 2-Bolt Flange Units
- Take-Up Units
- Wide Slot Take-Up Units
- Cylindrical Units
- Hanger Units
- Screw Conveyor Hanger Units

SOLIDLUBE HOUSINGS:

- **LT**
  - Uses “SC” Housing
  - Housings are interchangeable with all SC housings except that the 1-1/2” SOLIDLUBE unit is used in SC housings intended for the 1-7/16” SC inner unit**.**
- **LTB**
  - Uses “SCB” Housing
  - Shaft height (“M” dimension) or backing height is approximately 1/16” less than the LT series (Check SOLIDLUBE and SCB “M” dimensions columns in our Bearing Catalog.)
- **MM**
  - Uses “Type K” Housing
  - Type K housings accept SOLIDLUBE units with bore sizes 1” less than the bore of the Type K roller bearing unit used in the Type K housings (To verify, use the “S” dimension in the Bearing Catalog for MM SOLIDLUBE bearing units and compare with the spherical dimension “K” in the Bearing Catalog for Type K roller bearing units.)
- **HY**
  - Uses “Type C/Special Duty” Housing
  - Special, all sizes are made-to-order.

Note: Stock ball bearing and roller bearing housings are used, but housings are not interchangeable bore size to bore size.

LM800 for Limited Shaft Movement:

The LM800 SOLIDLUBE bearing is designed specifically for limited movement applications.

- Available in pillow blocks and flange bearings
- Bore sizes of ¾”, 1”, 1-1/4” and 1-1/2”
- Temperature range of -40° to 800°F

700 and 1000 Series – Inch
Radial Load Ratings (Normal Loads)

Shaft Size	Radial Load Ratings in Pounds at various Revolutions per Minute																								
	Up to 10	25	50	75	100	150	200	250	300	350	400	450	500	550	600	700	800	900	1000	1100	1300	1600	1900	2200	2500
3/4"	560	560	560	560	560	380	285	230	190	165	145	125	110	105	96	82	72	64	57	52	44	35	30	26	22
7/8", 15/16", 1"	750	750	750	750	610	405	315	245	205	175	155	130	120	110	105	90	80	70	60	54	47	38	32	..	..
1-1/8", 1-3/16"	1050	1050	1050	908	680	450	340	270	225	190	170	150	135	125	115	97	85	75	68	62	42	42	..	..	..
1-1/4", 1-3/8", 1-7/16", 1-1/2"	1610	1610	1610	1140	855	570	430	340	280	245	215	190	170	155	145	120	105	95	86	78	66	..	..	..	..
1-11/16", 1-3/4"	1980	1980	1790	1190	895	595	440	390	295	255	220	200	180	165	150	130	110	99	89	81	..	..	..	..	..
1-15/16", 2"	2360	2360	1860	1240	930 .	620	465	370	310	265	235	205	185	170	155	135	115	105	..	..	..	..	..	..	..
2-3/16"	2870	2870	2010	1340	1000	670	500	400	335	285	250	225	200	180	165	145	125	..	..	..	..	..	..	..	..
2-7/16", 2-1/2"	3760	3760	2360	1580	1180	795	590	475	390	340	295	265	235	215	195	170	..	..	..	..	..	..	..	..	..
2-15/16", 3"	5970	5970	3120	2070	1560	1040	780	625	515	445	390	345	345	315	290	..	..	..	..	..	..	..	..	..	..
3-7/16", 3-1/2"	9100	8010	4000	2670	2000	1340	1000	800	670	570	500	445	400	365	..	..	..	..	..	..	..	..	..	..	..
3-15/16", 4"	11800	9160	4590	3060	2290	1530	1150	930	765	665	575	510	..	..	..	..	..	..	..	..	..	..	..	..	..
4-7/16", 4-1/2"	15200	10300	5150	3440	2580	1720	1290	1030	860	740	645	..	..	..	..	..	..	..	..	..	..	..	..	..	..
4-15/16", 5"	18400	11400	5710	3810	2860	1910	1430	1140	955	815	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..

NOTE: If housing and shaft temperatures differ more than 200°, consult factory for special clearances.
The above ratings apply to all base loaded pillow blocks. all cylindrical units and flange bearings (up to 700°F), For flange bearings operating at temperatures above 700°F, or cap and side loading of pillow blocks, consult Application Engineering. For operation speeds below heavy line, use LT1000 and/or hardened shaft.

THRUST LOAD RATINGS:

Shaft locating collars may be used for slight amounts of thrust only. Generally, 10% of the radial load applies.

700 and 1000 Series - Inch
Radial Load Ratings in Pounds
(Limited Shaft Movement Applications)

Bearing Size	Maximum Radial Load		Maximum Thrust Load (lbs)
	Base Load (lbs)	Cap or Side Load (lbs)	
3/4"	1100	775	56
7/8", 15/16", 1"	1500	795	75
1-1/8", 1-3/16"	2100	820	105
1-1/4", 1-3/8", 1-7/16", 1-1/2"	3200	1710	161
1-11/16", 1-3/4"	4000	1905	198
1-15/16", 2"	4700	1920	236
2-3/16"	5700	1900	287
2-7/16", 2-1/2"	7500	2360	376
2-15/16", 3"	12000	4151	597

Note: Use these load ratings only where:
- Shaft movement is limited to approximately ±90°
- Shaft movement is infrequent as opposed to continuous
- Maximum Bearing temperature is 700°F
- Maximum cap load is limited by the pillow block housing capacity.

LM800
Radial Load Ratings

Bearing Size	Maximum Radial Load	
	Base Load (lbs)	Cap Load (lbs)
3/4"	560	560
1"	750	600
1-1/4"	1610	600
1-1/2"	1610	600

Note: These load ratings are to be used only when shaft rotation is less than 10 RPM and temperature does not exceed 800°F. Maximum allowable thrust load is 50 lbs.

BORE SIZES:

- **Bore Size Range:**
  - LT 3/4” to 3”
  - MM 3-7/16” to 5”
  - HY Over 5”
- **Special Bore Sizes:**
  - Special bores can be provided, but special bores are much higher in cost than stock bores with delivery of 14-16 weeks. This delivery time also applies to replacement situations involving small quantities of special bore sizes.

BUSHINGS:

- **Bushing Material:**
  - Bushing material is a carbon graphite material (700 Series bushing material has been rated as “exempt” by the FDA)
  - Special carbon graphite compounds can be formulated for special applications
  - Alternate materials such as bronze, polymers, fibers, etc. can be supplied on a special order basis
- **Noise or High Pitched Squeal:**
  - Carbon-graphite bushings can develop a high frequency vibration in resonance with the operating system to cause noise. Dampening or change of resonant frequency of the shaft is required to eliminate noise.
- **Corrosion on shaft:**
  - When commercial steel shafting is exposed to corrosive media, the shaft will oxidize (rust), pit, etc. The SOLIDLUBE bushing is chemically inert, but a rusty shaft will grow into it thus eliminating clearances and restricting movement. Corrective action is to use corrosive resistant shafting such as stainless steel and/or to provide for regularly scheduled axial movement of the shaft.
- **Vacuum Applications:**
  - Carbon-graphite bushings have only traces of gas. The degassing rate of the bushings is better than cast iron, and thus the bushings will function in a vacuum.

SHAFTING:

- **Shaft Hardness:**
  - Softer shafting will tend to reduce bearing life and may experience wear itself.
  - Commercial steel shafting may be used for temperatures not exceeding 700°.
  - For extended bearing life at any temperature, the shaft should have a hardness of 35 Rockwell “C” or higher.
- **Shaft Finish:**
  - 10 to 20 micro-inches is recommended.
  - A finish rougher than 20 micro-inches will lessen bushing life.
  - A finish smoother than 10 micro-inches will not allow the optimum lubricant film to develop.

SHAFTING (cont.)

- **Shaft Expansion vs. Bearing Expansion:**

  – The bushing, after being installed in the inner housing, is in a compressed state and will expand at the same rate as cast iron. Some types of stainless steel expand twice as fast as cast iron. The user must be aware of this and design the shaft diameter accordingly. This is even more important when the bearing housing and shaft temperatures differ more than 200°F. DODGE provides extra clearances in the bearings to make up for the difference in expansion. However, care should be taken not to use up more than 50% of the clearance allowed.

- **Shaft Materials for Elevated Temperatures:**

  – Stainless Steel: Grades such as 17-4,15-5 and 13-8 are hardenable.
  – Hard Chrome Coating: Shafts can be spray coated with hard chrome. This should be satisfactory up to 800°F.
  – Ceramic Coating: Ceramic can be sprayed on and will form an excellent coating.
  – High Grade, Specialty Steels: Many of these materials are good in excess of 1000°F. In many applications a cost savings can be obtained by fitting sleeves of these materials on more economical shafting.

  Note: Customers should check with their supplier, especially with hard chrome and ceramic, since these can flake off when the coefficient of thermal expansion of the base material differs greatly from that of the coating.

SOLIDLUBE Bearing Corrosion (Chemical) Resistance

Type of Chemical	Chemical	Bearing Series	
		LM800 700	1000
Acids and Acidic Solutions	Mineral (Non-Oxidizing)	♦	♦
	Mineral (Oxidizing)	O	♦
	Inorganic Salts (Acid Forming)	♦	♦
	Organic (Strong)	♦	♦
	Organic (Weak) pH 3-7	♦	♦
	Organic Salts (Acid Forming)	♦	♦
Alkalis (Bases & Alkaline Solutions)	Mineral (Non-Oxidizing)	♦	♦
	Mineral (Oxidizing)	□	♦
	Inorganic Salts (Base Forming)	♦	♦
	Organic (Strong)	♦	♦
	Weak Organic Bases pH 7-11	♦	♦
Gases	Acid	♦	♦
	Alkaline (base)	♦	♦
	Anhydrous (dew Point below -30°F)	□	□
	Cyrogenic (Liquefied)	O	□
	Inert	♦	♦
	Oxidizing	O	□
	Reducing	♦	♦
Salts	Acid Salts	□	□
	Alkaline Sales	□	□
	Metals	♦	♦
	Neutral Salts	O	□
	Neutral Salt Solutions	♦	♦
Solvents	Aliphatic	♦	♦
	Aromatic	♦	♦
	Chlorinated, Fluorinated	♦	♦
	Oxygenated, Sulfides	♦	♦

♦ – Good. Not known interaction; compatible, □ – Questionable (depends on conditions), O – Not recommended

- **Expected Life:**

  The inner unit assembly may be rotated 180° on the shaft to utilize a new bushing surface and increase bearing life. SOLIDLUBE is a wear type bearing, and we currently do not have general life expectancy charts; however, we can calculate life expectancy estimates for critical applications upon request.

- **Dirty Environments:**

  Caution: Sand, grit, lime, etc. reduce life as these hard abrasive particles act like a grinding compound.

- **Coefficient of Friction:**

  Static .20 to .30
  Dynamic .05 to .15

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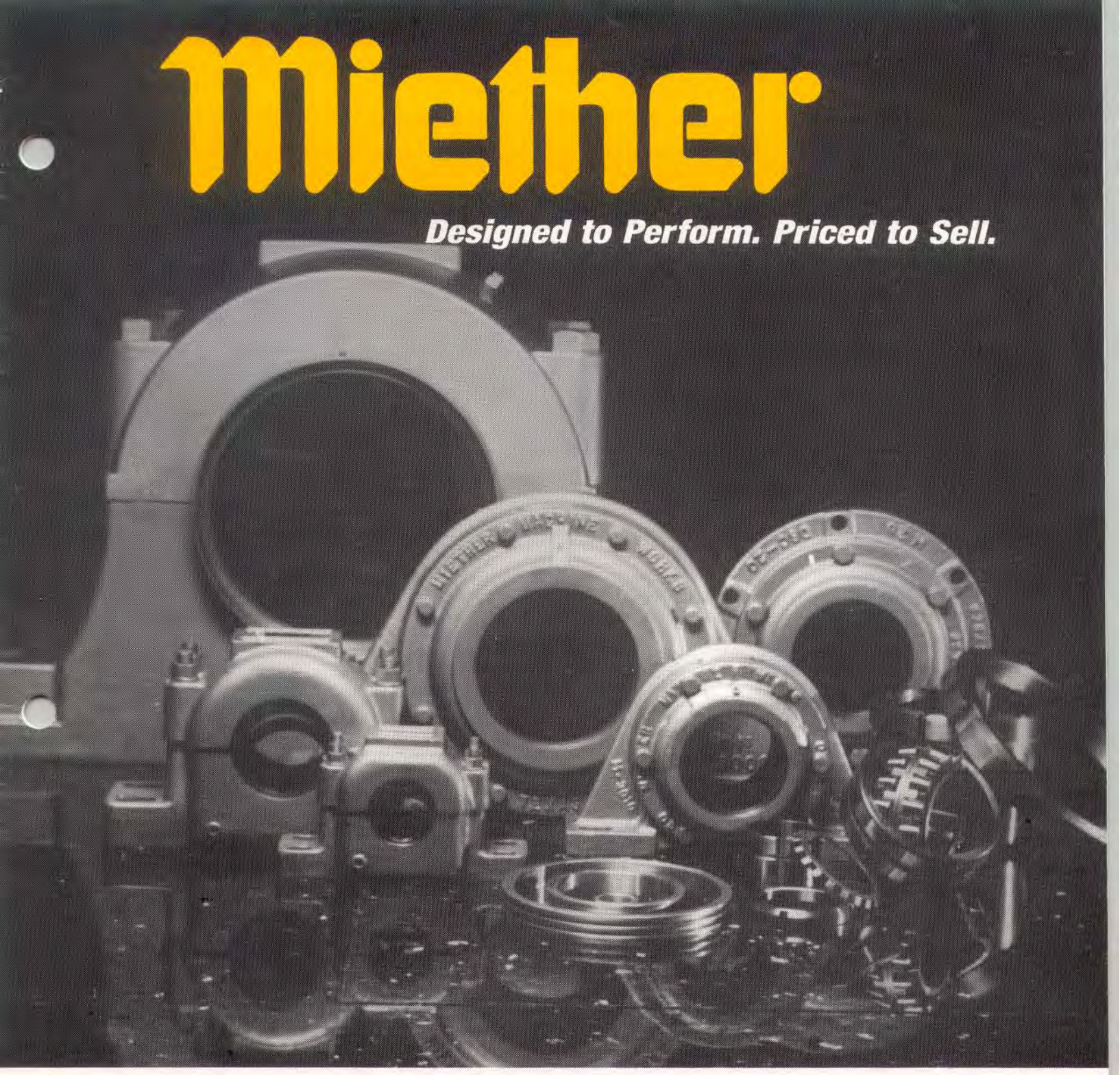
3/09 PRINTSHOP

Roller Bearing, Fixed, Miether, SAF 22338, 8-3/8” Bore

- Miether Assembly, Lubrication & Maintenance Manual
- Miether 22338 Sizing & Order Guide

Miether

Designed to Perform. Priced to Sell.



Assembly • Lubrication • Maintenance

Miether Miether Bearing Products Inc. *An Alco Industries Company*

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http://www/miether.com • E mail miether@worldnet.att,net 800 / 6 4 3-8 4 3 7

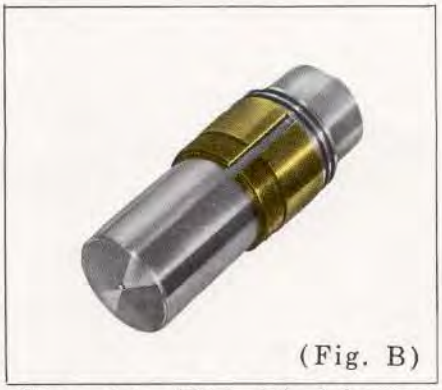
Telefax 915/363-8211

Note: Leave bearing in protective wrapping until you are ready to install it on the shaft . . . do not remove slushing compound, it protects the bearing and will mix with any lubricant you choose.

(Fig. A)

Step #1. (Fig. A) Inner triple seal

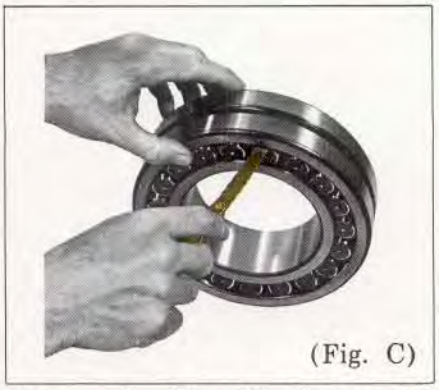
Slide inner triple seal onto shaft. This seal slides freely into position.



(Fig. B)

Step #2. (Fig. B) Adapter Sleeve

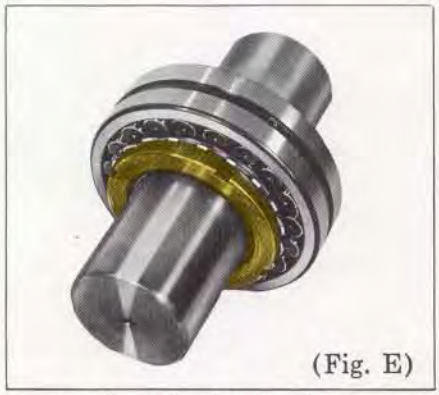
Slide adapter sleeve onto shaft with threads to outside. Locate sleeve where bearing centerline will be. Bearing will be easier to mount and remove if you put micronized or powdered (not flaked) graphite on outer diameter of sleeve.



(Fig. C)

Step #3. (Fig. C) Unmounted clearance

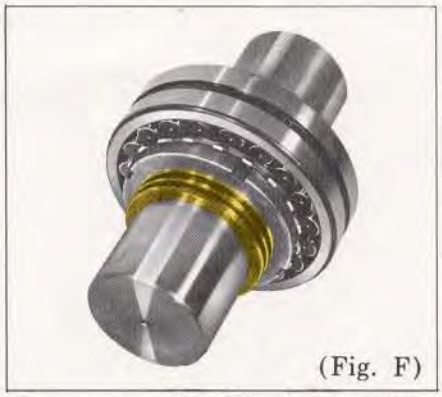
Before you put bearing on shaft determine unmounted internal clearance. Insert progressively larger feeler blades full length of roller between most vertical unloaded roller and outer bearing ring. Slide feeler blade through . . . . do not roll it. Record measurement of largest size blade that slides through. This is the unmounted internal clearance.



(Fig. E)

Step #6. (Fig. E) Locknut and Lockwasher

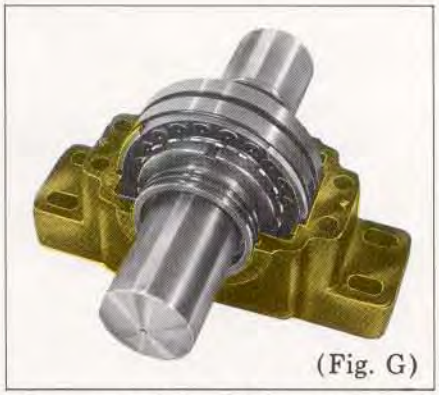
Remove locknut. Mount lockwasher on adapter sleeve with inner prong of lockwasher toward face of bearing and in slot of adapter sleeve. Re-apply locknut until tight. Do not drive bearing farther up adapter sleeve . . . . check to see that clearance has not changed (Refer to Table 1, page 6). Find lockwasher tang nearest a locknut slot. If slot is slightly past tang, don't loosen nut, tighten to meet a washer tang.



(Fig. F)

Step #7. (Fig. F) Outer triple seal

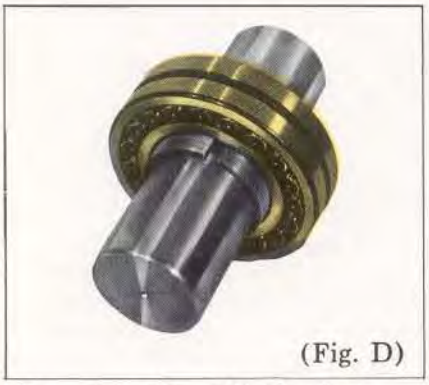
Slide outer triple seal onto shaft. Locate both inner triple seal and outer triple seal to match labyrinths in base section of housing.



(Fig. G)

Step #8. (Fig. G) Lower half of housing

Remove any paint or burrs from the mating surfaces at the split and thoroughly clean housing. The vertical hole in the lower part of each enclosure groove must be free of any foreign matter for proper lubrication. Set lower half of housing in place and oil bearing seat. Place shaft with bearing into lower half of housing while carefully guiding triple seal rings on the shaft into enclosure grooves. Bolt fixed housing in place.

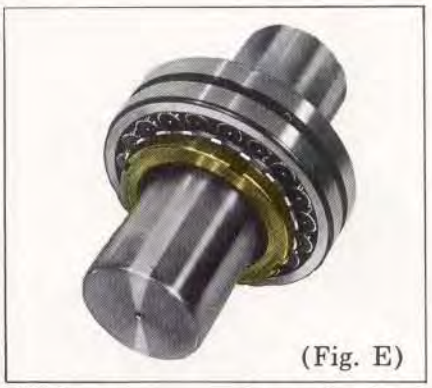


(Fig. D)

Step #4. (Fig. D) Bearing

Mount bearing on adapter sleeve, starting with large bore of inner ring to match taper of adapter. With bearing hand-tight on adapter, locate bearing to proper axial position on the shaft.

Leave lockwasher off until you have finished the next step.



(Fig. E)

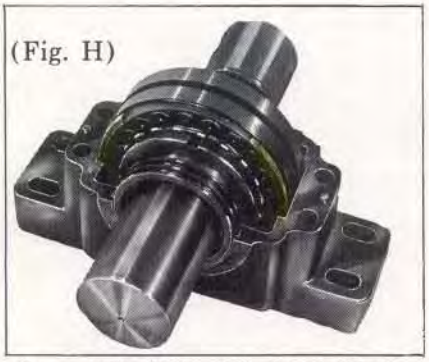
Step #5. (Fig. E) Locknut

Put locknut on with chamfered face toward bearing. A coating of graphite on face of locknut where it contacts bearing will make mounting easier.

Large size bearings will require a heavy-duty spanner wrench and extension to obtain required reduction in internal clearance.

Do not attempt to tighten locknut with hammer and drift . . . locknut will be damaged and chips can enter bearing. Tighten locknut and measure internal clearance with feeler blades between most vertical unloaded roller and outer ring until clearance is less than the figure measured in Step #3 above. Refer to tabulation on page 6 Table 1 to determine proper amount of reduction in internal clearance.

(Fig. H)



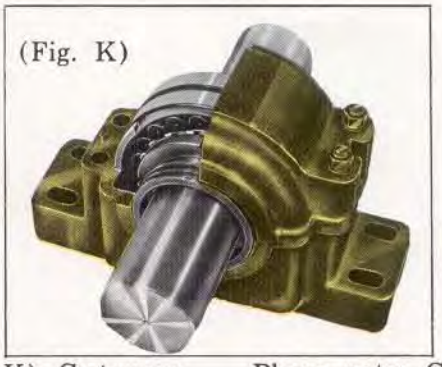
Step #9. (Fig. H) Stabilizing Ring

Move shaft axially so that stabilizing ring may be inserted between "Fixed" Bearing outer ring and housing shoulder on locknut side of bearing. Center all other bearings on one shaft in their housing seats.

Please note: There must be only one "Fixed" bearing per shaft. Other bearing(s) must be free to permit shaft expansion.

If the pillow block is to have one closed end, an end plug is supplied which fits snugly into triple seal groove. It is inserted in lower half of housing before upper half is bolted to base. If grease is used as a lubricant it should be applied to the bearing (See Lubrication notes . . . Page 8).

(Fig. K)



Step #10. (Fig. K) Cutaway illustration

Here a section of the housing has been removed to show you the position of all the parts . . . check before you put on cap to see that all parts are in their correct positions.

The bearing seat in the upper half of the housing (cap) should be deburred, thoroughly cleaned, oiled and placed over bearing. A sealing compound such as Permatex 2 may be used between the mating surfaces of the cap and base to eliminate lubricant leakage. The two dowel pins will align upper half of housing.

Please note: Caps and bases of pillow blocks are not interchangeable . . . each cap and base must be assembled with its mating part.

Lockwashers and capbolts are then applied and tightened to complete the assembly.

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(Fig. L)

Step #1. (Fig. L) Inner triple seal—Cylindrical bore

Slide inner triple seal onto shaft. This seal slides freely into position.

Step #2. Press small bearing onto shaft.

To press small bearings onto a shaft, fit clean pipe over shaft and rest it on inner bearing race. Before pressure is applied to bearing apply a coat of light oil or micronized graphite to the shaft and bearing bore. Be sure bearing is square on shaft and then apply pressure with an arbor press.

(Fig. M)

Step #3. (Fig. M) Bearing with cylindrical bore

To mount larger bearings that are not easily pressed onto a shaft, heat bearing in clean oil to a maximum of 200° F for approximately 15 minutes. Be sure to place supports under bearing to isolate it from bottom of container and prevent overheating the bearing. Mount bearing on shaft firmly against shaft shoulder. Quickly follow through with steps #4 and #5 to prevent bearing's drawing away from its proper position against shaft shoulder.

(Fig. N)

Step #4. (Fig. N) Lockwasher

Mount lockwasher over threads on shaft with inner prong of lockwasher toward face of bearing and in slot in shaft.

Step #5. (Fig. N) Locknut on shaft

Apply locknut with the chamfered face toward the bearing. Tighten with spanner wrench until bearing firmly seated against shaft shoulder. Bend one of the lockwasher tangs into a slot in locknut. If slot is slightly past tang, don't loosen nut, tighten to meet a tang.

To complete the mounting proceed with Steps 7 through 10 as for Adapter mountings.

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ASSEMBLY INSTRUCTIONS FOR ONE-PIECE BLOCKS WITH SELF-ALIGNING SPHERICAL ROLLER BEARINGS

Miether

Note: Leave bearing in package until ready to assemble. Gather all necessary parts and tools before starting. Clean all parts except bearing. Leave slushing compound on bearing (it will mix with any lubricant you choose). Remove shipping plugs and install lubrication fittings in pillow block.

Step #1: Check shaft for nicks and burrs, correct if necessary and apply a light coat of machine oil. Clean threads of adapter and locknut with stiff brush and apply light coat of lubricant.

Step #2: Bench check unmounted internal clearance of bearing. (See Page 6, Table 1.)

Step #3: Slide inboard end cap and housing body on shaft if space permits; if not, slide inboard end cap on shaft. Mount bearing on adapter with small bore end next to adapter thread. Place lockwasher (used with small bearings only) against bearing with inner prong of lockwasher toward bearing and slot of adapter.

Step #4: Screw locknut on adapter until it contacts the bearing. Do not tighten beyond contact. Slide adapter and bearing, with locknut outboard, onto shaft and locate to correct position on shaft. Tighten locknut on adapter. For large locknuts use a heavy duty spanner wrench and extension. Check bearing internal clearance at intervals during tightening until correct amount of clearance remains. (See Page 6, Table 1.) Peen one tang of lockwasher into one slot of the locknut. On larger bearings: bolt lockplate with tab in adapter slot to face of locknut. Lockwire heads of capscrews.

Step #5: Slide housing body over bearing assembly. Slide outboard end cap onto shaft. Bolt inboard and outboard end caps to housing body.

On closed end pillow blocks the shaft should not extend more than 1/8" beyond bearing locknut to avoid rubbing against end cap.

Use only fixed bearing per shaft.

Bearing may be lubricated with either grease or oil bath. Bearing cavity should be approximately one-half full of grease or filled to the center line of the lowest rollers when oil bath is used. Pillow blocks can also be supplied for air-oil mist or circulating oil.

Cylindrical Mount. Follow same procedures as for adapter mount.

FEATURES OF THE SOLID HOUSING PILLOW BLOCKS

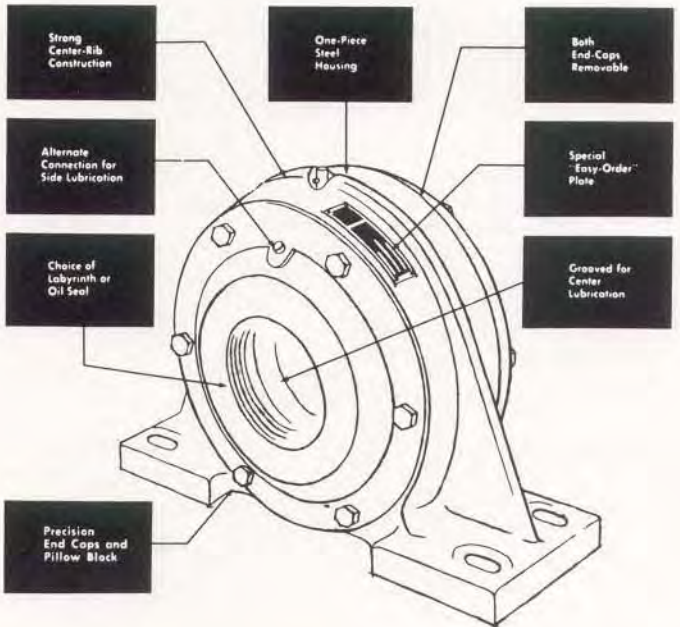

TABLE 1. Recommendation for Mounting a Spherical Roller Bearing on a Tapered Seat

Bearing Bore mm		Decrease in Internal Clearance Inches	Bearing Bore mm		Decrease in Internal Clearance Inches
Over	Incl		Over	Incl	
40	65	.0010	250	315	.005
65	100	.0015	315	355	.006
100	120	.0020	355	400	.007
120	140	.0025	400	500	.008
140	180	.0030	500	560	.009
180	200	.0035	560	630	.010
200	225	.0040	630	710	.012
225	250	.0045	710	800	.013
			800	900	.014

Note: The axial displacement of the bearing is approximately 15 times the clearance decrease.

TABLE 2.
Shaft Tolerance Limits for Pillow Block Mountings

Nominal Diameter Inches		Diameter Tolerance Limits Inches	
Over	Including	S-1	S-2 & S-3
½	1	+.000 —.001	+.000 —.001
1	2	+.000 —.002	+.000 —.002
2	4	+.000 —.003	+.000 —.003
4	6	+.000 —.004	+.000 —.004
6	10	+.000 —.004	+.000 —.004
10	15	+.000 —.005	+.000 —.005
15 UP		+.000 —.005	+.000 —.005

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The selection of the proper type of lubricant and lubrication system for spherical roller bearing pillow blocks is based on a combination of several factors depending on operating temperature, speed and design conveniences.

GREASE LUBRICATION

Since the simplest design that will accomplish the job is usually the best design, thought should first be given to the possibility of grease lubrication. Here the factors to be considered are:

1. Operating temperature should be below 200°F.
2. Load and speed should be within the limits shown in the "Load-Capacity" tables.
3. Correct type and grade of grease should be used.
4. Correct quantity of grease should be applied.

Excess grease in a pillow block may result in high induced temperatures; therefore the quantity of grease should be kept at approximately 1/3 to 1/2 of the free air space. A re-greasing schedule based on operating conditions should be drawn up and adhered to. For general purpose applications a grade #2 sodium or lithium soap grease, will provide good service. Because of the variety of oils, bases and additives used in present day greases, it is not good practice to mix greases of different types and makes. Where contamination or other operating conditions are severe the Miether Engineering Department should be consulted.

OIL LUBRICATION

Although oil lubrication will allow roller bearings to run at speeds and temperatures higher than those permissible with grease, is essential that the following points be observed:

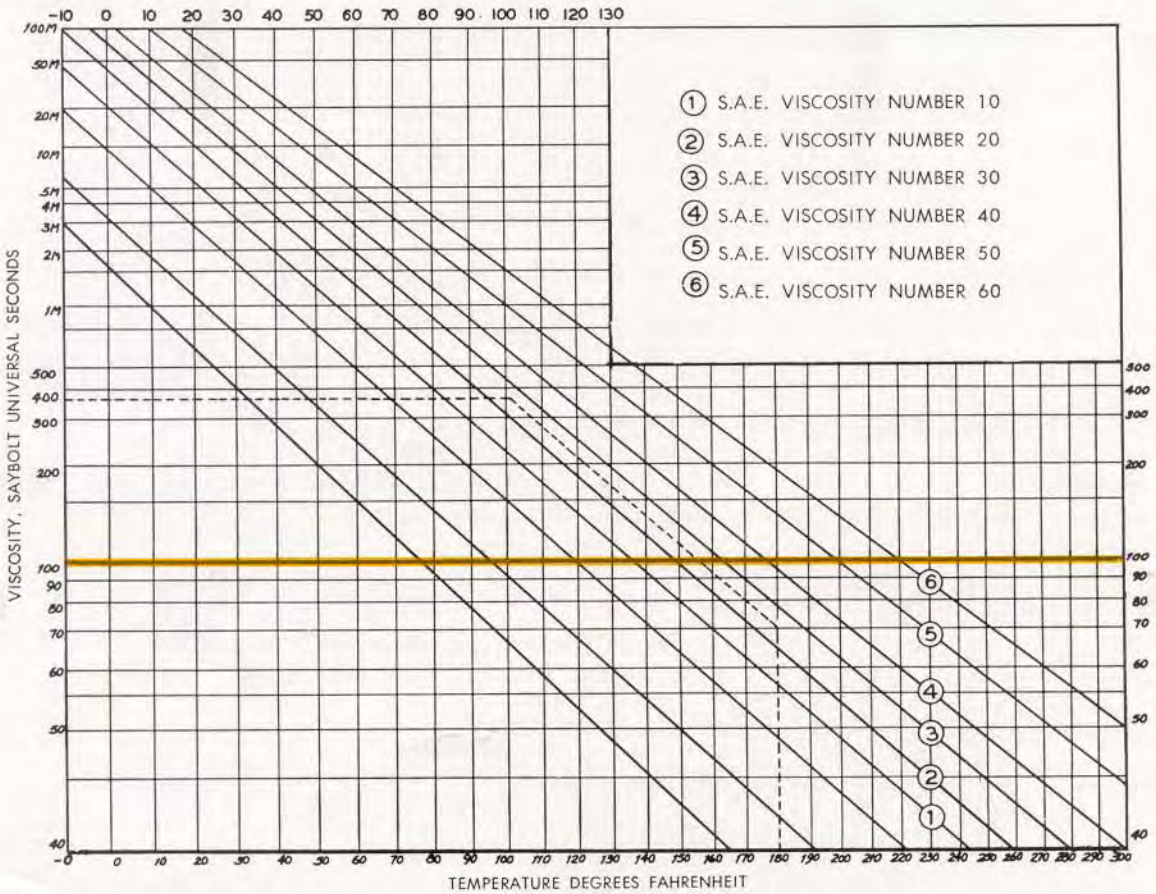
1. Only high quality petroleum oil should be used.
2. The oil should have a minimum viscosity of 100 SUS at the operating temperature.
3. The correct quantity must be applied.

Petroleum oils of poor quality, animal oils and vegetable oils tend to oxidize easily and form sludge deposits on the bearing parts. In order to provide an oil film of the correct shear strength an oil with a minimum viscosity of 100 SUS at the operating temperature should be used. As the viscosity falls below this level the bearing life will be reduced. For example, a bearing running in a fluid with a viscosity of 25 SUS may be expected to have life equal to 1% of calculated life.

The quantity of oil used in roller bearings is quite critical. Too much oil will result in churning and excess heat. Too little oil will not coat the load surfaces adequately and will result in early failures. Where a splash system is used the oil level should be maintained at the mid-point of the lowest roller when the bearing is stationary. Drop feed systems and mist systems should be adjusted on a flow versus operating temperature basis.

The Oil Selection chart on facing page may be used as a guide in selecting the proper oil viscosity. Find the operating temperature on the bottom scale then go up vertically to or past the yellow line until it intersects one of the slanted lines. For example, at 170°F we would have to go past the heavy yellow line to find the first intersecting slanted line to be number "4". Number "4" is SAE 40 oil.

The limiting speed for grease and splash oil are shown in the "Load Rating and Limiting Speed" charts. If a circulating oil system is used, a limiting speed of 150% of the grease limits is used. These limiting speeds are conservative and can be increased with experience on the specific application.



CLEANING DATA

You may have to clean bearings when they have been removed from their positions, during overhaul of equipment or to remove accumulated dirt of deteriorated lubricants.

To clean unmounted bearings use a clean petroleum solvent or kerosene. You may soak the bearings in a hot light oil (200° F max) or if you have extremely oxidized greases you may boil in an emulsifying cleaner. If compressed air is used be sure it is clean . . . do not allow the bearing to spin during blowing. After all solvents have been removed coat bearing with petroleum and reinstall in the pillow block or wrap in clean oil-proof paper while awaiting reassembly.

To clean mounted bearings flush a hot, light oil (180° to 200°) through the housing while rotating the shaft slowly. A hot aqueous emulsion may be used as a flush. When the bearing is clean remove all solvents and flush housing and bearing with a hot light oil. Relubricate with the recommended lubricant. Caution: Solvent should be lower than 200°F flash point.

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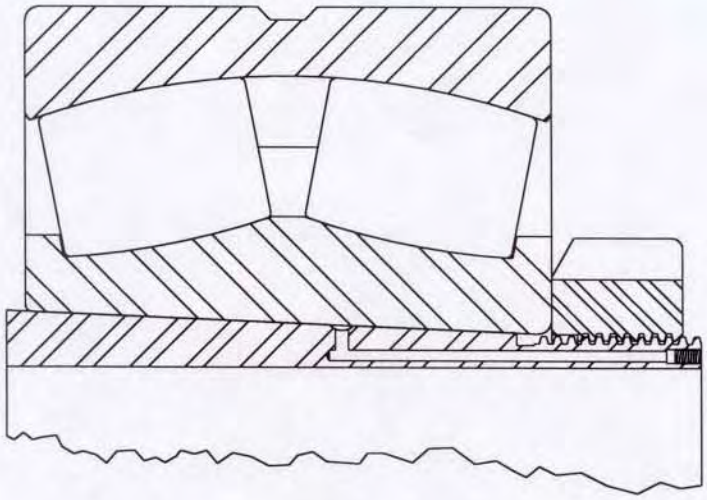
Radial Clearance Reduction of FAG Spherical Roller Bearings with Tapered Bore

Nominal bore diameter		Radial clearance prior to mounting Clearance group						Reduction in radial clearance		Axial displacement on 1:12 taper				Axial displacement on 1:30 taper				Smallest rad. clear. After mounting		
d		C0		C3		C4				Shaft		Sleeve		Shaft		Sleeve		C0	C3	C4
over	to	min	max	min	max	min	max	min	max	min	max	min	max	min	max	min	max	min	min	min
mm		0.0001 in.		0.0001 in.		0.0001 in.		0.0001 in.		inch		inch		inch		inch		0.0001 inch		
30	40	14	20	20	26	26	34	8	10	0.014	0.016	0.014	0.018					6	10	16
40	50	18	24	24	32	32	39	10	12	0.016	0.018	0.018	0.02					8	12	20
50	65	22	30	30	37	37	47	12	16	0.018	0.024	0.02	0.028					10	14	22
65	80	28	37	37	47	47	59	16	20	0.024	0.03	0.028	0.033					10	16	28
80	100	32	43	43	55	55	71	18	24	0.028	0.035	0.03	0.039	0.069	0.089	0.071	0.094	14	20	31
100	120	39	53	53	67	67	87	20	28	0.028	0.043	0.031	0.047	0.075	0.106	0.079	0.11	20	26	39
120	140	47	63	63	79	79	102	26	35	0.043	0.055	0.047	0.059	0.106	0.138	0.11	0.142	22	31	43
140	160	51	71	71	91	91	118	30	39	0.047	0.063	0.051	0.067	0.118	0.157	0.122	0.165	22	35	51
160	180	55	79	79	102	102	134	31	43	0.051	0.067	0.055	0.075	0.126	0.165	0.13	0.181	24	39	59
180	200	63	87	87	114	114	146	35	51	0.055	0.079	0.059	0.087	0.138	0.177	0.142	0.197	28	39	63
200	225	71	98	98	126	126	161	39	55	0.063	0.087	0.067	0.094	0.157	0.217	0.165	0.224	31	47	71
225	250	79	106	106	138	138	177	43	59	0.067	0.094	0.071	0.102	0.165	0.236	0.181	0.244	35	51	79
250	280	87	118	118	154	154	193	47	67	0.075	0.102	0.079	0.114	0.185	0.264	0.189	0.272	39	55	87
280	315	95	130	130	169	169	213	51	75	0.079	0.118	0.087	0.126	0.197	0.295	0.205	0.303	43	59	94
315	355	106	142	142	185	185	232	59	83	0.094	0.134	0.102	0.142	0.236	0.323	0.244	0.331	47	67	102
355	400	118	158	158	205	205	256	67	91	0.102	0.142	0.114	0.154	0.256	0.354	0.268	0.362	51	75	114
400	450	130	173	173	224	224	284	79	102	0.122	0.161	0.134	0.173	0.303	0.394	0.315	0.409	51	79	122
450	500	146	193	193	248	248	311	83	110	0.13	0.173	0.142	0.189	0.323	0.433	0.331	0.441	63	91	138
500	560	161	213	213	268	268	343	94	126	0.146	0.197	0.161	0.213	0.362	0.492	0.378	0.504	67	98	142
560	630	181	236	236	299	299	386	102	138	0.157	0.213	0.173	0.232	0.394	0.531	0.409	0.551	79	114	161
630	710	201	264	264	335	335	429	118	157	0.181	0.244	0.201	0.268	0.453	0.61	0.472	0.63	83	122	177
710	800	224	295	295	378	378	480	134	177	0.209	0.276	0.228	0.299	0.524	0.689	0.535	0.709	91	138	201
800	900	252	331	331	421	421	539	146	197	0.224	0.307	0.248	0.335	0.563	0.768	0.583	0.787	106	154	224
900	1000	280	366	366	469	469	598	161	217	0.248	0.335	0.276	0.37	0.622	0.827	0.646	0.866	118	169	252

Rolling Bearing Greases

Field of application	Grease name	Grease type	Brief description of application field	Temperature range deg F.	Suitable for speed indicies $k_s \times n \times d_m$ to min^{-1} mm	Suitable for the load ratio P/C to radial	Base oil viscosity at 40 deg C mm^2/s	Penetration NLGI class	Other properties Operating conditons Applications
I	Shell Alvania 3	Lithium soap base grease with mineral base oil	For bearings under normal stressing conditions, outside diameter D > 60 mm	-20... + 285	500,000	0.15	100	2	Grease for normal cases of applications. Suitable as sealing grease. compatible with elastomers.
II	Mobil Mobilith SHC 460	Lithium soap base grease with EP additives and mineral base oil	Special grease for the highest possible loads, large bearings	-0... +265	200,000	0.7	490	2	For extremely heavy loads and moderate speeds. Suitable as sealing grease, compatible with elastomers.
III	Exxon Andok C	Sodium with mineral base oil	Special grease for fast speeds, low starting friction	-10... +250	700,000	0.15	95	3 - 4	Stiff rolling bearing grease due to speedy grease distribution in the bearing, favorable starting behavior, low starting friction. For bearings on vertical shafts.
I, II, and III	Optimol Longtime PD2	Lithium soap base grease with EP additives and mineral base oil	Universal grease for high loads and almost all speeds	-40... +300	700,000	0.3	85	2	Universal rolling bearingmgrease for heavy loads, high temperatures, high speed indicies and acceleration forces, for rotating outer rings and reversing operations. Compatible with elastomers.

Optimol is distributed by Castrol
Call 1-800-gear-oil for distributor location
Mobil equivalent - Mobilith AW2 (not quite as good as Optimol)

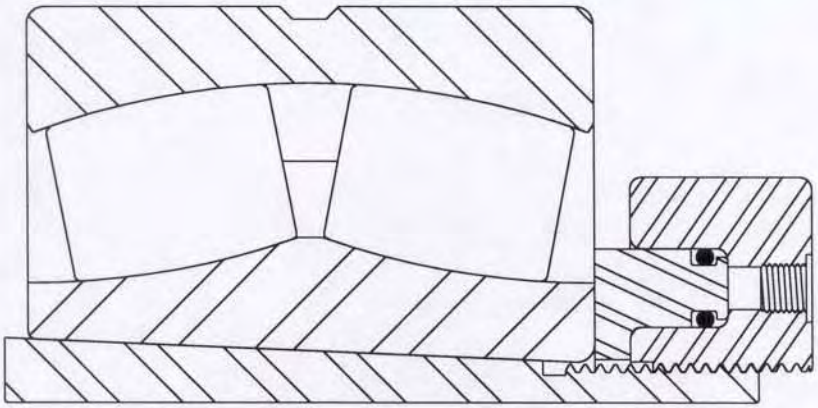


Hydraulic Adapter

Hydraulic adapters are designed to facilitate the dismounting of a tapered bore bearing.

A hydraulic adapter is a sleeve that has been modified for oil injection. A circular groove is milled into the circumference of the sleeve. Oil can be injected into the groove thru the threaded pump connection. The fluid pressure will eventually separate the mating surfaces of the sleeve and bearing, forcing the bearing to slide off of the tapered adapter.

Caution: Before you pressurize the sleeve, loosen the locknut a few turns. Do not completely remove nut. When the bearing does break loose, it will do so with considerable force. The locknut will act as a stop for the bearing.



Hydraulic Nuts

A hydraulic nut is a steel ring that threads onto an adapter sleeve or threaded shaft. The ring has an annular groove machined into one side to accept a circular piston. As oil is injected into one of the two G ¼" BSP connections, the fluid pressure drives the piston out of the nut and pushes the bearing over the tapered sleeve.

Hydraulic assistance is recommended for bore diameters of 200 mm and larger.

Miether Bearing does not stock hydraulic nuts. They are made to order. Normal delivery for this item is 8 weeks.

The steel ring is made from 4140 alloy.

Hydraulic nuts are expensive. The hard material coupled with 1 to 2 pc production runs drive up cost.

HOW TO ORDER:

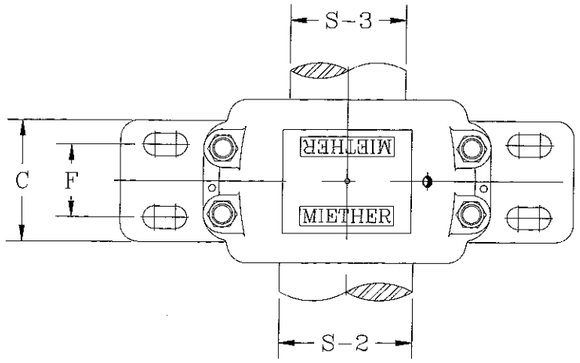
- When you order SAF 22216 you receive;

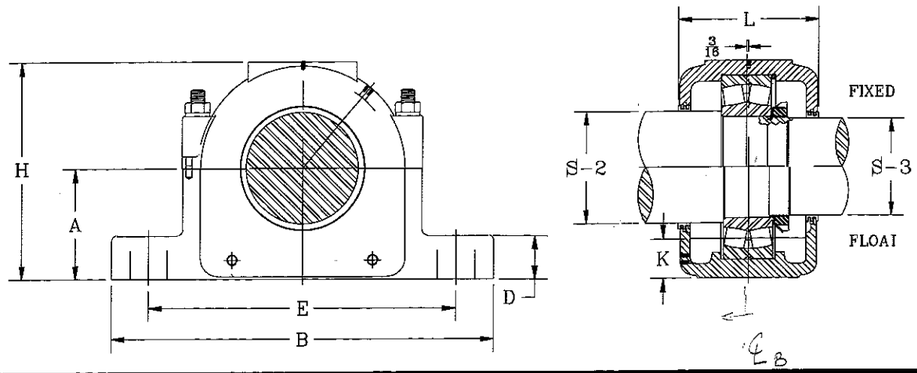
1 SAF 216 Housing (Housing, seal rings and stabilizing ring)
1 No 22216 Bearing.
1 No. AN 16 Locknut, 1 No W 16 Lockwasher.

- If you order a closed housing the proper end plug is included.
- All housings include stabilizing ring either use or discard.
- Always specify shaft size when ordering.
- Housing styles include;

SAF - Cast Iron SAFD - Ductile Iron
SAFS - Cast Steel

- All Miether housings have four bolt cap.
- The sizes listed below are standard items





SPLIT

SAF 222 CYLINDRICAL MOUNTED PILLOW BLOCK PART NUMBERS

SHAFT DIAMETER S-2 IN.	SHAFT DIAMETER S-3 IN.	COMPLETE PILLOW BLOCK NUMBER	PILLOW BLOCK HOUSING ONLY	BEARING NUMBER	LOCKNUT	LOCK-WASHER	TRIPLE SEAL RING S-2 SHAFT 1 REQD'	TRIPLE SEAL RING S-3 SHAFT 1 REQD'	STABILIZING RING (1 REQUIRED)
3 1/16	2 7/16	SAF 22213	SAF213	22213	N 13	W 13	LER 55	LER 37	SR- 13-11
3 7/16	2 13/16	*SAF 22215	SAF215	22215	AN 15	W 15	LER 79	LER 46	SR- 15-12
3 5/8	3	*SAF 22216	SAF216	22216	AN 16	W 16	LER 82	LER 54	SR- 16-13
3 15/16	3 3/16	*SAF 22217	SAF217	22217	AN 17	W 17	LER 89	LER 63	SR- 17-14
4 1/8	3 3/8	*SAF 22218	SAF218	22218	AN 18	W 18	LER 96	LER 191	SR- 18-15
4 1/2	3 13/16	*SAF 22220	SAF220	22220	AN 20	W 20	LER 118	LER 106	SR- 20-17
4 7/8	4 3/16	SAF 22222	SAF222	22222	AN 22	W 22	LER 121	LER 113	SR- 22-19
5 5/16	4 9/16	SAF 22224	SAF224	22224	AN 24	W 24	LER 127	LER 119	SR- 24-20
5 7/8	4 15/16	SAF 22226	SAF226	22226	AN 26	W 26	LER 136	LER 122	SR- 26-0
6 1/4	5 5/16	SAF 22228	SAF228	22228	AN 28	W 28	LER 144	LER 127	SR- 28-0
6 5/8	5 3/4	SAF 22230	SAF230	22230	AN 30	W 30	LER 151	LER 134	SR- 30-0
7	6 1/16	SAF 22232	SAF232	22232	AN 32	W 32	LER 156	LER 142	SR- 32-0
7 7/16	6 7/16	SAF 22234	SAF234	22234	AN 34	W 34	LER 161	LER 148	SR- 34-0
7 13/16	6 7/8	SAF 22236	SAF236	22236	AN 36	W 36	LER 165	LER 154	SR- 36-30
8 3/8	7 1/4	SAF 22238	SAF238	22238	AN 38	W 38	LER 171	LER 160	SR- 38-32
8 3/4	7 5/8	SAF 22240	SAF240	22240	AN 40	W 40	LER 175	LER 164	SR- 40-34
9 9/16	8 5/16	SAF 22244	SAF244	22244	N 44	W 44	LER 179	LER 170	SR- 44-38

FOR 4 BOLT BASE PLEASE SPECIFY FSAF.

SAF 222 PILLOW BLOCK DIMENSIONS

A IN.	B IN.	C IN.	D IN.	E MAX IN.	E MIN IN.	F IN.	H IN.	K STATIC OIL LEVEL IN.	L IN.	BOLTS (NO. REQ'D) IN.	WEIGHT LBS. HOUSING LER, SR	COMPLETE PILLOW BLOCK NUMBER
3	11	3 1/8	1	9 1/2	8 1/8		5 15/16	1 1/8	4 1/2	(2)- 5/8	22	SAF 22213
3 1/4	11 1/4	3 1/8	1 1/8	9 5/8	8 5/8	1 7/8	6 3/8	1 1/4	4 3/4	(2)- 5/8 (4)- 1/2	25	*SAF 22215
3 1/2	13	3 1/2	1 3/8	11	9 5/8	2 1/8	6 7/8	1 11/32	4 7/8	(2)- 3/4 (4)- 5/8	33	*SAF 22216
3 3/4	13	3 1/2	1 7/16	11	9 7/8	2 1/8	7 5/16	1 7/16	5	(2)- 3/4 (4)- 5/8	36	*SAF 22217
4	13 3/4	3 7/8	1 1/2	11 5/8	10 3/8	2 1/8	7 3/4	1 17/32	5 3/4	(2)- 3/4 (4)- 5/8	43	*SAF 22218
4 1/2	15 1/4	4 3/8	1 3/4	13 1/8	11 5/8	2 3/8	8 3/4	1 3/4	6	(2)- 7/8 (4)- 3/4	60	*SAF 22220
4 15/16	16 1/2	4 3/4	2	14 1/2	12 5/8	2 3/4	9 5/8	1 7/8	6 1/2	(4)- 3/4	83	SAF 22222
5 1/4	16 1/2	4 3/4	2 1/8	14 1/2	13 1/4	2 3/4	10 1/4	1 15/16	7 3/8	(4)- 3/4	92	SAF 22224
6	18 3/8	5 1/8	2 3/8	16	14 5/8	3 1/4	11 9/16	2 7/16	8	(4)- 7/8	136	SAF 22226
6	20 1/8	5 7/8	2 3/8	17 1/8	16	3 3/8	11 3/4	2 1/8	7 5/8	(4)- 1	141	SAF 22228
6 5/16	21 1/4	6 1/4	2 1/2	18 1/4	17	3 3/4	12 1/2	2 3/16	8 3/8	(4)- 1	159	SAF 22230
6 11/16	22	6 1/4	2 5/8	19 1/4	17 3/8	3 3/4	13 5/16	2 3/16	8 3/4	(4)- 1	174	SAF 22232
7 1/16	24 3/4	6 3/4	2 3/4	21 5/8	19 3/8	4 1/4	14 3/16	2 5/16	9 5/8	(4)- 1	226	SAF 22234
7 1/2	26 3/4	7 1/8	3	23 5/8	20 7/8	4 5/8	14 7/8	2 9/16	10	(4)- 1	273	SAF 22236
7 7/8	28	7 1/2	3 1/8	24 3/8	21 5/8	4 1/2	15 11/16	2 5/8	10 5/8	(4)- 1 1/4	311	SAF 22238
8 1/4	29 1/2	8	3 3/8	25	22 1/2	5	16 1/2	2 11/16	11 1/8	(4)- 1 1/4	338	SAF 22240
9 1/2	32 3/4	8 3/4	3 3/4	27 7/8	24 3/4	5 1/4	18 5/8	3 3/8	11 7/8	(4)- 1 1/2	466	SAF 22244

All housings come with stabilizing ring. Use for fixed, discard for float. Use only one "Fixed" bearing per shaft.

SAF 223 CYLINDRICAL MOUNTED PILLOW BLOCK PART NUMBERS

SHAFT DIAMETER S-2 IN.	SHAFT DIAMETER S-3 IN.	COMPLETE PILLOW BLOCK NUMBER	PILLOW BLOCK HOUSING ONLY	BEARING NUMBER	LOCKNUT	LOCK-WASHER	TRIPLE SEAL RING S-2 SHAFT 1 REQD'	TRIPLE SEAL RING S-3 SHAFT 1 REQD'	STABILIZING RING (1 REQUIRED)
4 1/8	3 3/8	SAF 22318	SAF 318	22318	AN18	W18	LER 112	LER 191	SR- 21-18
4 1/2	3 13/16	SAF 22320	SAF 320	22320	AN20	W20	LER 118	LER 106	SR- 24-20
4 7/8	4 3/16	SAF 22322	SAF 322	22322	AN22	W22	LER 121	LER 113	SR- 0-22
5 5/16	4 9/16	SAF 22324	SAF 324	22324	AN24	W24	LER 127	LER 119	SR- 0-24
5 7/8	4 15/16	SAF 22326	SAF 326	22326	AN26	W26	LER 136	LER 122	SR- 0-26
6 1/4	5 5/16	SAF 22328	SAF 328	22328	AN28	W28	LER 144	LER 127	SR- 0-28
6 5/8	5 3/4	SAF 22330	SAF 330	22330	AN30	W30	LER 151	LER 134	SR- 36-30
7	6 1/16	SAF 22332	SAF 332	22332	AN32	W32	LER 156	LER 142	SR- 38-32
7 7/16	6 7/16	SAF 22334	SAF 334	22334	AN34	W34	LER 161	LER 148	SR- 40-34
7 13/16	6 7/8	SAF 22336	SAF 336	22336	AN36	W36	LER 165	LER 154	SR- 0-36
8 3/8	7 1/4	SAF 22338	SAF 338	22338	AN38	W38	LER 171	LER 160	SR- 44-38
8 3/4	7 5/8	SAF 22340	SAF 340	22340	AN40	W40	LER 175	LER 164	SR- 0-40

SAF 223 PILLOW BLOCK DIMENSIONS

A IN.	B IN.	C IN.	D IN.	E MAX IN.	E MIN IN.	F IN.	H IN.	K STATIC OIL LEVEL IN.	L IN.	BOLTS (NO. REQ'D) IN.	WEIGHT LBS. HOUSING LER, SR	COMPLETE PILLOW BLOCK NUMBER
4 3/4	15 1/2	4 3/8	2	13 1/2	12	2 1/4	9 3/16	2	6 7/8	(4)- 3/4	78	SAF 22318
5 1/4	16 1/2	4 3/4	2 1/8	14 1/2	13 1/4	2 3/4	10 1/4	2 1/8	7 3/8	(4)- 3/4	91	SAF 22320
6	18 3/8	5 1/8	2 3/8	16	14 5/8	3 1/4	11 9/16	2 1/2	8	(4)- 7/8	125	SAF 22322
6 5/16	21 1/4	6 1/4	2 1/2	18 1/4	17	3 3/4	12 1/2	2 9/16	8 3/8	(4)- 1	175	SAF 22324
6 11/16	22	6 1/4	2 5/8	19 1/4	17 3/8	3 3/4	13 5/16	2 5/8	8 3/4	(4)- 1	202	SAF 22326
7 1/16	24 3/4	6 3/4	2 3/4	21 5/8	19 3/8	4 1/4	14 3/16	2 11/16	9 5/8	(4)- 1	248	SAF 22328
7 1/2	26 3/4	7 1/8	3	23 5/8	20 7/8	4 5/8	14 7/8	2 7/8	10	(4)- 1	290	SAF 22330
7 7/8	28	7 1/2	3 1/8	24 3/8	21 5/8	4 1/2	15 11/16	2 15/16	10 5/8	(4)- 1 1/4	322	SAF 22332
8 1/4	29 1/2	8	3 3/8	25	22 1/2	5	16 1/2	3 1/16	11 1/8	(4)- 1 1/4	348	SAF 22334
8 7/8	31 1/4	8 1/4	3 1/2	26 5/8	24	5 1/4	17 15/16	3 3/8	11 3/8	(4)- 1 1/4	448	SAF 22336
9 1/2	32 3/4	8 3/4	3 3/4	27 7/8	24 3/4	5 1/4	18 13/16	3 11/16	11 7/8	(4)- 1 1/2	485	SAF 22338
9 7/8	34 1/4	9	4	29 1/2	26 1/4	5 1/2	20	3 3/4	12 1/16	(4)- 1 1/2	594	SAF 22340

Biosolids Dryer Rotor Position Indicator

- BEI Industrial Encoders, HS35F-100--SS Absolute Encoder Product Ordering & Data Sheet

Built on the same rugged design as the incremental model, the HS35 Absolute Encoder is available with various output options including Gray Code and Natural Binary. Designed with a cast aluminum housing, a sealed connector and shaft seals, it carries an IP65 environmental rating. With the optional insulating inserts, it can be mounted on smaller diameter shafts. It is designed for either a through shaft mounting or blind shaft mounting with a closed cover to maintain its environmental rating.

The H25 Incremental Encoder is available with the following certification:

CE EN 55011 and EN 61000-6-2

Electrical Specifications

Code: 12 or 13 bits NB or GC
Counts Per Shaft Turn: 4096 or 8192 (with S3 option only)
Count Transition Accuracy: ± 1/2 bit maximum
Supply Voltage: 5–28 VDC
Current Requirements: 120 mA typical
Output Formats: Parallel: Gray Code, Natural Binary
Voltage/Output: (see note 2)
28V/V: Line Driver, 5–28 VDC in, $V_{out} = V_{in}$
28V/5: Line Driver, 5–28 VDC in, $V_{out} = 5$ VDC
28V/OC: Open Collector, 5–28 VDC in, OC_{out}
SSI: 5–28 VDC in/$5V_{out}$ (consult factory for more information)
Protection Level: Reverse, overvoltage and output short circuit protection
Frequency Response: 100kHz (1200 RPM for 12-bits)
Output Termination Pinouts: see tables, back page

Mechanical & Environmental Specs

Shaft Bore: 1.000, 0.875, 0.750, 0.625, 0.500. Diameters under 0.875 are supplied with insulated sleeves.
Allowable Misalignment: 0.005" T.I.R. on mating shaft 0.75" from shaft end
Bore Runout: 0.001 T.I.R. maximum
Starting Torque at 25°C: Through shaft version (SS) = 7 in-oz (max); Blind shaft version (BS) = 4 in-oz max
Bearings: 52100 SAE High carbon steel
Shaft Material: 416 Stainless Steel
Bearing Housing: Die cast aluminum with protective finish
Cover: Die cast aluminum with protective finish
Bearing Life: 7.5 X 10^9 revs (50,000 hours @ 2500 RPM)
Maximum RPM: 6,000 mechanical (see frequency response, above)
Moment of Inertia: 0.019 oz-in-sec^2
Weight: 18oz typical

Connector

MS3112E14-19P, 19–pin connector on encoder body, mates to MS3116J14-19S (or equivalent)

NOTES & TABLES: All notes and tables referred to in the text can be found on the back of this page.

HS35 Absolute Encoder Ordering Options

28V/V FOR ASSISTANCE CALL 800-350-2727

Use this diagram, working from left to right to construct your model number (example: HS35F-100-R1-SS-12GC-28V/V-CW-SM14/19). All notes and tables referred to can be found on the back of this page.

X — HS35 — F — 100 — R2 — SS — 12 — GC — 28v/v — CW — SM14/19 — NONE

- **X** = Express Encoder
- **TYPE:** HS = Hollow Shaft 35 = 3.5" Encoder Diameter
- **HOUSING :** F = Standard
- **SHAFT BORE:** 100 = 1.00" 87 = 0.875" 75 = 0.75" 62 = 0.625" 50 = 0.50" etc
- **TETHER:** R1 = Tether Block and Pin R2 = Tether Arm
- **SHAFT SEAL CONFIGURATION:** SS = Dual Shaft Seals BS = Blind Shaft with single seal and cover *See note 1*
- **NUMBER OF BITS:** 12 = 12 Bits, 4096 counts 13 = 13 Bits, 8192 counts *(with S3 option only)*
- **CODE TYPE:** GC = Gray Code NB = Natural Binary
- **VOLTAGE/OUTPUT:** 28V/V = 5-28$V_{in/out}$ 28V/5 = 5-28V_{in}/5V_{out} 28V/OC = 5-28V_{in}/OC_{out} A1 = 4-20mA A2 = 0-10V S3 = Serial Synchronous Interface *See note 2 (consult factory for more information)*
- **DIRECTION OF COUNT:** CW = Clockwise increasing count CCW = Counter clockwise increasing count
- **OUTPUT TERMINATION:** SM14/19 = 19 Pin connector; SCS = Shielded/Jacketed Cable with Cable Seal. Length of Cable is specified in inches (i.e. SCS18 = 18 inches) M18 = MS3102R18-1P (A1, A2 and S3 output only) (*Consult factory for more information)*
- **SPECIAL FEATURES:** S = Special features specified on purchase order *See note 3 (consult factory for more information)*

EXPRESS ENCODERS: Items highlighted with are standard Express Encoders and ship in one to three days.

These commodities, technology or software if exported from the United States must be in accordance with the Bureau of Industry, and Security, Export Administration regulations. Diversion contrary to U.S law is prohibited.

CST CUSTOM SENSORS & TECHNOLOGIES BEI INDUSTRIAL ENCODERS
Tel: 805-968-0782 / 800-350-2727 | Fax: 805-968-3154 / 800-960-2726 | 7230 Hollister Ave., Goleta, CA 93117-2807 | www.beiied.com

Specification No. 924-02070-001 Rev.06-08

Serial Synchronous Interface (SSI)

SSI output provides effective synchronization in a closed-loop control system. A clock pulse train from a controller is used to clock out sensor data: one bit of position data is transmitted to the controller per one clock pulse received by the sensor. The use of a differential driver permits reliable transmission of data over long distances in environments that may be electrically noisy. The encoder utilizes a clock signal, provided by the user interface, to time the data transmission. Receiving electronics must include an appropriate receiver as well as line terminating resistors.

Features :

- Synchronous transmission
- Transmission lengths to 1000 feet
- Accepts clock rates from 100 KHz to 1.8 MHz

Data Transmission Sequence

1. Output driver of the encoder is a MAX 491 transceiver in transmit mode. The recommended receiver is a MAX 491 transceiver in receive mode.
2. Controller provides a series of pulses (or differential pulse pairs) on the CLOCK input lines.
3. On the first HIGH-to-LOW CLOCK transition, the encoder latches its data at the current position and prepares to transmit.
4. Controller reads data on the falling edge of the next 15 clock cycles.
5. The first bit is a START bit and is always HIGH.
6. Next comes 13 data bits beginning with the most significant bit (MSB) and ending with the parity bit. On 12 bit encoders, bit 13 is LOW. When parity is not ordered, parity is LOW.
7. After the last CLOCK HIGH-to-LOW transition, a minimum of 40 microseconds must pass before the beginning of the next CLOCK series.

Interfacing Long Data Lines

Cable impedance can create a transmission delay, in effect, shifting the phase relationship between the clock pulse and the data. If this phase shift exceeds 180°, then the wrong bit position will be sampled by the receiver. As a result, the maximum allowable clock frequency is a function of the cable length. For 24 AWG, stranded, 3 pair cable (BEI part number 37048-003 or equivalent) the group delay is 1.36ns/ft. The table below shows the maximum transmission rate allowable as a function of cable length to ensure a phase shift of less than 90°.

CLOCK, Maximum (kHz) =
92,000 / Cable Length (ft)CW

Cable Length (ft)	50	100	200	300	500	1000
Max Freq (kHz)	1800	900	500	300	200	100

Output Code and Terminations

	PARALLEL CODE		TERMINATION TYPE	
	Gray Code	Natural Binary	Cable	M14/19 Conn
	12 Bit	12 Bit		
MSB	G_{11}	2^{11}	WHT/BLK	A
	G_{10}	2^{10}	WHT/BRN	B
	G_9	2^9	WHT/RED	C
	G_8	2^8	WHT/ORN	D
	G_7	2^7	WHT/YEL	E
	G_6	2^6	WHT/GRN	F
	G_5	2^5	WHT/BLU	G
	G_4	2^4	WHT/VIO	H
	G_3	2^3	WHT/GRY	J
	G_2	2^2	WHT	K
	G_1	2^1	GRY/BLK	L
LSB_{12}	G_0	2^0	GRY/BRN	M
LSB_{13}			GRY/RED	N
	0V (CIRCUIT COMMON)[1]		GRY/ORN	P
	DIRECTION OF COUNT		ORN	R
	CASE GROUND		GRN	S
	0V (CIRCUIT COMMON)		BLK	T
	LATCH CONTROL		YEL	U
	+V (SUPPLY VOLTAGE)		RED	V
	SHIELD DRAIN		BARE	—

[1]Pin P is available for a tri-state option

Ordering SSI : HOW TO SPECIFY SSI OUTPUT IN THE ENCODER MODEL NUMBER: Use the designation, S3 between the Code Format designation and the Connector designation.
Example: H25D-SS-12GC-S3-CW-SM18

SSI Output Termination Table

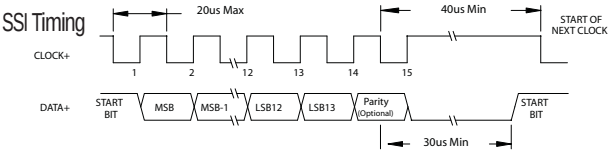
	M18 Conn	M14/19 Conn	Cable Conn
DATA +	A	A	YEL
DATA-	H	B	WHT/YEL
CLOCK+	B	C	BLU
CLOCK-	I	D	WHT/BLU
DIR CONTROL	C	R	ORN
CASE GROUND	G	S	GRN
CIRCUIT COMMON	F	T	BLK
+V SUPPLY VOLTAGE	D	V	RED
SHIELD DRAIN	—	—	BARE

Direction of Count: Standard is CW increasing when viewed from the shaft end. Pin R is normally HI (or N/C) and is pulled up internally to +V. To reverse the count direction, Pin R must be pulled LO (COMMON).

Latch control: Encoder outputs are active and provide continuous parallel position information when Pin U is HI (or N/C). Pin U is pulled up internally to +V. When Pin U is LO (COMMON) the encoder outputs are latched at the logic state that is present when the latch is applied and will stay latched until Pin U is no longer grounded.

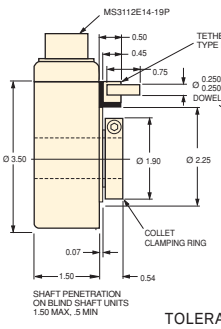
M18 Connector is a MS3102R18-1P, 10-pin connector on the encoder body and mates to an MS3106F18-1S connector or can be used with a standard cable/connector assembly, BEI P/N 924-31186-18XX (Where XX = 10, 20 30 or 50 for a 10, 20, 30, or 50 foot length). This is the preferred connector for SSI output.

M14/19 Connector is a MS3112E14-19P, 19-pin connector on the encoder body and mates to an MS3116J14-19S or equivalent.

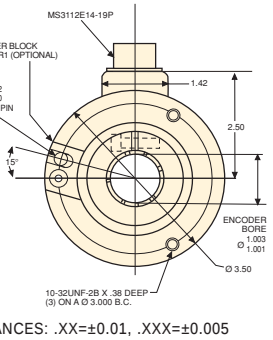


Dimensions

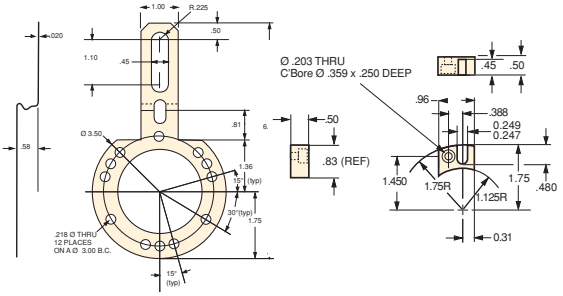
MS Connector Termination



R1 Tether Block and Pin



R2 Tether Arm



TOLERANCES: .XX=±0.01, .XXX=±0.005

Notes

1. The shaft seal is recommended in virtually all installations. The most common exceptions are applications requiring a very low starting torque or those requiring operation at both high temperature and high speed.

2. Output IC's: Output IC's are available as either Line Driver (LD) or NPN Open Collector (OC) types. Open Collectors require pull-up resistors, resulting in higher output source impedance (sink impedance is similar to that of line drivers). In general, use of a Line Driver style output is recommended. Line Drivers source or sink current and their lower impedance mean better noise immunity and faster switching times. **Warning:** Do not connect any line driver outputs directly to circuit common/0V, which may damage the driver. Unused outputs should be isolated and left floating. Our applications specialists would be pleased to discuss your system requirements and the compatibility of your receiving electronics with Line Driver type outputs.

28V/V: Multi-voltage Line Driver (7272*): 100 mA source/sink. Input voltage 5 to 28 VDC +/- 5% standard (Note: $V_{out} = V_{in}$). This driver is TTL compatible when used with 5 volt supply. Supply lines are protected against overvoltage to 60 volts and reverse voltage. Outputs are short circuit protected for one minute. Supply current is 120 mA typical (plus load current). This is the recommended replacement for 3904R and 7406R open collector outputs with internal pullup resistors. It is also a direct replacement for any 4469, 88C30, 8830 or 26LS31 line driver

28V/5: Multi-voltage Line Driver (7272*): 100 mA source/sink. Input voltage 5 to 28 VDC +/- 5% standard, internally regulated with 5V (TTL compatible) logic out. Supply lines are protected against overvoltage to 60 volts and reverse voltage. Outputs are short circuit protected for one minute. Supply current is 90 mA typical (plus load current). Note: Limit encoder load to 2.5W max at ambient. Example at 12 VDC: 2.5W/(+12VDC minus +5VDC) = 357 mA total allowed current. Consult factory for your specific requirements.

28V/OC: NPN Open Collector (3904*, 7273*). Current sink of 80 mA max. Current sourced by external pull- up resistor. Output can be pulled up to voltage other than supply voltage (30 V max). Input voltage 5 to 28 VDC +/- 5% standard. Supply current is 120 mA typical. This replaces prior IC's with designations of 3904, 7406, 3302, 681 and 689.

3. Special –S at the end of the model number is used to define a variety of non-standard features such as special shaft lengths, voltage options, or special testing. Please consult the factory to discuss your special requirements.

* Products manufactured prior to April 2007 used the line driver IC number instead of voltage output in model number.

Figures

Figure 1
Gray Code

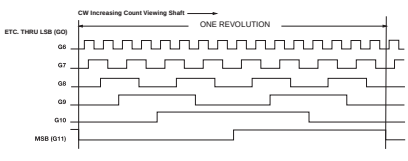
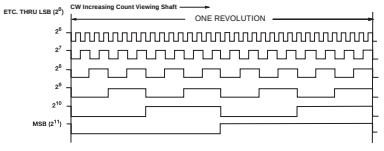


Figure 2
Natural Binary



Temperature Indicator, Ashcroft, 30-CI-60-040-0/200F &, 30-CI-60-040-50/500F

- Installations and Maintenance Instructions
- Bimetal Thermometers Dimensions
- Bimetal Thermometers Specifications
- Thermowell Selection Sheet

INSTALLATION AND MAINTENANCE INSTRUCTIONS FOR ASHCROFT® TYPE 91 SERIES ADAPTER KIT

ASHCROFT®

The Type 91 Series Adapter Sets were designed to provide a simple means of installing a bimetal dial thermometer into an existing industrial glass thermometer well.

The adapter set consists of:

1. A metal liner and spring assembly.
2. An adapter nut.
3. A small supply of heat conducting medium.

METHOD OF SELECTING THE SET

The Adapter Sets are available in four different sizes, to cover various depths of wells. The "Selection Chart" shows the Adapter Set number and the Bimetal Dial Thermometer stem length to use for any well depth from 3⅝″ up to 25⅛″.

To select the proper Adapter Set and Bimetal Dial Thermometer stem length, measure first the well depth by inserting a pencil, or any small diameter rod or stiff wire until it reaches the bottom. (See Figure 1.) Be sure the rod does not hang up on any shoulder inside the well. Using your thumb as an index, withdraw the rod and measure the distance from the end of the rod to the index point. (See Figure 2.)

Then use the chart to select the Adapter Set and the Bimetal Dial Thermometer stem length to fit the well.

Note that one stem length of thermometer covers several different well depths by using the correct Adapter Set.

For example, a thermometer with a 9″ long stem can be used for well depths between 7⅛″ and 10⅛″ by choosing the correct Adapter Set.

The liner is tapped with a 5⁄16″-18 machine thread so it can be removed from the well if desired.

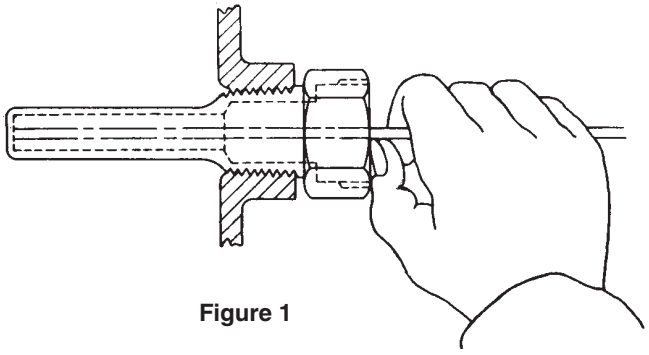


Figure 1

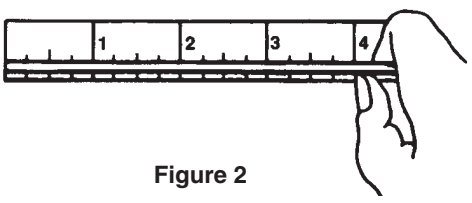


Figure 2

INSTALLATION

Assemble the adapter nut into the well and tighten securely. (See Figure 3.)

Before installing the Bimetal Dial Thermometer into the adapter and well, coat the lower 3″ section of the thermometer with a layer of heat conducting medium. This will improve the temperature response of the thermometer.

The metal liner is then slipped over the end of the thermometer stem and a coating of heat conducting medium is applied to the outside wall of the liner.

The thermometer and the liner are then inserted into the well and tightened in position. Do not tighten more than is necessary to prevent the thermometer from turning.

Where service temperatures exceed 350°F the heat conducting medium may smoke when first subjected to a high temperature. This is caused by the vehicle, in the heat conducting medium, vaporizing and leaving the dry solids behind. This should not be cause for alarm. The dry solids will act equally well as a heat conducting medium for temperatures up to 1000°F.

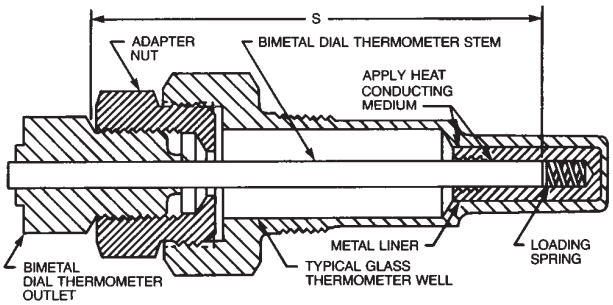


Figure 3

SELECTION CHART

WELL DEPTH IN INCHES	ADAPTER SET NO.	STEM LENGTH "S"
3		
4	91B	4
5	91A	
6	91C	6
7	91B	
8	91A	
9	91D	9
10	91C	
11	91B	
12	91A	
13		
14	91D	12
15	91C	
16	91B	15
17	91A	
18	91D	18
19	91C	
20		
21		
22		
23	91D	24
24	91C	
25	91B	
	91A	

Note: If the measured well depth falls on the dividing line between two stem lengths and/or two Adapter Sets choose the stem and/or Adapter Set above the line.

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INSTALLATION AND MAINTENANCE INSTRUCTIONS FOR ASHCROFT® BIMETAL DIAL THERMOMETERS

ASHCROFT®

GENERAL

In removing the thermometer out of the packing box, handle it by the case or case outlet. Avoid handling it by the stem.

INSTALLATION OF THERMOMETERS

The thermometer should be mounted at any convenient location where it will be subjected to the average temperature variations to be indicated.

Avoid bending the stem as this will cause misalignment of the internal parts, resulting in undue frictional errors.

To tighten the thermometer to the apparatus, use a wrench applied to the hexagon head of the threaded connection located just outside of the case.

INSTALLATION

Locate the stem so that at least two inches will be subjected to the average temperature to be measured.

Exposing the stem to a temperature in excess of the highest dial reading should be avoided.

The thermometer is normally provided with a threaded connection. To tighten the thermometer to the apparatus or into the well, use an open-end wrench applied to the hexagon head of the threaded connection.Turn until reasonably tight, then tighten still further in the same manner as a pipe elbow or similar pipe fitting until the scale is in the desired position for reading. DO NOT TIGHTEN BY TURNING THE THERMOMETER CASE. *Install the dry type thermometer so that the maximum case temperature is kept below 200°F at all times. Install the liquid filled type thermometer so that the maximum case temperature is kept below 150°F at all times.*

When a thermometer is equipped with a well, the well should be installed onto the apparatus first. The stem of the thermometer should then be coated with a heat conducting medium (a mixture of glycerin and graphite or vaseline or any other heavy lubricant may be used), after which the thermometer stem is inserted, and tightened into the well.

XC2 INSTALLATION

The XC2 variation meets the NSF/ANSI standard 2 (2002E) guidelines for non-exposed applications. Please refer to the NSF guidelines for certified installation instructions and approved materials.

CAUTION: *Thermowells should be used on all pressurized applications, to protect the thermometer from corrosion or physical damage, and to facilitate removal of the thermometer without disturbing the process*.

TESTING

Ashcroft Bimetal Dial Thermometers are carefully calibrated at the factory and under most operating conditions will retain their accuracy indefinitely. However, as in the case of all instruments, it is well to make periodic checks for accuracy against known standards.

ADJUSTMENT

If it is necessary to make an adjustment to the thermometer proceed as follows:

On thermometers fitted with an “External Adjustment” – Use a small wrench, small screwdriver or a coin to turn the slotted hexagon head in the back of the case until the pointer indicates the proper temperature on the dial.

MAINTENANCE OF DIAL THERMOMETERS

Aside from occasional testing, little or no maintenance is required.

Be sure that the gasketed glass cover is on the case at all times, as moisture and dirt inside the case will eventually cause the thermometer to lose its accuracy. (See caution note below.)

If the thermometer is used for measuring the temperature of a material that may harden and build up an insulating layer on the stem, the thermometer should be removed from the apparatus occasionally, and the stem cleaned. Observe this precaution to ensure the sensitivity of the instrument.

CAUTION:
Bimetal Thermometers operating below freezing must have a perfectly tight case to prevent entrance of moisture which eventually will condense and freeze inside the stem. This condition shows up as a failure of the thermometer to read accurately below 32°F or 0°C. For this reason it is important to avoid damage to the glass front while the stem temperature is at freezing or below. All thermometers are hermetically sealed in a dry atmosphere at the factory and require no further maintenance.

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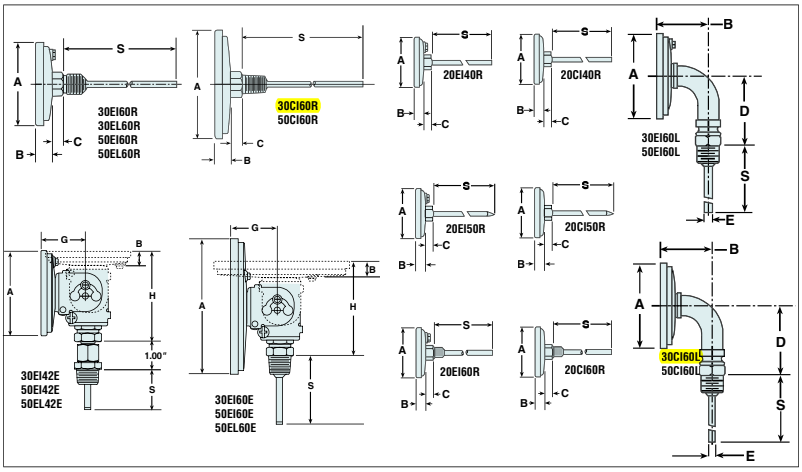
Bimetal Thermometers Dimensions

ASHCROFT®

Bimetal Thermometers
Series CI

Series CI



Case Series	Dial Size	Connection Location	A	B	C	D	E	G	H	S	NPT	Hex	Weight in ounces[3] S – 2½″ Case Series CI	EI	EL
CI, EI	2″	Rear (Plain)	2 3/32 (53)	3/8 (10)	5/16 (8)	–	–	–	–	–[2]	–	1 1/16	4½	4½	–
CI, EI	2″	Rear (Plain, pointed stem)	2 3/32 (53)	3/8 (10)	5/16 (8)	–	–	–	–	–[2]	–	1 1/16	4½	4½	–
CI, EI	2″	Rear (Threaded)	2 3/32 (53)	3/8 (10)	5/16 (8)	–	–	–	–	–[2]	¼	1 1/16	4½	4½	–
CI, EI, EL	3″	Rear	3 5/32 (80)	19/32 (15)	5/16 (8)	–	–	–	–	–[2]	½	7/8	7	7	8
CI, EI	3″	Lower	3 5/32 (80)	1 27/32 (47)	–	2 5/8 (67)	¼ (6)	–	–	–[2]	½	7/8	11	11	–
EI	3″	Everyangle	3 5/32 (80)	19/32 (15)	–	–	–	1 21/32 (42)	3 7/16 (87)	–[2]	½	7/8	–	10	–
CI, EI, EL	5″	Rear	5 1/32 (128)	23/32 (18)	5/16 (8)	–	–	–	–	–[2]	½	7/8	15	16	18
CI, EI	5″	Lower	5 1/32 (128)	1 15/16 (49)	–	3 5/8 (92)	¼ (6)	–	–	–[2]	½	7/8	24	26	–
EI, EL	5″	Everyangle	5 1/16 (128)	23/32 (18)	–	–	–	1 7/8 (48)	3 9/16 (91)	–[2]	½	7/8	–	25	28

NOTES

1 Figures in parenthesis ( ) are in millimeters. All other dimensions are in inches.

2 Standard "S" dimensions are 2½, 4, 6, 9, 12, 15, 18 and 24 inches.
Standard stem diameter is ¼ inch.

3 Add 1 oz. for every 2 inches of stem length.

Series CI Dim. Dwg.

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Bimetal Thermometers Specifications

TFL 5412 NOTE: SCRUBBER WATER TEMP. INDICATOR: 30-CI-R-040-0/200F

THERMAL HEATING FLUID TEMP. INDICATOR: 30-CI-60-L-040-50/550F

ASHCROFT®

Bimetal Thermometers
Series CI, ASME B40.3
Grade A (±1% of span)

- ***Hermetically sealed***
- ***Tamper resistant***
- ***Maxivision® dial***
- ***±1% full-span accuracy (ASME B40.3 Grade A)***
- ***All-welded stainless steel construction***
- ***Silicone on the coil provides vibration dampening and superior time response***
- ***Heavy-duty glass standard; plastic or shatterproof glass optional***
- ***Limited five-year warranty***

This series is tamper proof, hermetically sealed and has the Maxivision® dial. The connection locations are rear and lower. The CI series of Ashcroft® industrial bimetal thermometers was designed for applications where external adjustment or pointer reset are not desired.

The hermetic seal prevents entry of moisture into the casing, thus minimizing the possibility of fogging inside the case. The Maxivision dial provides accurate temperature readings.

IN A RUSH? ASK FOR ASHCROFT GOLD SERVICE

SELECTION TABLE

Case Size		Style Code	Stem				Stem Lengths Available		Temperature Range					
Dial	Code		Connection	Code	Location	Code	"S" Length (inches)	Code	°F* Fahrenheit	°/Div.	Fig. Inter.	°C Celsius	°/Div.	Fig. Inter.
2″	20	CI	Plain	40	Rear	R			–80/120	2	20	–50/50	1	10
			Pointed Plain	50	Rear	R	2½	025	–20/120††			–20/120	2	20
			¼ NPT	60	Rear	R	4	040	30/130††	1	10	0/50††	1	5
3″	30		½ NPT	60	Rear	R	6	060	0/200		20	0/100	1	10
					Lower	L	9	090	0/250	2		10/150	2	20
5″	50		½ NPT	60	Rear	R	12	120	50/300			0/200		
							15	150	50/400		50	0/300		
							18	180	50/550	5		50/450**†	5	50
					Lower	L	24	240	200/700†			100/500**†		
									100/800†	10	100			
									200/1000**†					

*Dual scale ranges available for all standard °F ranges (3″ and 5″ case only)

**Satisfactory for continuous service up to 800°F or 425°C. Can be used for intermittent service from 800 to 1000°F, or 425 to 500°C.
Use Ashcroft Duratemp® thermometers for ranges above and below those listed above.

†Minimum stem length for these ranges is 4″.

††Minimum stem length for lower connection is 4″.

Thermowells must be used on all pressure or velocity applications, to protect the stem of thermometer from corrosion and physical damage, and to facilitate removal of the thermometer without disturbing the process.
Maximum ambient temperature is 200°F (95°C).

Overtemperature Limits	
Top of Range °F	Maximum Overtemperature
up to 250	100% of span
250/550	50% of span
550/1000	800°F **

TO ORDER THIS CI SERIES BIMETAL THERMOMETER:

Select: 30 CI 60 R 040 0/250°F XNH

1. Case Size: 3″ Code 30
2. Style: Code CI
3. Stem Conn: ½ NPT Code 60
4. Stem Location: Rear Code R
5. Stem Length: 4″ Code 040
6. Range: Code 0/250°F
7. Options: Stainless Steel Tag (see Page 210)

Consult factory for guidance in product selection
Phone (203) 385-0217, Fax (203) 385-0602 or
mail@ashcroft.com

MADE IN U.S.A.

Thermowell Selection Sheet

ASHCROFT®

Thermowells

75	W	0750	____	____	H	T	260	C	____	____	____	____
Size		U-Dimesion	Thread	Lagging	Shank	Type	Bore	Material	Cap & Chain	Facing	Rating	Special Lagging Length

Code	Inches
50	½
75	¾
10	1
12	1¼
15	1½
20	2
30	3
40	4

Code	Inches
0162	1⅝
0250	2½
0450	4½
0750	7½
1050	10½
1350	13½
1650	16½
1950	19½
2250	22½

Code	Inches
–	Without
L	With

Code	Type
T	NPT Thd.
W	Weld-in
F	Flanged
V	Van Stone
S	Socket Weld
M	Limited Space Threaded
G	Ground Joint
C	Sanitary

Code	Type
AA	Brass
B	Carbon Steel
C	AISI 304
S	AISI 316

Code	Rating #
150	150
300	300
600	600
1500	1500
2500	2500

Code	Internal Thread
–	½ NPSM

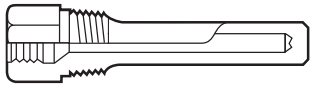
Code	Shank
H	Tapered
S	Straight
R	Stepped
B	Built-up

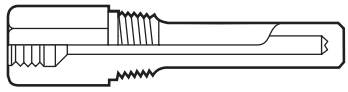
Code	Diameter
260	.260˝
385	.385˝

Code	Material
1	Brass
2	Stainless Steel

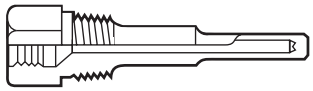
Code	Facing
F	Flat Face
R	Raised Face
J	Ring Joint
L	Lap Joint

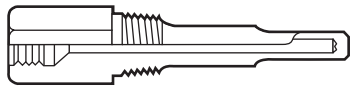
Type: Straight (Uniform) Shank, Threaded
Bore Size: .385
Process Conn.: ½, ¾, 1 NPT, Wed-In
Materials: Brass, Carbon Steel
304 Stainless Steel, 316 Stainless Steel


Standard Configuration

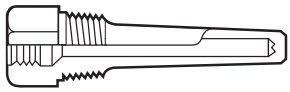

Lagging Configuration

Type: Stepped Shank, Threaded
Bore Size: .260
Process Conn.: ½, ¾, 1 NPT
Materials: Brass, Carbon Steel
304 Stainless Steel, 316 Stainless Steel


Standard Configuration


Lagging Configuration

Type: Tapered Shank, Threaded
Bore Size: .260, .385
Process Conn.: ½, ¾, 1 NPT
Materials: Brass, Carbon Steel
304 Stainless Steel, 316 Stainless Steel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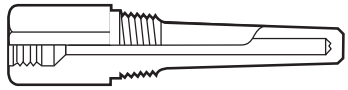
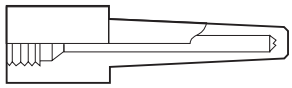

Lagging Configuration

Type: Socket Weld
Bore Size: .260, .385
Process Conn.: ¾˝, 1˝ Pipe Size
Materials: 304 Stainless Steel, 316 Stainless Steel, Carbon Steel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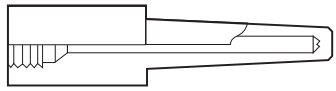
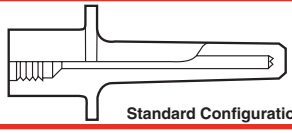
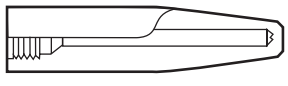

Lagging Configuration

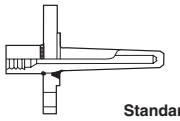
Type: Van Stone
Bore Size: .260, .385
Process Conn.: 1˝ 1½˝ Pipe Size
Materials: 304 Stainless Steel, 316 Stainless Steel


Standard Configuration

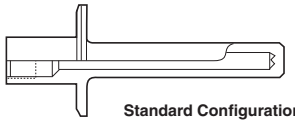
Type: Weld-in
Bore Size: .260, .385
Process Conn.: 1½˝ Dia.
Materials: 304 Stainless Steel, 316 Stainless Steel


Standard Configuration

Type: Flanged
Bore Size: 260, .385
Process Conn.: 1˝, 1½˝, 2˝ Pipe Size
Materials: 304 Stainless Steel, 316 Stainless Steel


Standard Configuration

Type: Sanitary
Bore Size: .260, .385
Process Conn.: Tri-Clamp connection® 1˝, 1½˝, 2˝
Materials: 304 Stainless Steel, 316 Stainless Steel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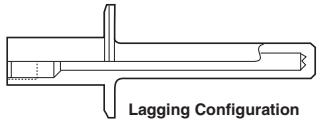
Lagging Configuration

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Phone (203) 378-8281, Fax (203) 385-0499 or
visit Pandora's Box, Part 1 or 2, ashcroft.com

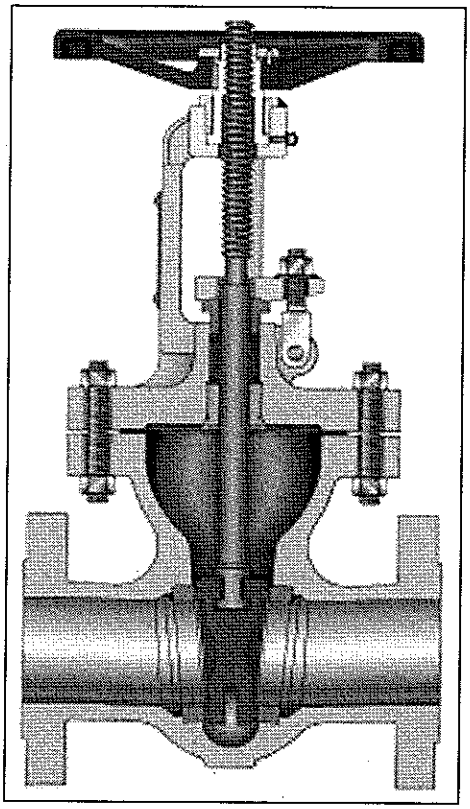
Thermal Oil Valve, Velan, Cast Carbon Gate Valve

- Velan Gate Valve Product Data & Sizing Sheet

VELAN

CAST CARBON, STAINLESS OR ALLOY STEEL API 600 BOLTED BONNET GATE VALVES, 2–60" (50–1500 mm)

ASME CLASSES 150, 300, 600, 900 AND 1500



CLASS	FIGURE NUMBER
150	0064C
300	1064C
600	2064C
900	7064C
1500	3064C

DESIGN FEATURES:

- **Universal Trim.** 13 CR stem, wedge in CA 15 or 13 CR faced, and Stellited seat API Trim 8 suitable for applications up to 850°F (454°C).
- **Seat face** Stellited, ground and lapped to a mirror finish.
- **Flexible Wedge** with low center stem-wedge contact, in solid CA15 (13 CR) or hardfaced with 13 CR, SS 316, Monel or Stellite. Wedge is ground and lapped to a mirror finish and tightly guided to prevent dragging and seat damage. A Stellite 6 hardfaced CF8M wedge is also available.
- **Non-rotating stem** with precision Acme threads and burnished finish. Double Acme for faster operation.
- **Body and bonnet joint** accurately machined. Gasket materials on page 3, details on page 13.

STANDARD MATERIALS

PART	MATERIALS			
Body[1]	WCB	WC6	WC9	CF8M
Bonnet[1]	WCB	WC6	WC9	CF8M
Stem[1][3]	SS 410			SS 630, 600 or SS 316
Wedge[1]	CA 15 or 13 CR faced WCB	CA 15 or 13 CR faced WC6	CA 15 or 13 CR faced WC9	CF8M
Seat[1][2]	Stellite 6 faced carbon steel	Stellite 6 faced F11	Stellite 6 faced F22	Stellite 6 faced F316
Packing flange	Carbon steel			Stainless steel
Gland bushing	Carbon steel			Stainless steel
Packing ring[1]	Graphite			Graphite
Gland stud	Gr. B or B7[4]			F316, B8M or 630[5]
Gland nut	Gr. 2H			Gr. 8M
Body/bonnet nut	Gr. 2H	Gr. 4		Gr. 8M
Body/bonnet stud	B7	B16		B8M or 630
Back seat[1][3]	SS 410			SS 316
Gasket[1]	Class 150: corrugated steel/graphite Class 300-1500: spiral wound stainless steel/graphite			
Key	Carbon steel			
Yoke bushing	Carbon steel			Stainless steel
Bearing	Steel			
Handwheel nut	Malleable iron or steel			
Handwheel[1]	Malleable iron or steel			
Grease fitting	Steel			
Groove pin	Carbon steel			Stainless steel
Bushing	Carbon steel			Stainless steel
Washer	Carbon steel			Stainless steel
Name plate	Stainless steel			
Identification tag	Stainless steel			
Rivet	Stainless steel			
Stem nut	A 439 Austenitic ductile iron Gr. D-2C			

(1) Other materials available. (2) Stellited. (3) Hardened.
(4) For eye bolts Gr.B, for studs B7 is used.
(5) For eye bolts F316, for studs B8M or 630 is used

DESIGN SPECIFICATIONS

ITEM	APPLICABLE SPECIFICATION
Wall thickness and general valve design	API 600, BS1414
Pressure-temperature rating	ASME B16.34
Face to face dimensions for butt weld and flanged valves	ASME B16.10
Flange design	ASME B16.5
Butt welding design	ASME B16.25
Materials	ASTM

- **Body and bonnet** castings are precision machined. One-piece bonnet up to 12" (300 mm) for better alignment and fewer parts.
- **Gland** has two-piece construction for easy alignment.
- **Flanges:**
  Classes 150–300: 1/16" raised face,
  Class 600 –1500: 1/4" raised face.
  Finish 125–250 AARH for all valves.
- **Rotating stem nut** is Austenitic ductile iron Gr. D-2C renewable in line (as shown). Thrust bearings are supplied as follows:
  150–300: 10–12" (250–300 mm), 1 bearing (top),
  16" (400 mm) and up, two bearings
  600: 6" (150 mm) and up
  900–1500: 6" (150 mm) and up.

For information on BELLOWS SEAL VALVES see VEL-BS catalog

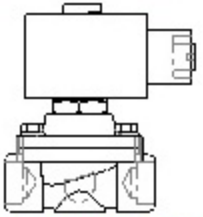
Solenoid Valve, ASCO, EF8210GO94MO

- ASCO EF8210GO94MO Ordering Information
- ASCO General Service Solenoid Valves Product Data
- ASCO Solenoid Valve Installation & Maintenance Instructions

ASCO®

Catalog No. EF 8210G094 MO 120/60,110/50

Valve Unit - 2W NC



General Information

Availability	5DAY	**Product Weight**	2.20 lb - 1.00 Kg
Order Code		**Shipping Weight**	2.29 lb - 1.04 Kg
Catalog Page	8210R1.pdf	**Kit Number**	302272-MO
Listed in Catalog			

Operating Pressure Ratings

Min Operating Pressure (Air)		**Max Operating Pressure (Air)**	150 PSI - 10.3 Bar
Min Operating Pressure (Water)		**Max Operating Pressure (Water)**	150 PSI - 10.3 Bar

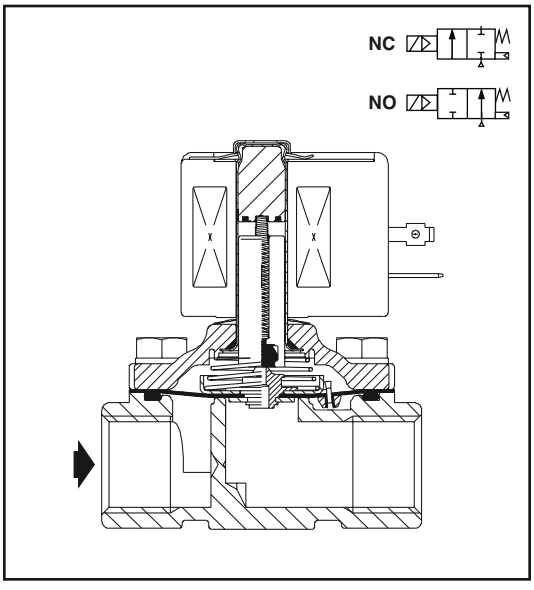
Technical Information

AC/DC	AC	**I&M Solenoid**	v6584R10_sec2.pdf
Actuation Method	Solenoid	**I&M Solenoid**	V6584R10_sec1.pdf
Body Material	Brass	**I&M Solenoid**	V6950R5_.pdf
Coil Class	FT	**Inlet Pipe Size (NPT)**	1/2
Coil Number	238614-032-D	**Lead Length**	18.00 in - 45.72 cm
Cv/Kv (Pressure Port)	4.00 Cv - 3.46 Kv	**Orifice Size**	5/8 in
I&M Pressure Vessel	V6031.pdf	**Solenoid Catalog Number**	EF8003G1
I&M Pressure Vessel	V5825R1.pdf	**Watt Rating 60 Hz**	10.10 W

5DAY = ASCO 5Day Product. Orders scheduled to ship within 5 business days.

Features

- Wide range of pressure ratings, sizes, and resilient materials provide long service life and low internal leakage
- High Flow Valves for liquid, corrosive, and air/inert gas service
- Industrial applications include:
  - Car wash
  - Laundry equipment
  - Air compressors
  - Industrial water control
  - Pumps



Construction

Valve Parts in Contact with Fluids		
Body	Brass	304 Stainless Steel
Seals and Discs	NBR or PTFE	
Disc-Holder	PA	
Core Tube	305 Stainless Steel	
Core and Plugnut	430F Stainless Steel	
Springs	302 Stainless Steel	
Shading Coil	Copper	Silver

Electrical

Standard Coil and Class of Insulation	Watt Rating and Power Consumption				Spare Coil Part Number			
		AC			General Purpose		Explosionproof	
	DC Watts	Watts	VA Holding	VA Inrush	AC	DC	AC	DC
F	-	6.1	16	40	238210	-	238214	-
F	11.6	10.1	25	70	238610	238710	238614	238714
F	16.8	16.1	35	180	272610	97617	272614	97617
F	-	17.1	40	93	238610	-	238614	-
F	-	20	43	240	99257	-	99257	-
F	-	20.1	48	240	272610	-	272614	-
H	30.6	-	-	-	-	74073	-	74073
H	40.6	-	-	-	-	238910	-	238914

Standard Voltages: 24, 120, 240, 480 volts AC, 60 Hz (or 110, 220 volts AC, 50 Hz). 6, 12, 24, 120, 240 volts DC. Must be specified when ordering.
Other voltages available when required.

Solenoid Enclosures

Standard: RedHat II - Watertight, Types 1, 2, 3, 3S, 4, and 4X; RedHat - Type I.

Optional: RedHat II - Explosionproof and Watertight, Types 3, 3S, 4, 4X, 6, 6P, 7, and 9; Red-Hat - Explosionproof and Watertight, Types 3, 4, 4X, 7, and 9.

(To order, add prefix "EF" to catalog number, except Catalog Numbers 8210B057, 8210B058, and 8210B059, which are not available with Explosionproof enclosures.)
See Optional Features Section for other available options.

Nominal Ambient Temp. Ranges

RedHat II/
RedHat AC: 32˚F to 125˚F (0˚C to 52˚C)

RedHat II DC: 32˚F to 104˚F (0˚C to 40˚C)
RedHat DC: 32˚F to 77˚F (0˚C to 25˚C)
(104˚F/40˚C occasionally)

Refer to Engineering Section for details.

Approvals

CSA certified. RedHat II meets applicable CE directives.
Refer to Engineering Section for details.

2/2 SERIES 8210

ASCO®

Specifications (English units)

Pipe Size (ins.)	Orifice Size (ins.)	Cv Flow Factor	Operating Pressure Differential (psi)							Max. Fluid Temp. °F		Brass Body			Stainless Steel Body			Watt Rating/ Class of Coil Insulation ⑦	
				Max. AC			Max. DC												
			Min.	Air-Inert Gas	Water	Light Oil @ 300 SSU	Air-Inert Gas	Water	Light Oil @ 300 SSU	AC	DC	Catalog Number	Const. Ref. ④	UL ⑤ Listing	Catalog Number	Const. Ref. ④	UL ⑤ Listing	AC	DC
NORMALLY CLOSED (Closed when de-energized), NBR or PTFE ② Seating																			
3/8	3/8	1.5	①	150	125	-	40	40	-	180	150	8210G073 ③	1P	●	8210G036 ③	1P	●	6.1/F	11.6/F
3/8	5/8	3	0	150	150	-	40	40	-	180	150	8210G093	5D	❍	-	-	-	10.1/F	11.6/F
3/8	5/8	3	5	200	150	135	125	100	100	180	150	8210G001	6D	❍	-	-	-	6.1/F	11.6/F
3/8	5/8	3	5	300	300	300	-	-	-	175	-	8210G006	5D	❍	-	-	-	17.1/F	-
1/2	7/16	2.2	①	150	125	-	40	40	-	180	150	8210G015 ③	2P	●	8210G037 ③	2P	●	6.1/F	11.6/F
1/2	5/8	4	0	150	150	-	40	40	-	180	150	8210G094	5D	❍	-	-	-	10.1/F	11.6/F
1/2	5/8	4	0	150	150	125	40	40	-	175	150	-	-	-	8210G087	7D	●	17.1/F	11.6/F
1/2	5/8	4	5	200	150	135	125	100	100	180	150	8210G002	6D	❍	-	-	-	6.1/F	11.6/F
1/2	5/8	4	5	300	300	300	-	-	-	175	-	8210G007	5D	❍	-	-	-	17.1/F	-
1/2	3/4	4	5	-	300	-	-	300	-	180	125	8210G227	5D	❍	-	-	-	17.1/F	40.6/H
3/4	5/8	4.5	0	150	150	125	40	40	-	175	150	-	-	-	8210G088	7D	●	17.1/F	11.6/F
3/4	3/4	5	5	125	125	125	100	90	75	180	150	8210G009	9D	❍	-	-	-	6.1/F	11.6/F
3/4	3/4	5	0	150	150	-	40	40	-	180	150	8210G095	8D	❍	-	-	-	10.1/F	11.6/F
3/4	3/4	6.5	5	250	150	100	125	125	125	180	150	8210G003	11D	❍	-	-	-	6.1/F	11.6/F
3/4	3/4	6	0	-	-	-	200	180	180	-	77	8210B026 ② ‡	10P	-	-	-	-	-	30.6/H
3/4	3/4	6	0	350	300	200	-	-	-	200	-	8210G026 ② ‡	40P	●	-	-	-	16.1F	-
1	1	13	0	-	-	-	100	100	80	-	77	8210B054 ‡	31D	-	8210D089	15D	-	-	30.6/H
1	1	13	0	150	125	125	-	-	-	180	-	8210G054	41D	●	8210G089	45D	●	16.1/F	-
1	1	13	5	150	150	100	125	125	125	180	150	8210G004	12D	❍	-	-	-	6.1/F	11.6/F
1	1	13.5	0	300	225	115	-	-	-	200	-	8210G027 ‡	42P	●	-	-	-	20.1/F	-
1	1	13.5	10	300	300	300	-	-	-	175	-	8210G078 ②	13P	-	-	-	-	17.1/F	-
1 1/4	1 1/8	15	0	-	-	-	100	100	80	-	77	8210B055 ‡	32D	-	-	-	-	-	30.6/H
1 1/4	1 1/8	15	0	150	125	125	-	-	-	180	-	8210G055	43D	●	-	-	-	16.1/F	-
1 1/4	1 1/8	15	5	150	150	100	125	125	125	180	150	8210G008	16D	❍	-	-	-	6.1/F	11.6/F
1 1/2	1 1/4	22.5	0	-	-	-	100	100	80	-	77	8210B056 ‡	33D	-	-	-	-	-	30.6/H
1 1/2	1 1/4	22.5	0	150	125	125	-	-	-	180	-	8210G056	44D	●	-	-	-	16.1/F	-
1 1/2	1 1/4	22.5	5	150	150	100	125	125	125	180	150	8210G022	18D	●	-	-	-	6.1/F	11.6/F
2	1 3/4	43	5	150	125	90	50	50	50	180	150	8210G100	20P	●	-	-	-	6.1/F	11.6/F
2 1/2	1 3/4	45	5	150	125	90	50	50	50	180	150	8210G101	21P	●	-	-	-	6.1/F	11.6/F
NORMALLY OPEN (Open when de-energized), NBR Seating (PA Disc-Holder, except as noted)																			
3/8	5/8	3	0	150	150	125	125	125	80	180	150	8210G033	23D	●	-	-	-	10.1/F	11.6/F
3/8	5/8	3	5	250	200	200	250	200	200	180	180	8210G011 ⑧ ⑨	39D	●	-	-	-	10.1/F	11.6/F
1/2	5/8	4	0	150	150	125	125	125	80	180	150	8210G034	23D	●	-	-	-	10.1/F	11.6/F
1/2	5/8	3	0	150	150	100	125	125	80	180	150	-	-	-	8210G030	37D	●	10.1/F	11.6/F
1/2	5/8	4	5	250	200	200	250	200	200	180	180	8210G012 ⑧ ⑨	39D	●	-	-	-	10.1/F	11.6/F
3/4	3/4	5.5	0	150	150	125	125	125	80	180	150	8210G035	25D	●	-	-	-	10.1/F	11.6/F
3/4	5/8	3	0	150	150	100	125	125	80	180	150	-	-	-	8210G038	38D	●	10.1/F	11.6/F
3/4	3/4	6.5	5	-	-	-	250	200	200	-	180	8210C013	24D	●	-	-	-	-	16.8/F
3/4	3/4	6.5	5	250	200	200	-	-	-	180	-	8210G013	46D	●	-	-	-	16.1/F	-
1	1	13	0	125	125	125	-	-	-	180	-	8210B057 ⑥ ⑩	34D	●	-	-	-	20/F	-
1	1	13	5	-	-	-	125	125	125	-	180	8210D014	26D	●	-	-	-	-	16.8/F
1	1	13	5	150	150	125	-	-	-	180	-	8210G014	47D	●	-	-	-	16.1/F	-
1 1/4	1 1/8	15	0	125	125	125	-	-	-	180	-	8210B058 ⑥ ⑩	35D	●	-	-	-	20/F	-
1 1/4	1 1/8	15	5	-	-	-	125	125	125	-	180	8210D018	28D	●	-	-	-	-	16.8/F
1 1/4	1 1/8	15	5	150	150	125	-	-	-	180	-	8210G018	48D	●	-	-	-	16.1/F	-
1 1/2	1 1/4	22.5	0	125	125	125	-	-	-	180	-	8210B059 ⑥ ⑩	36D	●	-	-	-	20/F	-
1 1/2	1 1/4	22.5	5	-	-	-	125	125	125	-	180	8210D032	29D	●	-	-	-	-	16.8/F
1 1/2	1 1/4	22.5	5	150	150	125	-	-	-	180	-	8210G032	49D	●	-	-	-	16.1/F	-
2	1 3/4	43	5	-	-	-	125	125	125	-	150	8210 103	30P	●	-	-	-	-	16.8/F
2	1 3/4	43	5	125	125	125	-	-	-	180	-	8210G103	50P	●	-	-	-	16.1/F	-
2 1/2	1 3/4	45	5	-	-	-	125	125	125	-	150	8210 104	27P	●	-	-	-	-	16.8/F
2 1/2	1 3/4	45	5	125	125	125	-	-	-	180	-	8210G104	51P	●	-			16.1/F	-

① 5 psi on Air; 1 psi on Water.
② Valve provided with PTFE main disc.
③ Valve includes Ultem (G.E. trademark) piston.
④ Letter "D" denotes diaphragm construction; "P" denotes piston construction.
⑤ ❍ Safety Shutoff Valve; ● General Purpose Valve.
Refer to Engineering Section (Approvals) for details.
⑥ Valves not available with Explosionproof enclosures.
⑦ On 50 hertz service, the watt rating for the 6.1/F solenoid is 8.1 watts.
⑧ AC construction also has PA seating.
⑨ No disc-holder.
⑩ Stainless steel disc-holder.
‡ Must have solenoid mounted vertical and upright.

Specifications (Metric units)

Pipe Size (ins.)	Orifice Size (mm)	Kv Flow Factor (m3/h)	Operating Pressure Differential (bar)							Max. Fluid Temp. ˚C		Brass Body			Stainless Steel Body			Watt Rating/ Class of Coil Insulation ⑦	
				Max. AC			Max. DC												
			Min.	Air-Inert Gas	Water	Light Oil @ 300 SSU	Air-Inert Gas	Water	Light Oil @ 300 SSU	AC	DC	Catalog Number	Const. Ref. ④	UL ⑤ Listing	Catalog Number	Const. Ref. ④	UL ⑤ Listing	AC	DC
NORMALLY CLOSED (Closed when de-energized), NBR or PTFE ② Seating																			
3/8	10	1.29	①	10	9	-	3	3	-	82	65	8210G073 ③	1P	●	8210G036 ③	1P	●	6.1/F	11.6/F
3/8	16	2.57	0	10	10	-	3	3	-	82	65	8210G093	5D	❍	-	-	-	10.1/F	11.6/F
3/8	16	2.57	0.3	14	10	9	9	7	7	82	65	8210G001	6D	❍	-	-	-	6.1/F	11.6/F
3/8	16	2.57	0.3	21	21	21	-	-	-	79	-	8210G006	5D	❍	-	-	-	17.1/F	-
1/2	11	1.89	①	10	9	-	3	3	-	82	65	8210G015 ③	2P	●	8210G037 ③	2P	●	6.1/F	11.6/F
1/2	16	3.43	0	10	10	-	3	3	-	82	65	8210G094	5D	❍	-	-	-	10.1/F	11.6/F
1/2	16	3.43	0	10	10	9	3	3	-	79	65	-	-	-	8210G087	7D	●	17.1/F	11.6/F
1/2	16	3.43	0.3	14	10	9	9	7	7	82	65	8210G002	6D	❍	-	-	-	6.1/F	11.6/F
1/2	16	3.43	0.3	21	21	21	-	-	-	79	-	8210G007	5D	❍	-	-	-	17.1/F	-
1/2	19	3.43	0.3	-	21	-	-	21	-	82	52	8210G227	5D	❍	-	-	-	17.1/F	40.6H
3/4	16	3.86	0	10	10	9	3	3	-	79	65	-	-	-	8210G088	7D	●	17.1/F	11.6/F
3/4	19	4.29	0.3	9	9	9	7	6	5	82	65	8210G009	9D	❍	-	-	-	6.1/F	11.6/F
3/4	19	4.29	0	10	10	-	3	3	-	82	65	8210G095	8D	❍	-	-	-	10.1/F	11.6/F
3/4	19	5.57	0.3	17	10	7	9	9	9	82	65	8210G003	11D	❍	-	-	-	6.1/F	11.6/F
3/4	19	5.14	0	-	-	-	14	12	12	-	25	8210B026 ② ‡	10P	-	-	-	-	-	30.6/H
3/4	19	5.14	0	24	21	14	-	-	-	93	-	8210G026 ② ‡	40P	●	-	-	-	16.1F	-
1	25	11.14	0	-	-	-	7	7	6	-	25	8210B054 ‡	31D	-	8210D089	15D	-	-	30.6/H
1	25	11.14	0	10	9	9	-	-	-	82	-	8210G054	41D	●	8210G089	45D	●	16.1/F	-
1	25	11.14	0.3	10	10	7	9	9	9	82	65	8210G004	12D	❍	-	-	-	6.1/F	11.6/F
1	25	11.57	0	21	16	8	-	-	-	93	-	8210G027 ‡	42P	●	-	-	-	20.1/F	-
1	25	11.57	0.7	21	21	21	-	-	-	79	-	8210G078 ②	13P	-	-	-	-	17.1/F	-
1 1/4	29	12.86	0	-	-	-	7	7	6	-	25	8210B055 ‡	32D	-	-	-	-	-	30.6/H
1 1/4	29	12.86	0	10	9	9	-	-	-	82	-	8210G055	43D	●	-	-	-	16.1/F	-
1 1/4	29	12.86	0.3	10	10	7	9	9	9	82	65	8210G008	16D	❍	-	-	-	6.1/F	11.6/F
1 1/2	32	19.29	0	-	-	-	7	7	6	-	25	8210B056 ‡	33D	-	-	-	-	-	30.6/H
1 1/2	32	19.29	0	10	9	9	-	-	-	82	-	8210G056	44D	●	-	-	-	16.1/F	-
1 1/2	32	19.29	0.3	10	10	7	9	9	9	82	65	8210G022	18D	●	-	-	-	6.1/F	11.6/F
2	44	36.86	0.3	10	9	6	3	3	3	82	65	8210G100	20P	●	-	-	-	6.1/F	11.6/F
2 1/2	44	38.57	0.3	10	9	6	3	3	3	82	65	8210G101	21P	●	-	-	-	6.1/F	11.6/F
NORMALLY OPEN (Open when de-energized), NBR Seating (PA Disc-Holder, except as noted)																			
3/8	16	2.57	0.0	10	10	9	9	9	6	82	65	8210G033	23D	●	-	-	-	10.1/F	11.6/F
3/8	16	2.57	0.3	17	14	14	17	14	14	82	82	8210G011 ⑧ ⑨	39D	●	-	-	-	10.1/F	11.6/F
1/2	16	3.43	0	10	10	9	9	9	6	82	65	8210G034	23D	●	-	-	-	10.1/F	11.6/F
1/2	16	2.57	0	10	10	7	9	9	6	82	65	-	-	-	8210G030	37D	●	10.1/F	11.6/F
1/2	16	3.43	0.3	17	14	14	17	14	14	82	82	8210G012 ⑧ ⑨	39D	●	-	-	-	10.1/F	11.6/F
3/4	19	4.71	0	10	10	9	9	9	6	82	65	8210G035	25D	●	-	-	-	10.1/F	11.6/F
3/4	16	2.57	0	10	10	7	9	9	6	82	65	-	-	-	8210G038	38D	●	10.1/F	11.6/F
3/4	19	5.57	0.3	-	-	-	17	14	14	-	82	8210C013	24D	●	-	-	-	-	16.8/F
3/4	19	5.57	0.3	17	14	14	-	-	-	82	-	8210G013	46D	●	-	-	-	16.1/F	-
1	25	11.14	0	9	9	9	-	-	-	82	-	8210B057 ⑥ ⑩	34D	●	-	-	-	20/F	-
1	25	11.14	0.3	-	-	-	9	9	9	-	82	8210D014	26D	●	-	-	-	-	16.8/F
1	25	11.14	0.3	10	10	9	-	-	-	82	-	8210G014	47D	●	-	-	-	16.1/F	-
1 1/4	29	12.86	0	9	9	9	-	-	-	82	-	8210B058 ⑥ ⑩	35D	●	-	-	-	20/F	-
1 1/4	29	12.86	0.3	-	-	-	9	9	9	-	82	8210D018	28D	●	-	-	-	-	16.8/F
1 1/4	29	12.86	0.3	10	10	9	-	-	-	82	-	8210G018	48D	●	-	-	-	16.1/F	-
1 1/2	32	19.29	0	9	9	9	-	-	-	82	-	8210B059 ⑥ ⑩	36D	●	-	-	-	20/F	-
1 1/2	32	19.29	0.3	-	-	-	9	9	9	-	82	8210D032	29D	●	-	-	-	-	16.8/F
1 1/2	32	19.29	0.3	10	10	9	-	-	-	82	-	8210G032	49D	●	-	-	-	16.1/F	-
2	44	36.86	0.3	-	-	-	9	9	9	-	65	8210 103	30P	●	-	-	-	-	16.8/F
2	44	36.86	0.3	9	9	9	-	-	-	82	-	8210G103	50P	●	-	-	-	16.1/F	-
2 1/2	44	38.57	0.3	-	-	-	9	9	9	-	65	8210 104	27P	●	-	-	-	-	16.8/F
2 1/2	44	38.57	0.3	9	9	9	-	-	-	82	-	8210G104	51P	●	-	-	-	16.1/F	-

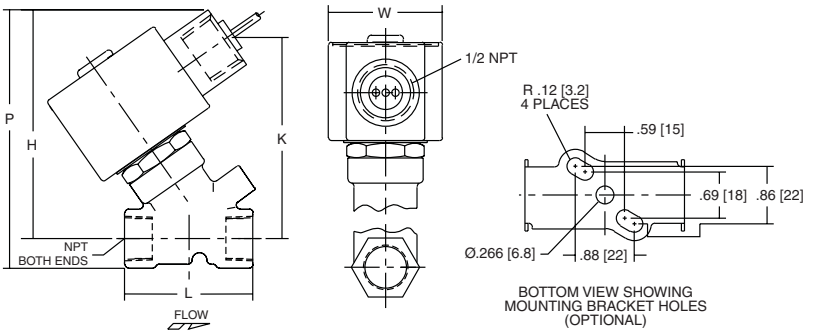
① 0.3 bar on Air; 0.0 bar on Water.
② Valve provided with PTFE main disc.
③ Valve includes Ultem (G.E. trademark) piston.
④ Letter "D" denotes diaphragm construction; "P" denotes piston construction.
⑤ ❍ Safety Shutoff Valve; ● General Purpose Valve.
Refer to Engineering Section (Approvals) for details.
⑥ Valves not available with Explosionproof enclosures.
⑦ On 50 hertz service, the watt rating for the 6.1/F solenoid is 8.1 watts.
⑧ AC construction also has PA seating.
⑨ No disc-holder.
⑩ Stainless steel disc-holder.
‡ Must have solenoid mounted vertical and upright.

Dimensions: inches (mm)

Const. Ref.		H	K	L	P	W
1*	ins.	3.85	3.00	1.91	3.41	1.69
	mm	98	76	49	87	43
2*	ins.	4.17	3.25	2.28	3.63	1.69
	mm	106	83	58	92	43
5	ins.	3.84	2.31	2.75	3.28	2.28
	mm	98	59	70	83	58
6*	ins.	3.38	1.94	2.75	2.80	2.28
	mm	86	49	70	71	58
7	ins.	4.19	2.50	2.81	3.47	2.39
	mm	106	64	71	88	61
8	ins.	4.13	2.47	2.81	3.44	2.29
	mm	105	63	71	87	58
9*	ins.	3.66	2.10	2.81	2.96	2.28
	mm	93	53	71	75	58
10*	ins.	5.25	X	2.81	4.59	2.31
	mm	133	X	71	117	59
11*	ins.	4.16	2.66	3.84	3.52	2.75
	mm	106	68	98	89	70
12	ins.	5.64	3.15	3.75	4.01	3.36
	mm	143	80	95	102	85
13	ins.	4.44	3.22	3.75	4.19	5.81
	mm	113	82	95	106	147
15*	ins.	5.34	X	3.75	4.47	3.84
	mm	136	X	95	114	98
16	ins.	5.64	3.15	3.66	4.01	3.56
	mm	143	80	93	102	90
18	ins.	6.11	3.30	4.38	4.16	3.92
	mm	155	84	111	106	100
20*	ins.	7.33	3.71	5.06	4.57	4.87
	mm	186	94	129	116	124
21*	ins.	7.33	3.71	5.50	4.57	4.87
	mm	186	94	140	116	124
23	ins.	4.35	2.65	2.75	3.79	2.28
	mm	110	67	70	96	58
24	ins.	5.06	X	3.78	4.44	2.75
	mm	129	X	96	113	70
25	ins.	4.64	2.81	2.81	3.94	2.28
	mm	118	71	71	100	58
26	ins.	6.53	X	3.75	4.91	3.19
	mm	166	X	95	125	81
27	ins.	8.22	X	5.50	5.47	4.87
	mm	209	X	140	139	124
28	ins.	6.53	X	3.66	4.91	3.19
	mm	166	X	93	125	81
29	ins.	7.03	X	4.38	5.06	4.40
	mm	179	X	111	129	112

* DC dimensions slightly larger.
IMPORTANT: Valves may be mounted in any position, except as noted in specifications table.

Const. Ref. 1, 2



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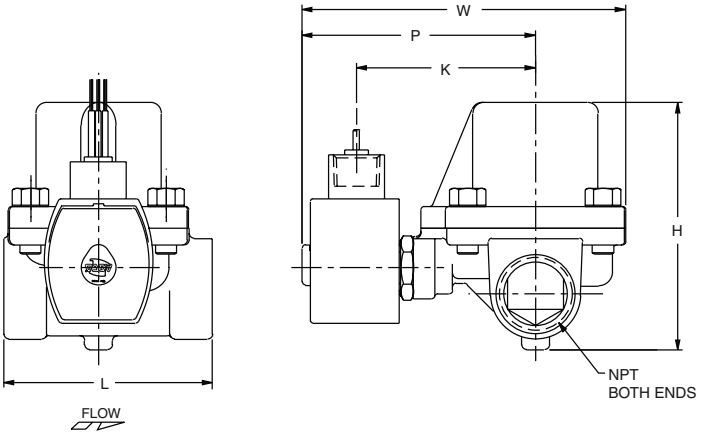

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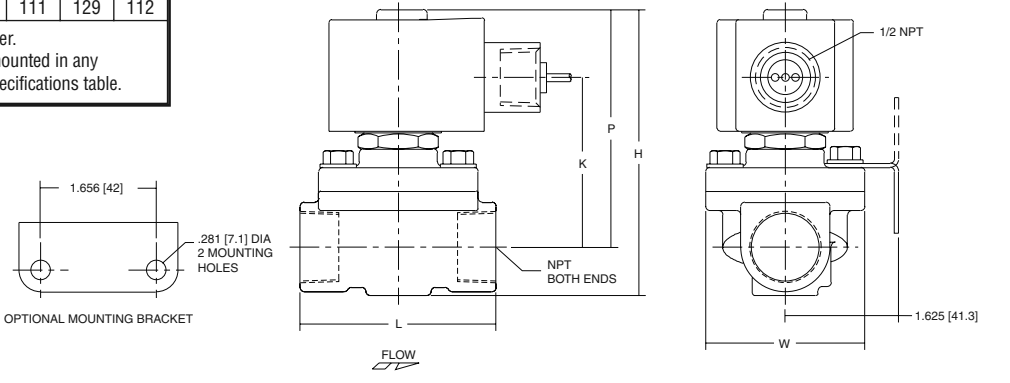
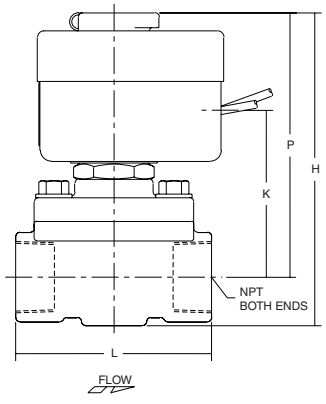


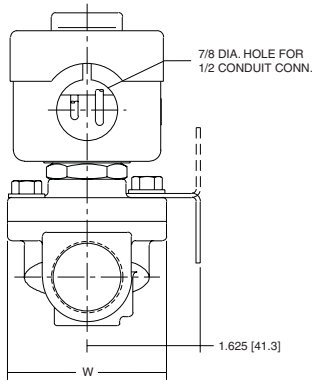
Dimensions: inches (mm)

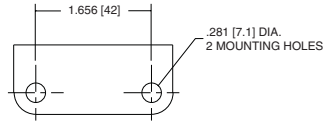
Const. Ref.		H	K	L	P	W
30	ins.	8.22	X	5.06	5.47	4.87
	mm	209	X	129	139	124
31	ins.	5.25	X	3.75	4.44	3.25
	mm	133	X	95	113	83
32	ins.	5.69	X	3.66	4.69	3.25
	mm	145	X	93	119	83
33	ins.	6.06	X	4.38	4.94	3.91
	mm	154	X	111	125	99
34	ins.	6.91	X	3.75	6.09	3.25
	mm	176	X	95	155	83
35	ins.	7.34	X	3.66	6.34	3.25
	mm	186	X	93	161	83
36	ins.	7.66	X	4.38	6.56	3.91
	mm	1.95	X	111	167	99
37	ins.	4.61	2.75	2.81	3.89	2.39
	mm	117	70	71	99	61
38	ins.	4.61	2.75	2.81	3.89	2.39
	mm	117	70	71	99	61
39	ins.	5.42	2.31	2.75	4.86	3.80
	mm	138	59	70	123	97
40	ins.	5.20	3.29	2.81	4.50	2.28
	mm	132	83	71	114	58
41	ins.	5.13	3.10	3.75	4.32	3.25
	mm	130	79	95	110	83
42	ins.	6.43	4.40	3.93	5.62	3.25
	mm	163	112	100	143	83
43	ins.	5.57	3.35	3.66	4.57	3.25
	mm	142	85	93	116	83
44	ins.	5.90	3.57	4.38	4.79	3.91
	mm	150	91	111	122	99
45	ins.	5.26	3.17	3.75	4.38	3.84
	mm	134	81	95	111	98
46	ins.	4.95	3.10	3.84	4.31	2.75
	mm	126	79	98	110	70
47	ins.	6.43	3.59	3.75	4.81	3.52
	mm	163	91	95	122	90
48	ins.	6.43	3.59	3.66	4.81	3.73
	mm	163	91	93	122	95
49	ins.	6.91	3.75	4.38	4.96	4.40
	mm	176	95	111	126	112
50	ins.	8.13	4.15	5.06	5.37	4.87
	mm	207	105	129	136	124
51	ins.	8.13	4.15	5.50	5.37	5.18
	mm	207	105	140	136	132

IMPORTANT: Valves may be mounted in any position, except as noted in specifications table.

Const. Ref. 10, 15, 24, 26-36

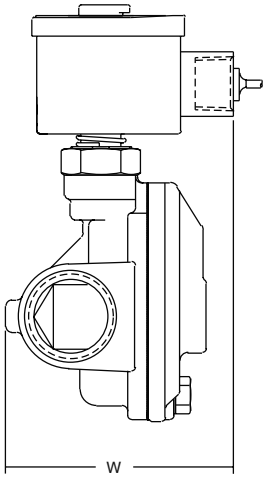


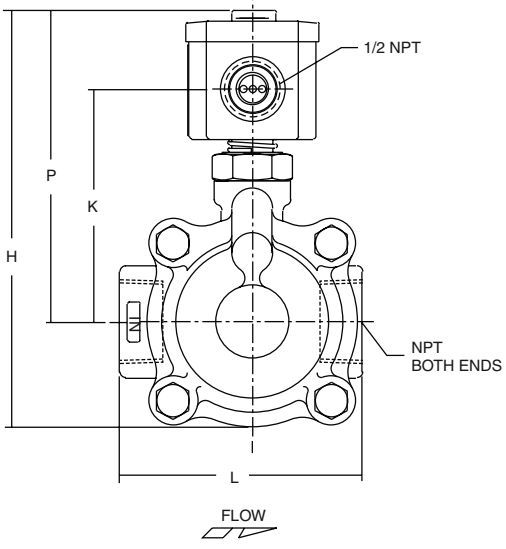




OPTIONAL MOUNTING BRACKET

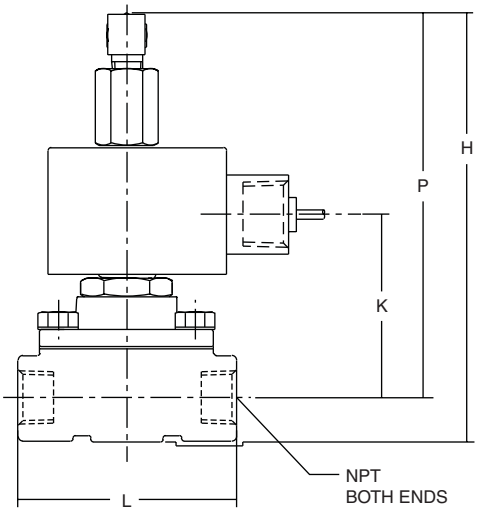
Const. Ref. 12, 16, 18

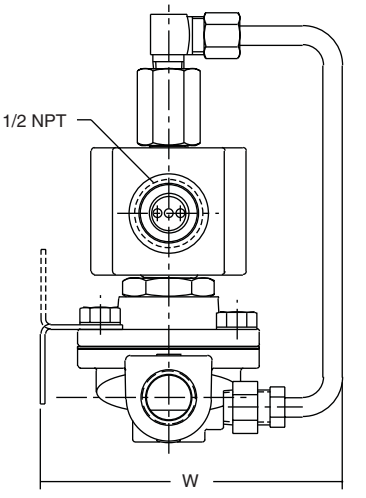


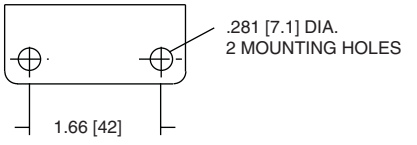


Dimensions: inches (mm)

Const. Ref. 39

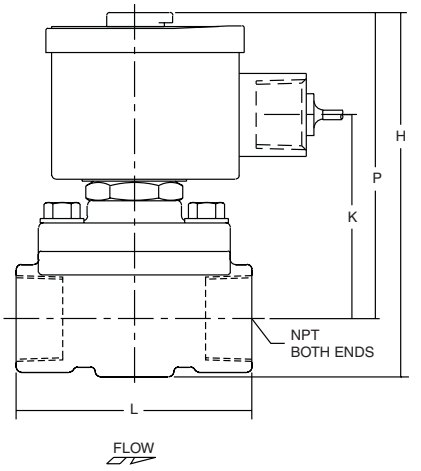


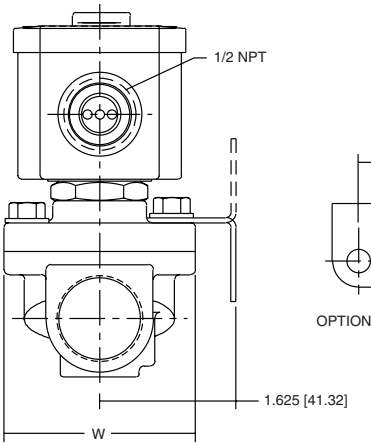


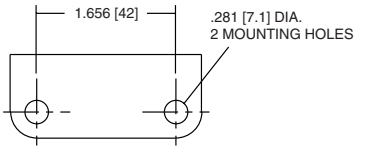


SHOWING MOUNTING
BRACKET ONLY

Const. Ref. 40-51







OPTIONAL MOUNTING BRACKET

Installation & Maintenance Instructions

ASCO Red-Hat II ®

OPEN – FRAME, GENERAL PURPOSE, WATERTIGHT/EXPLOSIONPROOF SOLENOIDS

SERIES
8003G/H
8202G/H
I&M No.V6584R10
(Section 1 of 2)

— SERVICE NOTICE —

ASCO® solenoid valves with design change letter "G" or "H" in the catalog number (ex. 8210G1) have an epoxy encapsulated ASCO® Red Hat II® solenoid. This solenoid replaces some of the solenoids with metal enclosures and open – frame constructions. Follow these installation and maintenance instructions if your valve or operator uses this solenoid.

See separate instructions for basic valve.

DESCRIPTION

Catalog numbers 8003G/H and 8202G/H are epoxy encapsulated pull – type solenoids. The green solenoid with lead wires and 1/2″ conduit connection is designed to meet Enclosure Type 1 – General Purpose, Type 2 – Dripproof, Types 3 and 3S – Raintight, and Types 4 and 4X – Watertight. The black solenoid on catalog numbers prefixed "EF" or "EV" is designed to meet Enclosure Types 3 and 3S – Raintight, Types 4 and 4X – Watertight, Types 6 and 6P – Submersible, Type 7, Explosionproof Class I, Division 1 Groups A, B, C, & D and Type 9, – Dust – Ignitionproof Class II, Division 1 Groups E, F & G. The Class II, Groups F & G Dust Locations designation is not applicable for solenoids or solenoid valves used for steam service or when a class "H" solenoid is used. See *Temperature Limitations* section for solenoid identification and nameplate/retainer for service. When installed just as a solenoid and not attached to an ASCO valve, the core has a 0.250 – 28 UNF – 2B tapped hole, 0.38 or 0.63 minimum full thread.

NOTE: Catalog number prefix "EV" denotes stainless steel construction.

Solenoid catalog numbers 8202G/H1, 8202G/H3, 8202G/H5 and 8202G/H7 are epoxy encapsulated push – type, reverse – acting solenoids having the same enclosure types as previously stated for Catalog numbers 8003G/H1 and 8003G/H2.

Series 8003G/H and 8202G/H solenoids are available in:

- **Open – Frame Construction:** The green solenoid may be supplied with 1/4″ spade, screw or DIN terminals. (Refer to Figure 4)
- **Panel Mounted Construction:** These solenoids are specifically designed to be panel mounted by the customer. Refer to Figures specified in this I&M and the section on *Installation of Panel Mounted Solenoid* for details.

Optional Features For Type 1 – General Purpose Construction Only

- **Junction Box:** This junction box construction meets Enclosure Types 2, 3, 3S, 4, and 4X. Only solenoids with 1/4″ spade or screw terminals may have a junction box. The junction box provides a 1/2″ conduit connection, grounding and spade or screw terminal connections within the junction box (See Figure 5).
- **DIN Plug Connector Kit No.K236034:** Use this kit only for solenoids with DIN terminals. The DIN plug connector kit provides a two pole with grounding contact DIN Type 43650 construction (See Figure 6).

OPERATION

Series 8003G/H – When the solenoid is energized, the core is drawn into the solenoid base sub – assembly. **IMPORTANT: When the solenoid is de – energized, the initial return force for the core, whether developed by spring, pressure, or weight, must exert a minimum force to overcome residual magnetism created by the solenoid. Minimum return force for AC construction is 11 ounces, and 5 ounces for DC construction.**

Series 8202G/H – When the solenoid is energized, the disc holder assembly seats against the orifice. When the solenoid is de – energized , the disc holder assembly returns. **IMPORTANT: Initial return force for the disc or disc holder assembly, whether developed by spring, pressure, or weight, must exert a minimum force to overcome residual magnetism created by the solenoid. Minimum return force is 1 pound, 5 ounces.**

INSTALLATION

Check nameplate for correct catalog number, service, and wattage. Check front of solenoid for voltage and frequency.

⚠ WARNING: Electrical hazard from the accessibility of live parts. To prevent the possibility of death, serious injury or property damage, install the open – frame solenoid in an enclosure.

FOR BLACK ENCLOSURE TYPES 7 AND 9 ONLY

⚠ CAUTION: To prevent fire or explosion, do not install solenoid and/or valve where ignition temperature of hazardous atmosphere is less than 165° C. On valves used for steam service or when a class "H" solenoid is used, do not install in hazardous atmosphere where ignition temperature is less than 180°C. See nameplate/retainer for service.

NOTE: These solenoids have an internal non – resetable thermal fuse to limit solenoid temperature in the event that extraordinary conditions occur which could cause excessive temperatures. These conditions include high input voltage, a jammed core, excessive ambient temperature or a shorted solenoid, etc. This unique feature is a standard feature only in solenoids with black explosionproof/dust – ignitionproof enclosures (Types 7 & 9).

⚠ CAUTION: To protect the solenoid valve or operator, install a strainer or filter, suitable for the service involved in the inlet side as close to the valve or operator as possible. Clean periodically depending on service conditions. See ASCO Series 8600, 8601, and 8602 for strainers.

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Temperature Limitations

For maximum valve ambient temperatures, refer to chart. The temperature limitations listed, only indicate maximum application temperatures for field wiring rated at 90°C. Check catalog number prefix and watt rating on nameplate to determine maximum ambient temperature. See valve installation and maintenance instructions for maximum fluid temperature.

NOTE: For steam service, refer to *Wiring* section, *Junction Box* for temperature rating of supply wires.

Temperature Limitations For Series 8003G or 8202G Solenoids for use on Valves Rated at 10.1, 11.6, 17.1, or 22.6 Watts			
Watt Rating	**Catalog Number Coil Prefix**	**Class of Insulation**	**Maximum † Ambient Temp.**
10.1 & 17.1	None, FB, KF, KP SC, SD, SF, & SP,	F	125°F (51.7°C)
10.1 & 17.1	HB, HT, KB, KH, SS, ST, SU,	H	140°F (60°C)
11.6 & 22.6	None, FB,KF, KP, SC, SD, SF, & SP.	F	104°F (40°C)
11.6 & 22.6	HP, HT, KB, KH, SS, ST, SU, & SV	H	104°F (40°C)

† Minimum ambient temperature −40° F (−40° C).

Temperature Limitations for series 8002H/8003H solenoids (Catalog Numbers 8262H & 8263H valves)						
		Wattage Ratings			Max. Ambient Temperature	
		AC		DC		
Prefix①	Coil Class	60 Hz	50 Hz		(°C)	(°F)
EF, EV	FT	10.1	10.1	–	52	125
EF, EV	FB	17.1	17.1	–		
	FT	10.1	10.1	–	55	131
	FB	17.1	17.1	–		
	HT	–	–	11.6	40②	104②
	HB	–	–	22.6		
EF, EV	HT	–	–	11.6		
EF, EV	HB	–	–	22.6		
	HT	10.1	10.1	–	60③	140③
	HB	17.1	17.1	–		
EF, EV	HT	10.1	10.1	–		
EF, EV	HB	17.1	17.1	–		

① = EF, EV data applies to Explosionproof coils only.
② = DC solenoid valves can be operated at maximum ambient temperature of 55°C / 131°F with reduced pressure ratings. See valve I&M for maximum operating pressure differential ratings.
③ = Steam Service Valves have a maximum ambient temperature of 55°C / 131°F.

Positioning

This solenoid is designed to perform properly when mounted in any position. However, for optimum life and performance, the solenoid should be mounted vertically and upright to reduce the possibility of foreign matter accumulating in the solenoid base sub−assembly area.

Wiring

Wiring must comply with local codes and the National Electrical Code. All solenoids supplied with lead wires are provided with a grounding wire which is green or green with yellow stripes and a 1/2″ conduit connection. To facilitate wiring, the solenoid may be rotated 360°. For the watertight and explosionproof solenoid, electrical fittings must be approved for use in the approved hazardous locations.

⚠ CAUTION: Cryogenic Applications – Solenoid lead wire insulation should not be subjected to cryogenic temperatures. Adequate lead wire protection and routing must be provided.

Additional Wiring Instructions For Optional Features:

- **Open−Frame solenoid with 1/4″ spade terminals.**

For solenoids supplied with screw terminal connections use #12−18 AWG stranded copper wire rated at 90°C or greater. Torque terminal block screws to 10±2 in−lbs [1,0±1,2 Nm]. A tapped hole is provided in the solenoid for grounding, use a #10−32 machine screw. Torque grounding screw to 15−20 in−lbs [1,7−2,3 Nm]. On solenoids with screw terminals, the socket head screw holding the terminal block to the solenoid is the grounding screw. Torque the screw to 15−20 in−lbs [1,7−2,3 Nm] with a 5/32″ h ex key wrench.

- **Junction Box**

The junction box is used with spade or screw terminal solenoids only and is provided with a grounding screw and a 1/2″ conduit connection. Connect #12−18 AWG standard copper wire only to the screw terminals. Within the junction box use field wire that is rated 90°C or greater for connections. For steam service use 105°C rated wire up to 50 psi or use 125°C rated wire above 50 psi. After electrical hookup, replace cover gasket, cover, and screws. Tighten screws evenly in a crisscross manner.

- **DIN Plug Connector Kit No.K236034**

1. The open−frame solenoid is provided with DIN terminals to accommodate the plug connector kit.
2. Remove center screw from plug connector. Using a small screwdriver, pry terminal block from connector cover.
3. Use #12−18 AWG stranded copper wire rated at 90°C or greater for connections. Strip wire leads back approximately 1/4″ for installation in socket terminals. The use of wire−end sleeves is also recommended for these socket terminals. Maximum length of wire−end sleeves to be approximately 1/4″. Tinning of the ends of the lead wires is not recommended.
4. Thread wire through gland nut, gland gasket, washer and connector cover.

NOTE: Connector housing may be rotated in 90° increments from position shown for alternate positioning of cable entry.

5. Check DIN connector terminal block for electrical markings. Then make electrical hookup to terminal block according to markings on it. Snap terminal block into connector cover and install center screw.
6. Position connector gasket on solenoid and install plug connector. Torque center screw to 5±1 in−lbs [0,6±1,1 Nm].

NOTE: Alternating current (AC) and direct current (DC) solenoids are built differently and cannot be converted from one to the other by changing the coil.

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Installation of Solenoid

Solenoids may be assembled as a complete unit. Tightening is accomplished by means of a hex flange at the base of the solenoid.

Installation of Panel Mounted Solenoid (See Figures 1 and 2)

1. Disassemble solenoid following instruction under *Solenoid Replacement* then proceed.
2. Install solenoid base sub–assembly through customer panel. 8202H panel mounted solenoids include a retainer to adapt the solenoid base sub–assembly to the customer panel. (See Figure 2)
3. Position finger washer on opposite side of panel over solenoid base sub–assembly.
4. Replace solenoid, nameplate/retainer and red cap.
5. Make electrical hookup, see *Wiring* section.

Solenoid Temperature

Standard solenoids are designed for continuous duty service. When the solenoid is energized for a long period, the solenoid becomes hot and can be touched by hand only for an instant. This is a safe operating temperature.

MAINTENANCE

⚠ WARNING: To prevent the possibility of death, serious injury or property damage, turn off electrical power, depressurize solenoid operator and/or valve, and vent fluid to a safe area before servicing.

Cleaning

All solenoid operators and valves should be cleaned periodically. The time between cleaning will vary depending on medium and service conditions. In general, if the voltage to the solenoid is correct, sluggish valve operation, excessive noise or leakage will indicate that cleaning is required. Clean strainer or filter when cleaning the valve.

Preventive Maintenance

- Keep the medium flowing through the solenoid operator or valve as free from dirt and foreign material as possible.
- Periodic exercise of the valve should be considered if ambient or fluid conditions are such that corrosion, elastomer degradation, fluid contamination build up, or other conditions that could impede solenoid valve shifting are possible. The actual frequency of exercise necessary will depend on specific operating conditions. A successful operating history is the best indication of a proper interval between exercise cycles.
- Depending on the medium and service conditions, periodic inspection of internal valve parts for damage or excessive wear is recommended. Thoroughly clean all parts. Replace any worn or damaged parts.

Causes of Improper Operation

- **Faulty Control Circuit:** Check the electrical system by energizing the solenoid. A metallic *click* signifies that the solenoid is operating. Absence of the *click* indicates loss of power supply. Check for loose or blown fuses, open–circuited or grounded solenoid, broken lead wires or splice connections.
- **Burned–Out Solenoid:** Check for open–circuited solenoid. Replace if necessary. Check supply voltage; it must be the same as specified on nameplate/retainer and marked on the solenoid. Check ambient temperature and check that the core is not jammed.
- **Low Voltage:** Check voltage across the solenoid leads. Voltage must be at least 85% of rated voltage.

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Solenoid Replacement

1. Disconnect conduit, coil leads, and grounding wire.

NOTE: Any optional parts attached to the old solenoid must be reinstalled on the new solenoid. For 3–way construction, piping or tubing must be removed from pipe adapter.

2. Disassemble solenoids with optional features as follows:

- **Spade or Screw Terminals**
  Remove terminal connections, grounding screw, grounding wire, and terminal block (screw terminal type only).

NOTE: For screw terminals, the socket head screw holding the terminal block serves as a grounding screw.

- **Junction Box**
- Remove conduit and socket head screw (use 5/32″ hex key wrench) from center of junction box. Disconnect junction box from solenoid.
- **DIN Plug Connector**
  Remove center screw from DIN plug connector. Disconnect DIN plug connector from adapter. Remove socket head screw (use 5/32″ hex key wrench), DIN terminal adapter, and gasket from solenoid.

3. Snap off red cap from top of solenoid base sub–assembly. For 3–way construction with pipe adapter (Figure 3), remove pipe adapter, nameplate and solenoid. Omit steps 4 and 5.
4. Push down on solenoid. Then using a suitable screwdriver, insert blade between solenoid and nameplate/retainer. Pry up slightly and push to remove.

NOTE: Series 8202G/H solenoids have a spacer between the nameplate/retainer and solenoid.

5. Remove solenoid from solenoid base sub–assembly.
6. Reassemble in reverse order of disassembly. Use exploded views for identification and placement of parts.
7. Torque pipe adapter to 90 inch–pounds maximum [10,2 Nm maximum]. Then make up piping or tubing to pipe adapter on solenoid.

Disassembly and Reassembly of Solenoids

1. Remove solenoid, see *Solenoid Replacement*.
2. Remove spring washer from solenoid base sub–assembly. For 3–way construction, remove pipe adapter and plugnut gasket.
3. Unscrew solenoid base sub–assembly from valve body.
4. Remove internal solenoid parts for cleaning or replacement. Use exploded views for identification and placement of parts.
5. If the solenoid is part of a valve, refer to basic valve installation and maintenance instructions for further disassembly.
6. Torque solenoid base sub–assembly and adapter to 175±25 in–lbs [19,8±2,8 Nm].

ORDERING INFORMATION FOR ASCO SOLENOIDS

When Ordering Solenoids for ASCO Solenoid Operators or Valves, order the number stamped on the solenoid. Also specify voltage and frequency.

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BGMU Submittal Package, Part 1 of 2, 05/03/2010, Page 113 of 635

Installation & Maintenance Instructions

ASCO Red-Hat II ®

OPEN – FRAME, GENERAL PURPOSE, WATERTIGHT/EXPLOSIONPROOF SOLENOIDS

SERIES
8003G/H
8202G/H

I&M No.V6584R10
(Section 2 of 2)

NOTICE: See Installation and Maintenance Instructions, I&M No. V6584R10 – Section 1 of 2 for detailed instructions.

Torque Chart

Part Name	Torque Value in Inch – Pounds	Torque Value in Newton – Meters
solenoid base sub – assembly	175 ± 25	19,8± 2,8
pipe adapter	90 maximum	10,2 maximum

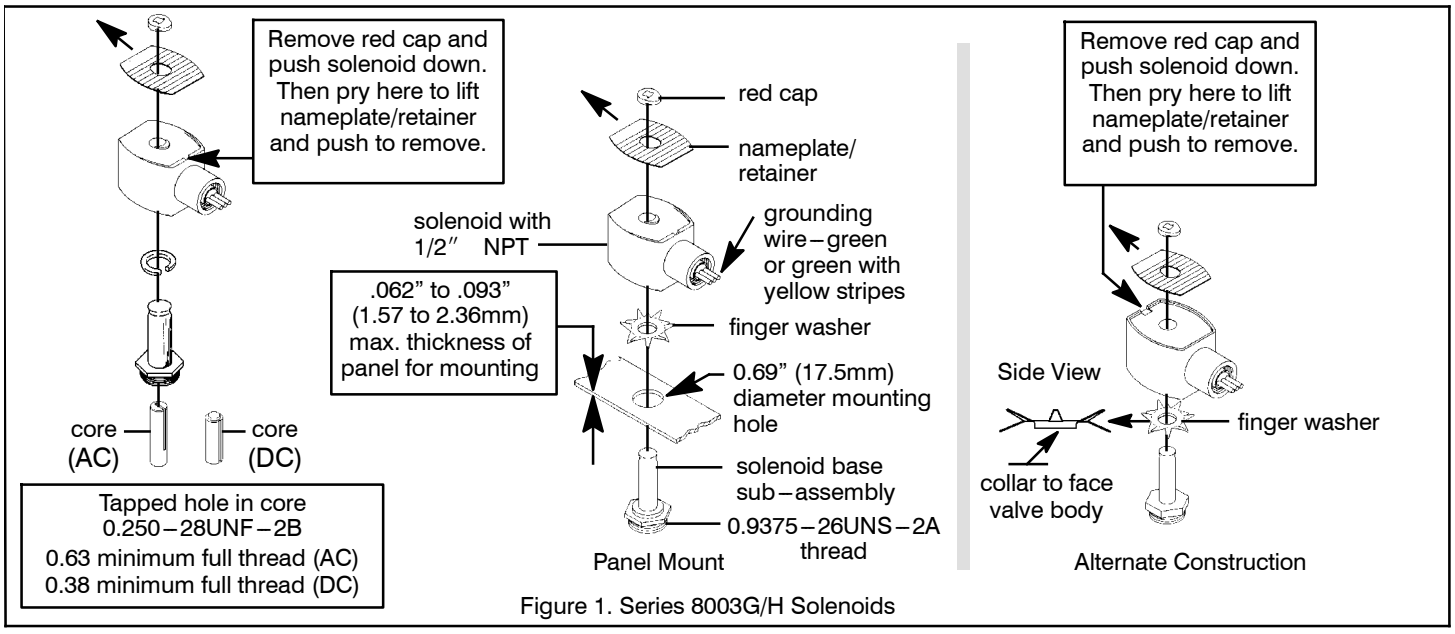

Figure 1. Series 8003G/H Solenoids

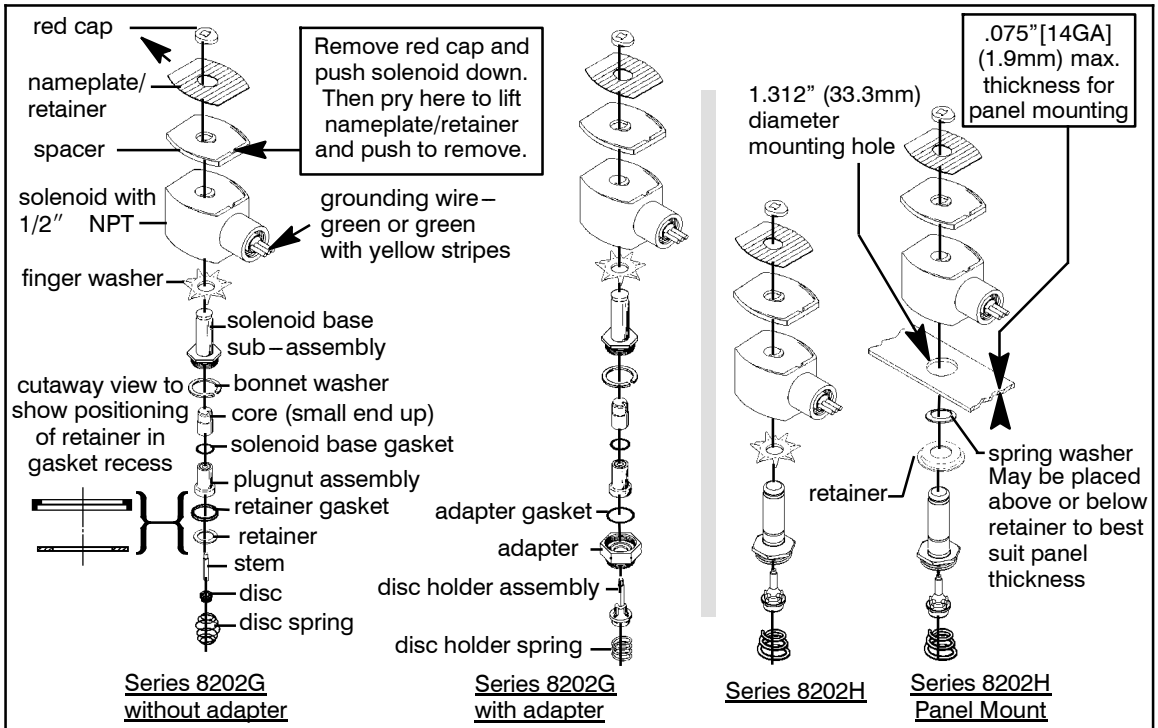

Figure 2. Series 8202G/H Solenoids

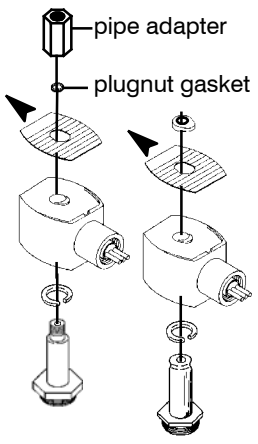

Figure 3.
Air Only Construction
Vent to Atmosphere

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Torque Chart

Part Name	Torque Value in Inch–Pounds	Torque Value in Newton–Meters
terminal block screws	10 ± 2	1,1 ± 0,2
socket head screw	15 – 20	1,7 – 2,3
center screw	5 ± 1	0,6 ± 0,1

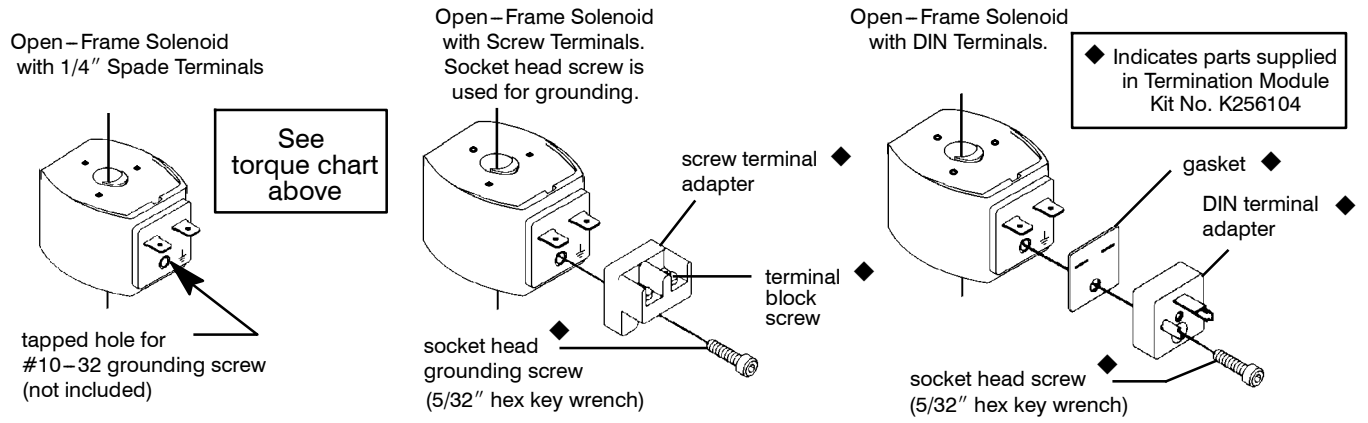

Figure 4. Open–frame solenoids

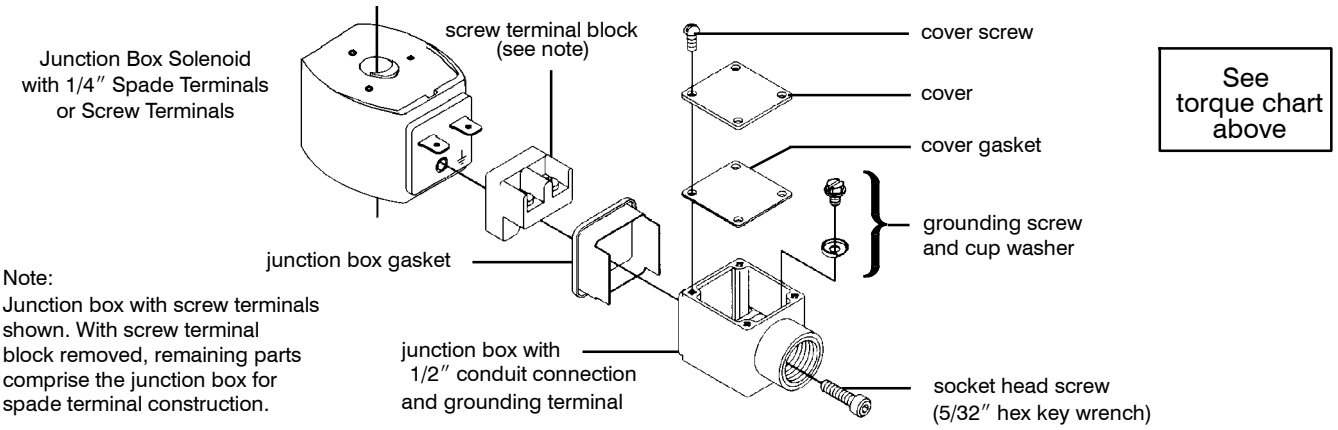

Figure 5. Junction box (optional feature)

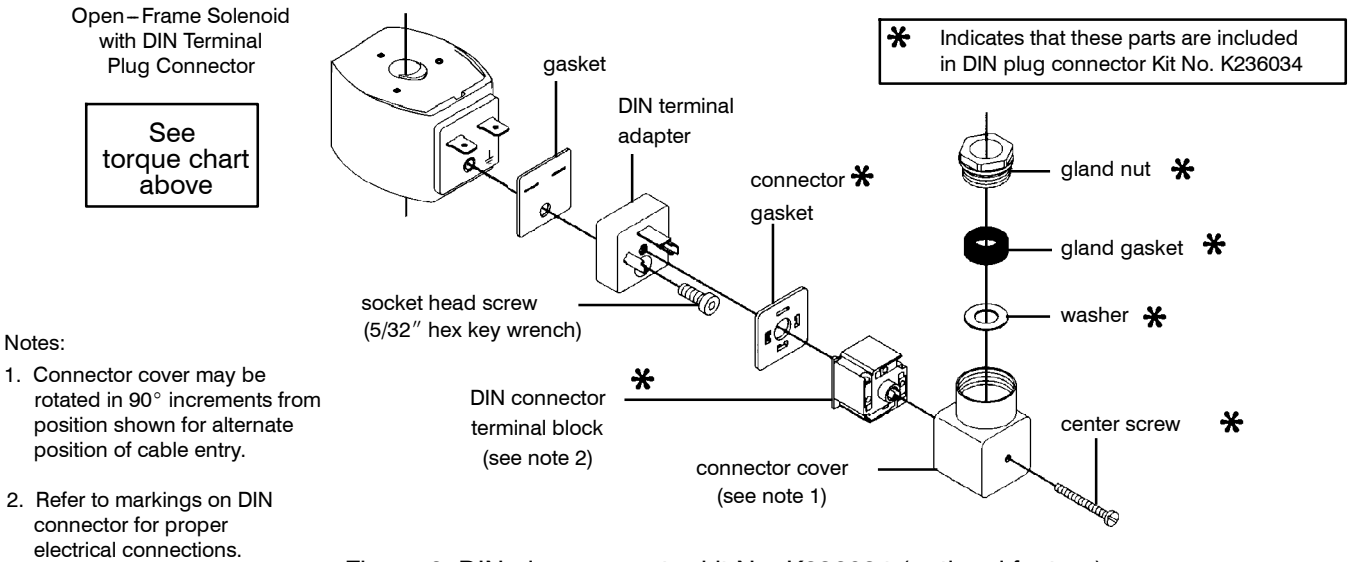

Figure 6. DIN plug connector kit No. K236034 (optional feature)

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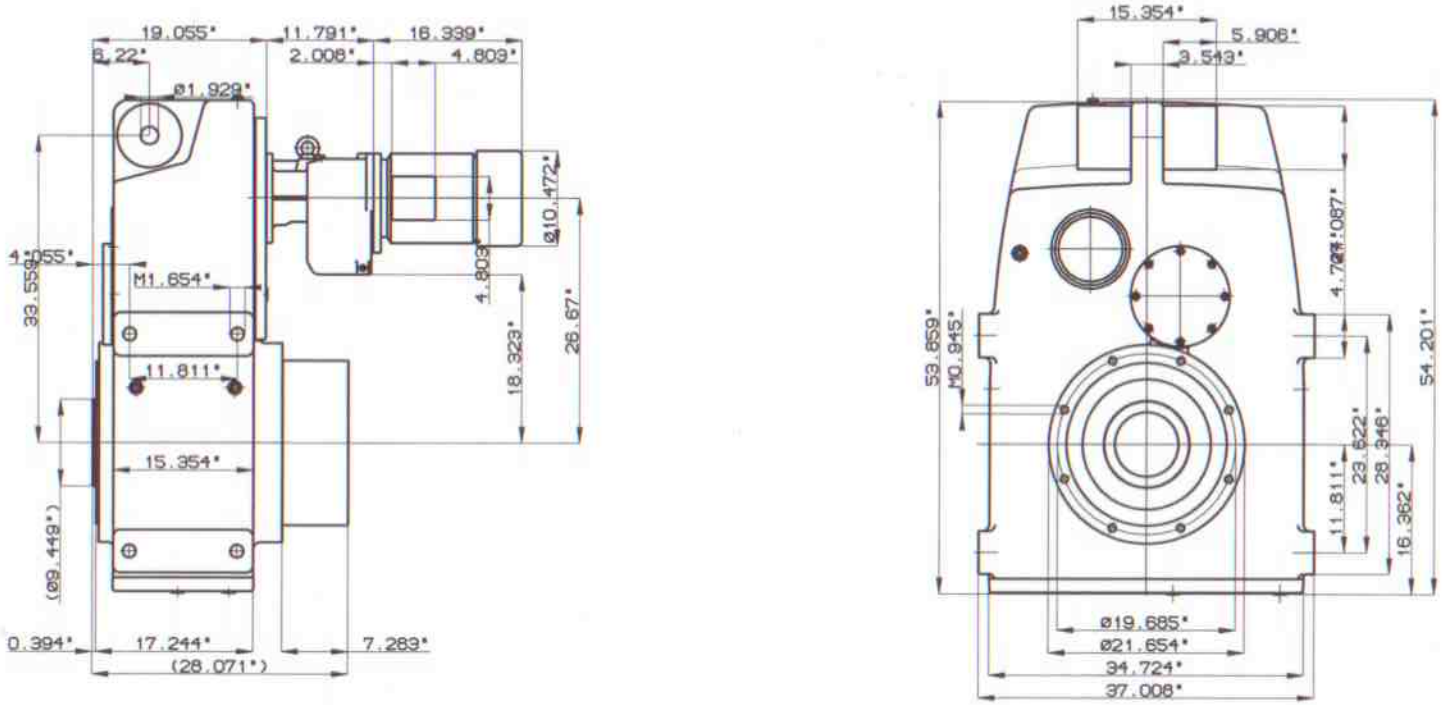
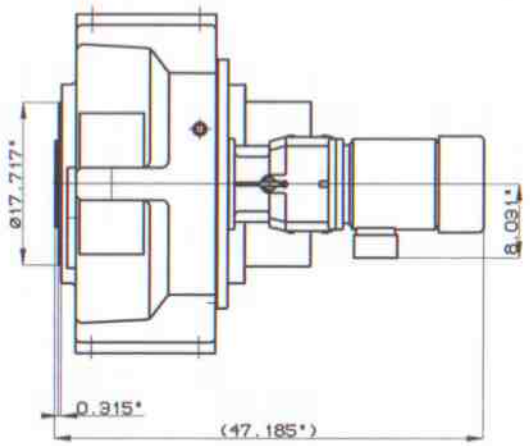
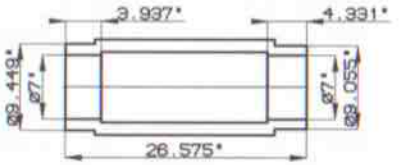
Gearmotor, Nord SK 11382/52 AZ SH G-132S/4

- Nord Drawing SK11382/52A-132S/4
- Dryer Rotor Gearmotor Ordering Guide
- SK11382 Oil Fill Quantities
- SK 11382/52 132S/4 Gearbox Dimensions
- SK 11382/52 132S/4 Gearmotor Specifications & Performance
- SK 11382/52 132S/4 Integral Motor Dimensions
- Integral Motor 132S/4 Order Form
- SK 11382/52 132S/4 Shrink Disc Specifications

Nord Drawing SK11382/52A-132S/4







The terminal box will be displayed in Pos. 1 in the dimensional drawi

SK 11382/52AZSHG - 132 S

NORD

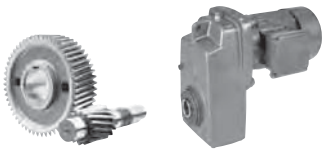
Nord Internet: http://www.nord.com

	Date	Name
Drawn	4/20/2010	Ter90

Technical design subject to change!
This drawing by NORDCAD 6.2.0

NOTE: TO INCLUDE APPROPRIATLEY PLACED AUTOVENT BREATHER (DR)
TFL 5412 - BOWLING GREEN IC 10,000 DRYER ROTOR GEARMOTOR

Clincher™ Ordering Guide



	Gear Unit	Shaft/Mounting	Reducer Options		Motor/Input	Motor Options
SK	❶ 11382/52	❷ AZ	❸ SH	-	❹ 132S/4	NONE
					see page 690	see page 690

GEARMOTORS

❶

Gear Unit			
0182NB	1382NB	1282/02	6382/22
0282NB	2382	2282/02	6382/32
1282	3382	3282/12	7382/22
2282	4382	4282/12	7382/32
3282	5382	5282/12	8382/22
4282	6382		8382/32
5282	7382		9382/42
6282	8382		9382/52
7282	9382		10382/52
8282	10382		11382/52
9282	11382		
10282	12382		
11282			

❷

Shaft/Mounting		
VZ - Solid Shaft/B14 Flange	**VX -** Solid Shaft/Foot	**AZ** - Hollow Shaft/B14 Flange
VF - Solid Shaft/B5 Flange	**LX -** Double Solid Shaft/Foot	**AF** - Hollow Shaft/B5 Flange
SCP - Screw Conveyor Package		**AX** - Hollow Shaft/Foot

❸

Reducer Options		
☐ **B -** Fixing Element Kit	☐ **VL -** Heavy Duty Output Bearings	☐ **VI -** Fluoro-rubber Seals
☒ **G -** Rubber Buffers	☐ **VL2 -** Spread Bearing Design	☐ **OSG -** Oil Sight Glass
☐ **VG -** Heavy Duty Rubber Buffers	☐ **VL3 -** Oil Safe Spread Bearing Design	☐ **OA -** Oil Expansion Chamber
☐ **H -** Hollow Shaft Cover	☐ **VL4-** Drywell Drop Bearing Design	☐ **OC -** Oil Cooler
☐ **H66 -** IP66 Hollow Shaft Cover	☐ **LX-** Double Solid Shaft	☐ **WC -** Water Cooling Cover
☒ **SH -** Shrink Disc & Cover	☐ **SM5 -** Stainless Steel Output Shaft	☐ **OT -** Oil Reservoir Tank
☐ **VSH -** Heavy Duty Shrink Disc & Cover	☐ **SWA -** Special Hollow Shaft	☐ **MDP -** Magnetic Drain Plug
☐ **PR -** Flange Pilot Removal	☐ **SWV -** Special Solid Shaft	☐ **ADP -** Additional Drain Plug
☐ **LL -** Long Term Storage	☐ Cross Drilled Shaft	

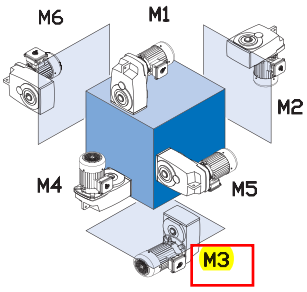
❹

Input Shaft	NEMA Adapter	IEC Adapter	Integral Motors		Integral Energy Efficent Motors		Scoop	Motor Platform	Servo Adapter (Keyed)
W	N56C	IEC 63	63S/4 - 0.16hp	160L/4 - 20hp	80LH/4 - 1hp	200LH/4 - 40hp	S56	MKN056	SEP 100
	N140TC	IEC 71	63L/4 - 0.25hp	180MX/4 - 25hp	90SH/4 - 1.5hp	225SH/4 - 50hp	S140T	MKN140	SEP 130
	N180TC	IEC 80	71S/4 - 0.33hp	180LX/4 - 30hp	90LH/4 - 2hp	225MH/4 - 60hp	S180T	MKN180	SEP 165
	N210TC	IEC 90	71L/4 - 0.50hp	200L/4 - 40hp	100LH/4 - 3hp	250MH/4 - 75hp	S210T	MKN210	SEP 215
	N250TC	IEC 100	80S/4 - 0.75hp	225S/4 - 50hp	112MH/4 - 5hp	280SH/4 - 100hp	S250T	MKN250	SEP 300
	N280TC	IEC 112	80L/4 - 1hp	225M/4 - 60hp	132SH/4 - 7.5hp	280MH/4 - 125hp	S280T	MKN280	**Servo Adapter (Clamp)**
	N320TC	IEC 132	90S/4 - 1.5hp	250M/4 - 75hp	132MH/4 - 10hp	315SH/4 - 150hp	S320T	MKN320	
	N360TC	IEC 160	90L/4 - 2hp	280S/4 - 100hp	160MH/4 - 15hp	315MH/4 - 175hp	S360T	MKN360	SEK 100
	N400TC	IEC 180	100L/4 - 3hp	280M/4 - 125hp	160LH/4 - 20hp	315MAH/4 - 200hp	S400T	MKN400	SEK 130
		IEC 200	100LA/4 - 5hp	315S/4 - 150hp	180MH/4 - 25hp	315LH/4 - 250hp			SEK 165
		IEC 225	112M/4 - 5.4hp	315M/4 - 175hp	180LH/4 - 30hp				SEK 215
		IEC 250	132S/4 - 7.5hp	315MA/4 - 200hp					SEK 300
		IEC 280	132M/4 - 10hp	315L/4 - 250hp					
		IEC 315	160M/4 - 15hp	Other Speeds Available		Other Speeds Available			

Product Specifications

Ratio
1154.35 :1
see pages 244 - 288
— OR —
Output Speed
1.5 rpm
see pages 244 - 288

Mounting Position
- ○ M1
- ○ M2
- ⊗ M3
- ○ M4
- ○ M5
- ○ M6
- ○ Special _____



Paint
- ⊗ Standard Stainless Steel Paint
- ○ NSD+ (gray)
- ○ NSD+W (white)
- ○ NSD-X3 (gray)
- ○ NSD-X3W (white)
- ○ Casting Primed
- ○ Special _____

Lubricant
- ⊗ Standard
- ○ Synthetic
- ○ Food Grade
- ○ Other _____

Hollow Shaft Diameter (If required)
7.00"
see pages 388 - 393

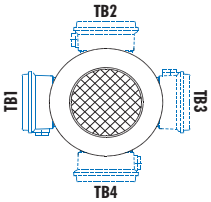
B5 Flange Diameter (If required)
NONE

SCP Drive Shaft Diameter (If required)
NONE
see page 29

Gearmotor Only Details

Voltage & Frequency
- ⊗ 230/460V-60Hz (460V only ≥ 40 hp)
- ○ 575V-60Hz
- ○ 208V-60Hz
- ○ 400V-50Hz
- ○ 115/230V-60Hz, 1 ph.
- ○ Other _____

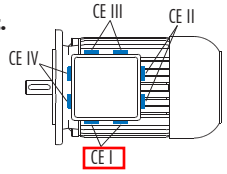
Terminal Box Pos.
- ○ TB1
- ⊗ TB2
- ○ TB3
- ○ TB4



Mtg. Pos. M1 Shown

Conduit Entry Loc.
- ⊗ CE I *
- ○ CE II
- ○ CE III *
- ○ CE IV

* Brakemotor



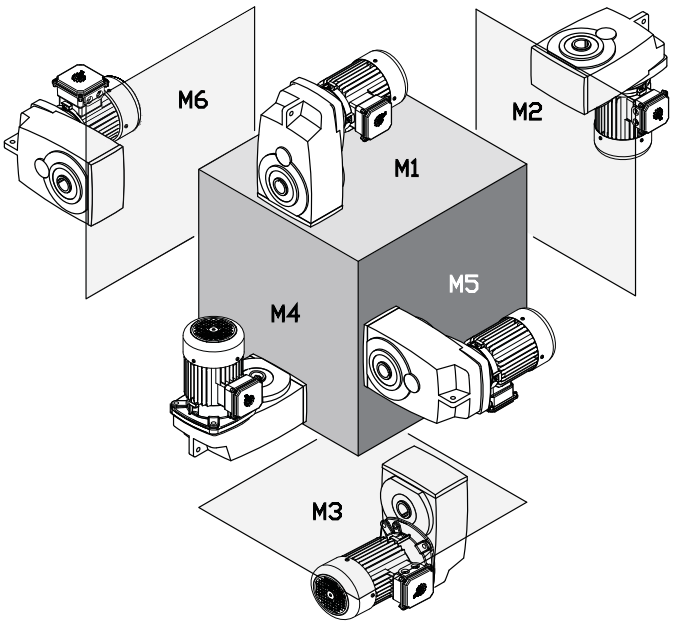
Mtg. Pos. M1 Shown

SK11382 Oil Fill Quantities

CLINCHER™ OIL FILL QUANTITIES

CLINCHER™ lubrication

Unless otherwise noted below, the following NORD Gear reducers are shipped from the factory with a pre-determined oil fill level in accordance to the specified reducer size and mounting position. For additional information, please refer to the "Oil Plug & Vent Locations" documentation for your gear unit.



HARMFUL SITUATION

Actual oil volume can vary slightly depending upon the gear case size, mounting and ratio. Prior to commissioning the reducer, check the oil-fill level using the reducer's oil level plug and drain or add addition oil as needed.

For mounting orientations other than shown please consult NORD Gear. Reducer modifications may be required.

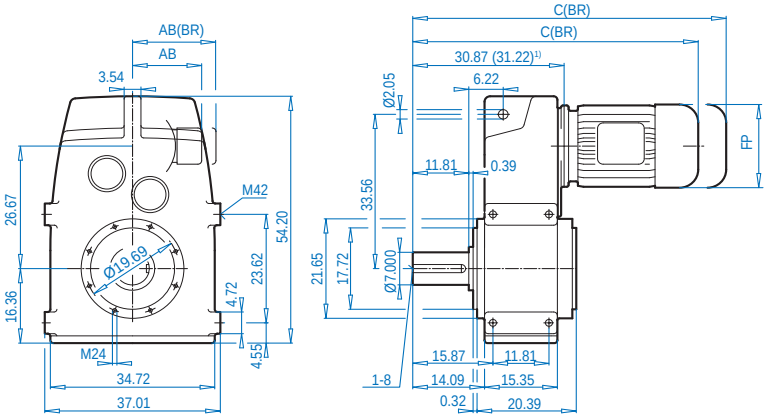
Type	M1		M2		M3		M4		M5		M6	
	Quarts	Liters	Quarts	Liters	Quarts	Liters	Quarts	Liters	Quarts	Liters	Quarts	Liters
SK 0182NB	0.420	0.400	0.580	0.550	0.630	0.600	0.580	0.550	0.370	0.350	0.370	0.350
SK 0282NB	0.740	0.700	1.06	1.000	0.850	0.800	1.16	1.10	0.950	0.900	0.950	0.900
SK 1282	0.950	0.900	1.37	1.30	0.950	0.900	1.27	1.20	1.000	0.950	1.000	0.950
SK 1382NB	1.37	1.30	2.43	2.30	1.48	1.40	2.22	2.10	2.11	2.00	2.01	1.90
SK 2282	1.74	1.65	2.54	2.40	2.01	1.90	2.11	2.00	1.90	1.80	1.90	1.80
SK 2382	1.80	1.70	2.75	2.60	2.01	1.90	3.28	3.10	1.59	1.50	1.59	1.50
SK 3282	3.33	3.15	4.33	4.10	3.44	3.25	4.33	4.10	3.33	3.15	3.33	3.15
SK 3382	4.33	4.10	5.18	4.90	3.49	3.30	5.92	5.60	3.49	3.30	3.49	3.30
SK 4282	4.97	4.70	6.45	6.10	5.02	4.75	5.71	5.40	4.97	4.70	4.97	4.70
SK 4382	6.24	5.90	7.19	6.80	5.18	4.90	8.77	8.30	5.18	4.90	5.18	4.90
SK 5282	7.93	7.50	9.30	8.80	7.93	7.50	9.30	8.80	7.61	7.20	7.61	7.20
SK 5382	13.21	12.50	12.68	12.00	7.08	6.70	14.80	14.00	8.77	8.30	8.77	8.30
SK 6282	17.97	17.00	14.80	14.00	12.68	12.00	18.50	17.50	10.57	10.00	14.80	14.00
SK 6382	17.44	16.50	13.74	13.00	10.15	9.60	19.03	18.00	14.80	14.00	13.21	12.50
SK 7282	26.42	25.00	22.20	21.00	21.14	20.00	28.54	27.00	16.91	16.00	22.20	21.00
SK 7382	23.25	22.00	21.14	20.00	16.91	16.00	26.42	25.00	24.31	23.00	20.08	19.00
SK 8282	39.11	37.00	34.88	33.00	31.71	30.00	43.34	41.00	32.77	31.00	32.77	31.00
SK 8382	35.94	34.00	33.82	32.00	26.42	25.00	40.17	38.00	37.00	35.00	31.71	30.00
SK 9282	78.22	74.00	73.99	70.00	58.14	55.00	76.10	72.00	63.42	60.00	62.36	59.00
SK 9382	77.16	73.00	73.99	70.00	47.56	45.00	78.22	74.00	68.70	65.00	63.42	60.00
SK 10282*	95.13	90.00	95.13	90.00	42.28	40.00	95.13	90.00	63.42	60.00	86.67	82.00
SK 10382*	89.84	85.00	105.67	100.00	77.16	73.00	105.70	100.00	84.56	80.00	84.56	80.00
SK 11282*	174.40	165.00	169.12	160.00	153.26	145.00	206.12	195.00	105.70	100.00	147.98	140.00
SK 11382*	169.12	160.00	163.84	155.00	147.98	140.00	221.97	210.00	163.84	155.00	142.70	135.00
SK 12382*	169.12	160.00	163.84	155.00	147.98	140.00	221.97	210.00	163.84	155.00	142.70	135.00

*** For shipping purposes the larger Clincher™ gear units are supplied without oil.**

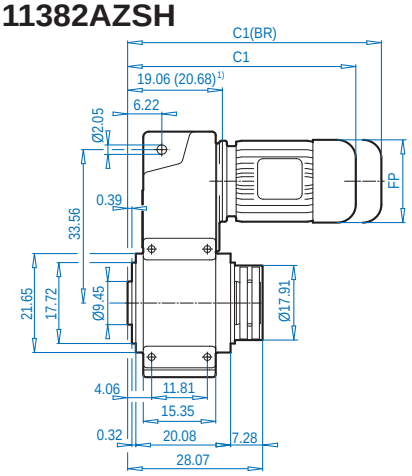
SK 11382/52 132S/4 Gearbox Dimensions

SK 11382 + Motor

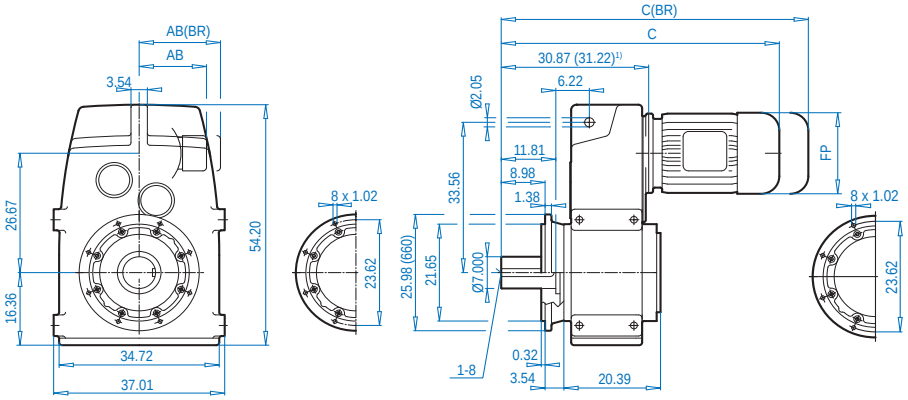
SK 11382VZ



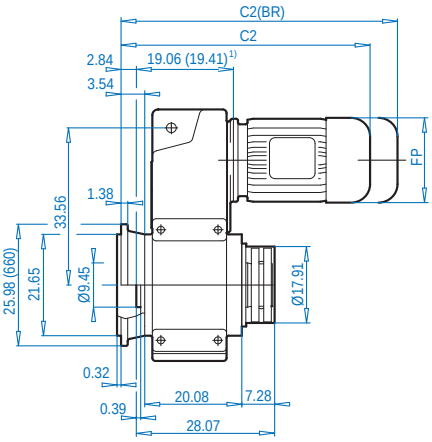
SK 11382AZSH



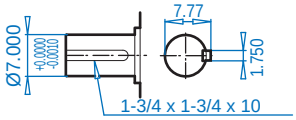
SK 11382VF



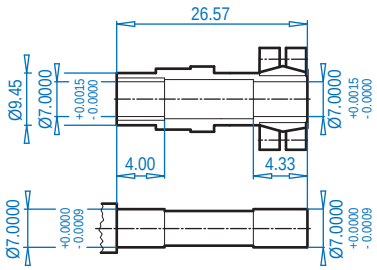
SK 11382AFSH



SK 11382V



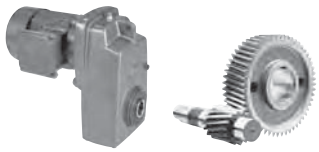
SK 11382**AZSH** ⇨📖 72



Motor dimensions

Standard eff.	160M/L		180MX/LX		200L	225S/M			250M		280S	280M1)		315S1)	315Ma1)	For Other Connection Possibilities please see ⇨📖 377 & 379
Energy eff.	160MH	160LH		180MH/LH	200LH		225SH	225MH		250MH	280SH		280MH1)	315SH1)	315MHa1)	
AB	8.90	8.90	8.90	10.20	12.05	12.05	12.80	12.80	15.43	15.43	17.01	17.01	17.01	20.28	20.28	
AB (BR)	8.90	8.90	8.90	10.20	12.05	12.05	-	-	15.43	15.43	17.01	17.01	17.01	-	-	
C1	37.87	39.44	39.44	42.75	46.14	46.14	46.02	46.02	48.97	51.73	53.11	51.69	56.02	57.60	63.11	
C1 (BR)	44.44	46.18	46.18	46.88	52.71	52.71	-	-	60.00	64.33	62.32	66.65	66.65	-	-	
C2	40.71	42.28	42.28	45.59	48.98	48.98	48.86	48.86	51.81	54.57	55.95	54.53	58.86	60.44	65.95	
C2 (BR)	47.28	49.02	49.02	49.72	55.55	55.55		-	60.08	62.84	67.17	65.16	69.49	-	-	
C	49.69	51.26	51.26	54.57	57.96	57.96	57.84	57.84	60.79	63.55	64.93	63.51	67.84	69.42	74.93	
C (BR)	56.26	58.00	58.00	58.70	64.53	64.53	-	-	69.06	71.82	76.15	74.14	78.47	-	-	
FP	12.60	12.60	12.60	14.09	15.67	15.67	17.52	17.52	19.49	19.49	22.64	21.85	21.85	25.39	25.39	

(BR) denotes Brakemotor



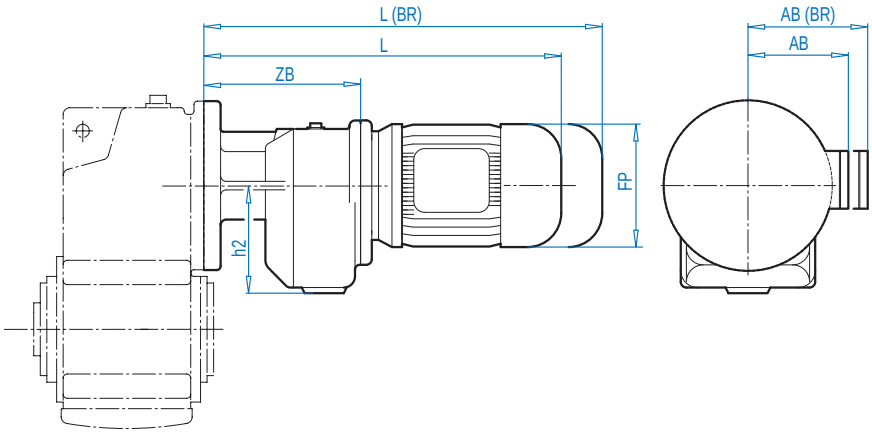
7.5 hp Gearmotors

Motor Power P_n [hp]	Output Speed n_2 [rpm]	Output Torque T_a [lb-in]	Service Factor f_B	AGMA Class	Gear Ratio i_{tot}	Standard Bearings F_{QN} OHL [lb]	Standard Bearings F_{AN} Thrust [lb]	Heavy Duty Bearings (VL) F_{QVL} OHL [lb]	Heavy Duty Bearings (VL) F_{AVL} Thrust [lb]	Model Type	Weight [lb]	Dim. Page
7.5	29	16246	3.0	III	59.66	6613	10463	13057	13500	SK 6382 - 132S/4	476	350
	24	20015	2.5	III	73.50	6892	10463	12951	13500	SK 6382 - 132SH/4		
	23	20472	2.6	III	75.18	6955	10463	12938	13500			
	19	25224	2.1	III	92.63	7191	10463	12769	13500			
	15	31258	1.7	II	114.79	7380	10463	12499	13500			
	14	34548	1.2	I	126.87	7385	10463	12323	13500			
	11	43536	1.2	I	159.88	7227	10463	11738	13500			
	10	46657	1.1	I	171.34	6827	10463	11498	13500			
	30	15497	3.2	III	56.91	7317	13050	15899	18000	SK 7282 - 132S/4	622	352
	25	18988	2.7	III	69.73	7691	13050	16830	18000	SK 7282 - 132SH/4		
	14	33595	2.0	III	123.37	8514	13050	18153	18000	SK 7382 - 132S/4	637	354
	12	41001	1.6	II	150.57	8750	13050	17946	18000	SK 7382 - 132SH/4		
	11	44160	1.3	I	162.17	8730	13050	17845	18000			
	8.5	55820	1.2	I	204.99	8962	13050	17395	18000			
	8	58935	1.2	I	216.43	8870	13050	17255	18000			
	6.3	74495	0.9	*	273.57	8921	13050	16416	18000			
	29	16186	3.5	III	59.44	9092	15779			SK 8282 - 132S/4	904	356
	24	19663	3.5	III	72.21	9590	16425			SK 8282 - 132SH/4		
	15	32260	3.4	III	118.47	10706	16425	22275	23625	SK 8382 - 132S/4	913	358
	14	34142	3.2	III	125.38	10899	16425	22500	23625	SK 8382 - 132SH/4		
	12	39188	2.8	III	143.91	11192	16425	22500	23625			
	11	41617	2.8	III	152.83	11259	16425	22500	23625			
	9.3	50557	2.2	III	185.66	11745	16425	22500	23625			
	8.6	54734	1.7	II	201.00	11761	16425	22500	23625			
	7.2	65904	1.8	II	242.02	12020	16425	22500	23625			
	5.9	80061	1.4	II	294.01	12328	16425	22500	23625			
	5.5	86678	1.3	I	318.31	12260	16425	22500	23625			
	4.5	105296	1.1	I	386.68	12438	16425	22500	23625			
	9.9	47667	4.0	III	175.05	15998	22950	27000	29250	SK 9382 - 132S/4	1579	362
	8.5	55736	3.5	III	204.68	16614	22950	27000	29250	SK 9382 - 132SH/4		
	6	79309	2.7	III	291.25	17838	22950	27000	29250			
	4.9	95950	2.3	III	352.36	18619	22950	27000	29250			
	3.9	122421	1.7	II	449.57	15741	22950	27000	29250	SK 9382/42 - 132S/4	1678	375
	2.8	168367	1.3	I	618.30	16016	22950	27000	29250	SK 9382/42 - 132SH/4		
	2.4	194803	1.1	I	715.38	15982	22950	27000	29250			
	2	241398	0.9	*	886.49	15257	22950	27000	29250			
	3.6	129550	2.4	III	475.75			29799	33750	SK 10382/52 - 132S/4	2986	375
	3	157350	2.0	III	577.84			29234	33750	SK 10382/52 - 132SH/4		
	2.5	188535	1.6	II	692.36			28456	33750			
	1.9	249477	1.2	I	916.16			26426	33750			
	1.5	317371	1.0	I	1165.49			23191	33750			
	1.2	386333	0.8	*	1418.74			18315	33750			
	2.9	164111	3.2	III	602.67			32427	38250	SK 11382/52 - 132S/4	4833	375
	2.4	199353	2.7	III	732.09			31631	38250	SK 11382/52 - 132SH/4		
	1.8	262226	2.0	III	962.98			29747	38250			
	1.5	314338	1.7	II	1154.35			27662	38250			
	1.3	376633	1.4	II	1383.12			24365	38250			
	0.95	498382	1.1	I	1830.22			13012	38250			
	0.75	632651	0.8	*	2323.3				38250			

(AGMA Class I = f_B 1.0 - 1.39 II = f_B 1.4 - 1.99 III = f_B ≥ 2.0 * = f_B < 1.0) **(Model Type in blue is an Energy Efficient motor)**

SK 11382/52 132S/4 Integral Motor Dimensions

SK 8382/42 - SK 11382/52



Motor dimensions

Type	SK 8382/42 , SK 9382/42							For Other Connection Possibilities please see ⇨🕮 377 & 379
Standard eff.	90S/L	100L		132S/M				
Energy eff.	90LH	100LH	112MH	132SH/SM				
AB	5.79	6.65	7.05	8.03				
AB (BR)	5.83	6.26	6.69	7.72				
L	21.12	22.30	23.20	26.59				
L (BR)	24.07	25.89	26.86	30.80				
ZB	10.25							
h2	6.89							
FP	7.20	7.91	8.98	10.47				
	SK 8382 ⇨🕮 358, SK 9382 ⇨🕮 362							

Type	SK 9382/52 , SK 10382/52 , SK 11382/52							For Other Connection Possibilities please see ⇨🕮 377 & 379
Standard eff.	100L		132S/M	160M/L		180MX		
Energy eff.	100LH	112MH	132SH/MH	160MH	160LH		180MH	
AB	6.65	7.05	8.03	8.90	8.90	8.90	10.20	
AB (BR)	6.26	6.69	7.72	8.90	8.90	8.90	10.20	
L	23.86	24.76	28.15	31.18	36.30	36.30	49.21	
L (BR)	27.45	28.42	32.36	38.23	40.43	40.43	53.34	
ZB	11.81							
h2	8.35							
FP	7.91	8.98	10.47	12.60	12.60	12.60	14.09	
	SK 9382 ⇨🕮 362, SK 10382 ⇨🕮 366, SK 11382 ⇨🕮 370							

(BR) denotes Brakemotor

Motor Order Form

	Frame	Size	Poles	Motor Options	Brake Size	Brake Options
SK	132	S	4	NONE	NONE	NONE

Frame	Size	Poles
63	S	4
71	SH	2
80	M	6
90	MH	4-2
100	MX	8-2
112	L	8-4
132	LA	12-2
160	LH	Other
180	LX	
200		
225		
250		
280		
315		

Paint

- ❍ Unpainted Aluminum Alloy
- ⊗ Standard Stainless Steel Paint
- ❍ NSD+ (gray)
- ❍ NSD+W (white)
- ❍ NSD-X3 (gray)
- ❍ NSD-X3W (white)
- ❍ Special _____

Electrical Motor Options

- ❐ **H** - Energy Efficient Motor
- ❐ **TW** - Thermostat
- ❐ **TF** - Thermistor
- ❐ **SH** - Space Heater (select voltage)
  - ❍ 110 Volt ❍ 230 Volt ❍ 460 Volt
- ❐ **ISO H** - Class H insulation
- ❐ **WU -** High Resistance Rotor
- ❐ **4-2** - 2-Speed, 4/2 Pole, 1800/3600rpm
- ❐ **8-2** - 2-Speed, 8/2 Pole, 900/3600rpm
- ❐ **ECR** - Single Phase Motor

Environmental Options

- ❐ **NSD+** - Nord Severe Duty Paint
- ❐ **NSDx3** - Nord Extreme Duty Paint
- ❐ **RD** - Canopy Drip Cover
- ❐ **RDD** - Double Fan Cover
- ❐ **KB** - Condensation Drain Holes (plugged)
- ❐ **KBO** - Condensation Drain Holes (open)
- ❐ **IP66** - IP66 Enclosure Protection
- ❐ **KKV** - Terminal Box Sealed with Resin
- ❐ **AICM** - Additional Insulation
- ❐ **EP** - Epoxy Dipped Windings

Frequency Inverter Related Options

- ❐ **F** - Blower Fan (200-575V 1 & 3 Phase)
- ❐ **FC** - Blower Cooling Fan (115V, 1 Phase)
- ❐ **IG__** - Incremental Encoder
- ❐ **IG__P** - Incremental Encoder with Plug
- ❐ **AG** - Absolute Encoder

Additional Motor Options

- ❐ **OL -** Totally Enclosed Non-Ventilated (TENV)
- ❐ **OL/H** - (TENV) Without Fan Cover
- ❐ **WE -** Second Shaft Extension (Fan Side)
- ❐ **HR -** Hand Wheel
- ❐ **Z -** High Inertia Cast Iron Fan
- ❐ **RLS -** Motor Backstop (rotation viewing fan)
  - ❍ Clockwise ❍ Counter-Clockwise
- ❐ **EKK -** Small Terminal Box (not UL approved)
- ❐ **MS -** Quick Power Plug Connector

Brake Size
BRE 5
BRE 10
BRE 20
BRE 40
BRE 60
BRE 100
BRE 150
BRE 250
BRE 400
BRE 800
BRE 1200

Brake Options

- ❐ **HL** - Hand Release Lever
- ❐ **FHL** - Locking Hand Release Lever
- ❐ **HLH** - Hand Release Lever with Hole
- ❐ **RG** Corrosion Protected Brake
- ❐ **SR** - Dust and Corrosion Protected Brake
- ❐ **ADJ_____Nm** - Adjust Brake Torque
- ❐ **BIP66** - IP66 Brake Enclosure
- ❐ **MIK** - Micro-switch
- ❐ **BSH** - Brake Heating/Bifilar Coil
- ❐ **NRB1** - Quiet Brake Release
- ❐ **NRB2** - Quiet Brake Motor Operation
- ❐ **FBR** - Brass Foil
- ❐ **DBR -** Double Brake
- ❐ **G...P -** High Performance Rectifier
- ❐ **G...V** - Sealed Rectifier
- ❐ **IR** - Current Sensing Relay

Rectifier Selection

Rectifier Wiring

- ❍ Across the line (from motor terminal box)
- ❍ Separate power source (frequency inverter, soft starter)

Brake Supply Voltage

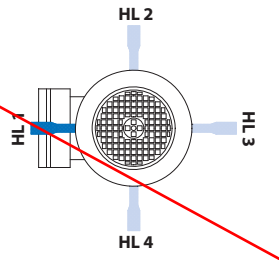
- ❍ 24 VDC
- ❍ 115 VAC
- ❍ 200 VAC
- ❍ 230 VAC
- ❍ 400 VAC
- ❍ 460 VAC
- ❍ 500 VAC
- ❍ 575 VAC
- ❍ Other _____

Braking Method

- ❍ Method 10
- ❍ Method 15
- ❍ Method 20
- ❍ Method 25
- ❍ Method 30
- ❍ Method 35
- ❍ Method 40
- ❍ Method 45
- ❍ Method 50
- ❍ Method 55

Hand Release Position

- ❍ HL1
- ❍ HL2
- ❍ HL3
- ❍ HL4



Mounting

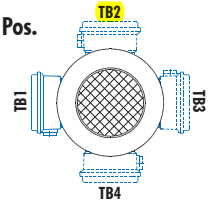
- ⊗ Integral to gearbox
- ❍ NEMA C-Face
- ❍ NEMA foot mount
- ❍ IEC B5 Mount
- ❍ IEC B14 Mount
- ❍ IEC foot mount

Voltage & Frequency

- ⊗ 230/460V-60Hz (460V only ≥ 40hp)
- ❍ 575V-60Hz
- ❍ 208V-60Hz
- ❍ 400V-50Hz
- ❍ 115/230V, 60Hz-1-ph.
- ❍ Other

Terminal Box Pos.

- ❍ TB1
- ⊗ TB2
- ❍ TB3
- ❍ TB4

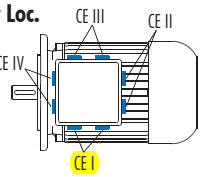


Mtg. Pos. M1 Shown

Conduit Entry Loc.

- ⊗ CE I *
- ❍ CE II
- ❍ CE III *
- ❍ CE IV

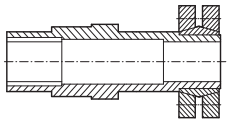
* Brakemotor



Mtg. Pos. M1 Shown

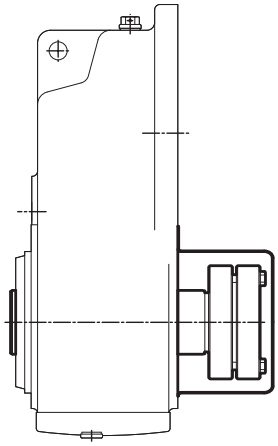
MOTORS

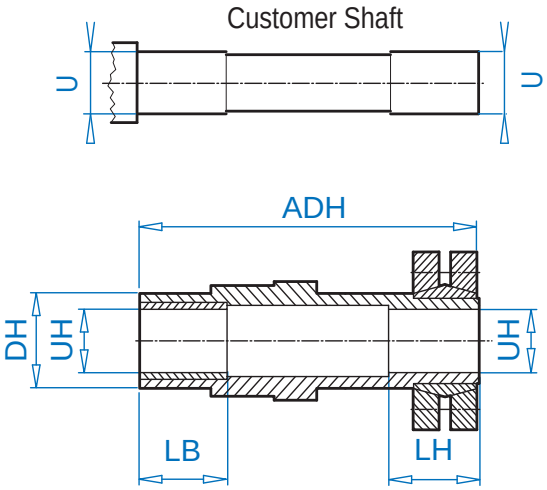
SK 11382/52 132S/4 Shrink Disc Specifications



Shrink Disc Shaft Dimensions

Shrink Disc Shaft Dimensions (AZSH)





TYPE	HOLLOW SHAFT		ADH	LB	LH	DH	CUSTOMER SHAFT	
	UH	TOLERANCE					U	TOLERANCE
SK 0282NB AZSH	1.1875	+0.0009 / -0.0000	6.30	1.18	1.57	1.57	1.1875	+0.0000 / -0.0006
	30mm	+0.021 / -0.000mm	160mm	30mm	40mm	40mm	30mm	+0.000 / -0.013mm
SK 1382NB AZSH	1.500	+0.0009 / -0.0000	8.66	1.57	1.77	1.97	1.500	+0.0000 / -0.0006
	35mm	+0.025 / -0.000mm	220mm	40mm	45mm	50mm	35mm	+0.000 / -0.016mm
SK 1282 AZSH	1.250	+0.0009 / -0.0000	6.38	1.18	1.57	1.77	1.250	+0.0000 / -0.0006
	30mm	+0.021 / -0.000mm	162mm	31mm	40mm	45mm	30mm	+0.000 / -0.013mm
SK 2282 AZSH	1.500	+0.0009 / -0.0000	7.68	1.57	1.77	1.97	1.500	+0.0000 / -0.0006
SK 2382 AZSH	35mm	+0.025 / -0.000mm	195mm	41.5mm	45mm	50mm	35mm	+0.000 / -0.016mm
SK 3282 AZSH	1.625	+0.0009 / -0.0000	8.86	1.61	2.17	2.17	1.625	+0.0000 / -0.0006
SK 3382 AZSH	40mm	+0.025 / -0.000mm	225mm	41mm	55mm	55mm	40mm	+0.000 / -0.016mm
SK 4282 AZSH	2.000	+0.0011 / -0.0000	10.28	2.01	2.17	2.76	2.000	+0.0000 / -0.0007
SK 4382 AZSH	50mm	+0.025 / -0.000mm	261mm	51mm	55mm	70mm	50mm	+0.000 / -0.016mm
SK 5282 AZSH	2.500	+0.0011 / -0.0000	11.61	2.17	2.76	3.35	2.500	+0.0000 / -0.0007
SK 5382 AZSH	60mm	+0.030 / -0.000mm	295mm	61mm	70mm	85mm	60mm	+0.000 / -0.019mm
SK 6282 AZSH	3.000	+0.0011 / -0.0000	14.57	2.56	3.35	3.94	3.000	+0.0000 / -0.0007
SK 6382 AZSH	70mm	+0.030 / -0.000mm	370mm	71mm	85mm	100mm	70mm	+0.000 / -0.019mm
SK 7282 AZSH	3.1875	+0.0013 / -0.0000	15.55	2.17	3.54	4.33	3.1875	+0.0000 / -0.0008
SK 7382 AZSH	80mm	+0.030 / -0.000mm	395mm	81mm	90mm	110mm	80mm	+0.000 / -0.019mm
SK 8282 AZSH	4.000	+0.0013 / -0.0000	17.95	2.76	3.74	5.12	4.000	+0.0000 / -0.0008
SK 8382 AZSH	100mm	+0.035 / -0.000mm	456mm	71mm	95mm	130mm	100mm	+0.000 / -0.022mm
SK 9282 AZSH	4.750	+0.0015 / -0.0000	21.06	3.23	4.33	6.30	4.750	+0.0000 / -0.0009
SK 9382 AZSH	125mm	+0.040 / -0.000mm	535mm	82mm	110mm	160mm	125mm	+0.000 / -0.022mm
SK 10282 AZSH	6.250	+0.0015 / -0.0000	25.98	4.72	5.12	8.66	6.250	+0.0000 / -0.0009
SK 10382 AZSH	160mm	+0.040 / -0.000mm	660mm	122mm	130mm	220mm	160mm	+0.000 / -0.025mm
SK 11282 AZSH	7.000	+0.0015 / -0.0000	26.57	4.00	4.33	9.45	7.000	+0.0000 / -0.0009
SK 11382 AZSH	180mm	+0.040 / -0.000mm	675mm	101.5mm	110mm	240mm	180mm	+0.000 / -0.025mm
SK 12382 AZSH	7.000	+0.0015 / -0.0000	33.27	4.00	10.59	9.45	7.000	+0.0000 / -0.0009
	180mm	+0.040 / -0.000mm	845mm	101.5mm	269mm	240mm	180mm	+0.000 / -0.025mm

Material Seal Level Indicator, Bindicator, LP3-1-A-1-G-A-10-0

- LP-30 Pulse Point Installation, Operation, & Maintenance Manual

LP-30 Pulse Point™

INSTALLATION, OPERATION & MAINTENANCE MANUAL

SAFETY INFORMATION

Before installing the Pulse Point level switch, please read these instructions and familiarize yourself fully with the requirements and functions of the sensor.

Do not dispose of the carton or packing material until the unit has been inspected for damage. If the unit is received damaged, notify the carrier or the factory for instructions. Failure to do so may void your warranty.

The Pulse Point sensor is a precision device. Very high voltage is present on the fork terminals. Always remove power before servicing.

All wiring must conform to NEC requirements or local electrical codes.

If any questions or problems arise during installation of this equipment, please contact the Bindicator Applications Department at 800-778-9242 or 864-574-8960.

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1.0 PRODUCT DESCRIPTION

1.1 Function

The Pulse Point™ is an electronic, vibratory level control designed for use in powders and granular solids. The Pulse Point uses a vibrating "tuning fork" to sense the presence of material.

The tuning fork contains two piezoelectric crystal assemblies: one "transmit" and one "receive" Piezo crystals convert electrical signals to mechanical movement, and vice versa. High-voltage pulses applied to the transmit crystal cause the tines of the fork vibrate. This vibration is mechanically coupled to the receive crystal which produces a small electrical signal (one-volt pulses). The receive crystal will produce low voltage pulses as long as the fork is vibrating.

If the fork stops vibrating, as it does when in contact with material in the vessel, the receive pulses stop. The electronics recognizes this loss of signal and causes the output relay to change state.

1.2 Applications

Unlike radio frequency and capacitance technology sensors, the Pulse Point senses material using a mechanical principle and is therefore not affected by the dielectric constant of the material. This makes it an ideal sensor in plastics, dust, shavings, and low-density powders and food. The Pulse Point can easily sense material as light as 2 lbs/cubic foot (32kg/cubic meter). It can be applied in any free flowing dry material up to 9/16” (14.3mm) in particle size.

1.3 Features

Features of the LP-30 Pulse Point include:

- Various models, mounting configurations, and fork coatings available to suit almost any application
- No calibration required
- Adjustable time delay
- Selectable fail-safe operation (high or low level)

1.4 Model Code Identification

The Pulse Point LP-30 Series are integral units, which have the electronics and tuning fork in the same enclosures. The fork may be pipe extended up to 10 feet.

LP-30 Series

LP3 - ___ - A - ___ - G - ___ - 10 - ___

Type (Specify insertion length in inches if applicable)
0 = No Pipe Extension (Standard NPT Mounting)
A = Galvanized ¾" Pipe Extension
B = 316 SS ¾" Pipe Extension
1 = Mild Steel Mounting Plate & Galvanized ¾" Pipe Extension
3 = 304 SS Mounting Plate & 316 SS ¾" Pipe Extension

Mounting Configuration
A = 1½" NPT Mounting
B = 1½" Pipe Extended
C = 1¼" Mounting
D = 1¼" Pipe Extended

Enclosure Rating
G = General Purpose - NEMA 4X

Voltage
1 = 120VAC
2 = 240VAC
3 = 100 VAC (Consult Factory)

Enclosure Material
A = Aluminum, Polyester Coated

Tuning Fork
1 = 316 SS
3 = 316 SS - Teflon® Coated

Pulse Point™ LP-30

Note: For direct replacement of Roto-Bin-Dicator control, order the 1¼" Pulse Point mounting configuration.

1.5 Technical Specifications

LP-30 Series

Power Requirements	120 VAC or 240 VAC or 100 VAC, 50/60 Hz
Power Consumption	5 VA
Operating Temperature	Electronics: -40° F to 140° F (-40° C to 60° C); Tuning Fork: -55° F to 248° F (-48° C to 120° C)
Output	6A SPDT @ 240 VAC or 28 VDC
Pressure Rating	150 psi (10.5 kg/cm^2) with 1½" NPT; 5 psi (0.35 kg/cm cm^2) with with mounting plate
Time Delay	Field programmable: ON, OFF or both; Adjustable (0-20 sec)
Fail Safe	Field selectable high/low level
Enclosure Material	Polyester coated aluminum
Enclosure Rating	General purpose NEMA 4X
Tuning Fork	316 SS standard; 316 SS with Teflon coating
Conduit Entry	3/4" NPT Dual
Mounting	1½" or 1¼" NPT; Extended forks can be mounted directly through 1½" or 1¼" NPT coupling
Mounting Plate Material	Mild Steel, 304 SS
Extended Pipe Material	Galvanized or 316 SS
Maximum Pipe Extension	10 ft (3 m)
Status Indicator	None
Minimum Material Density	2 lbs/ft^3 (32 kg/m^3)

1.6 Dimensions

Figures 1 and 2 illustrate the dimensions of the standard 1½" and 1¼" LP-30 units. See the Appendix beginning on page 16 for additional dimensions.

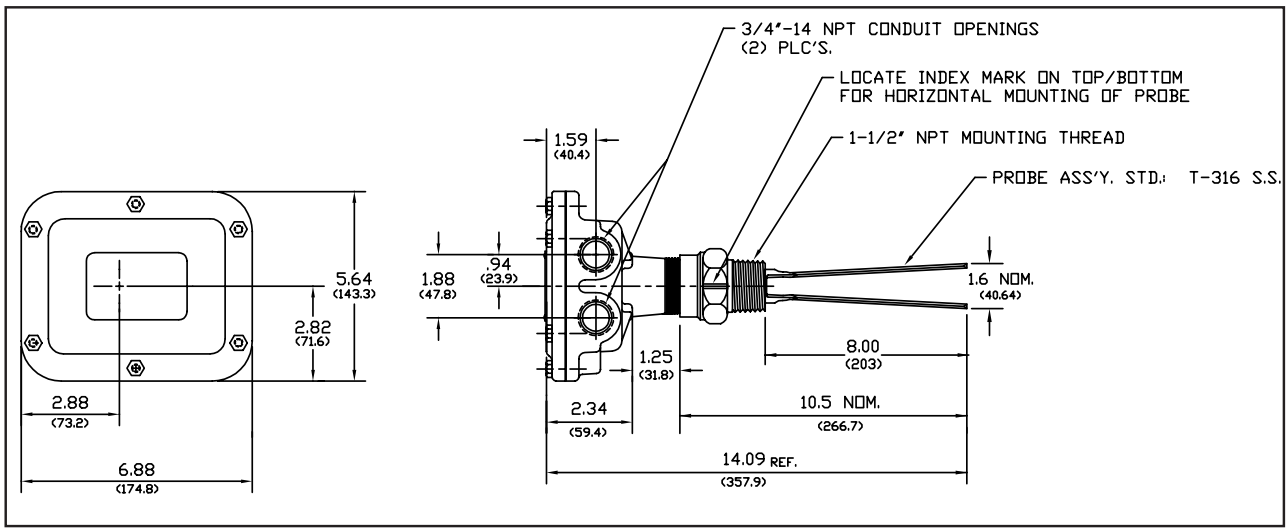


Figure 1. 1½" LP-30 Dimensions in (mm)

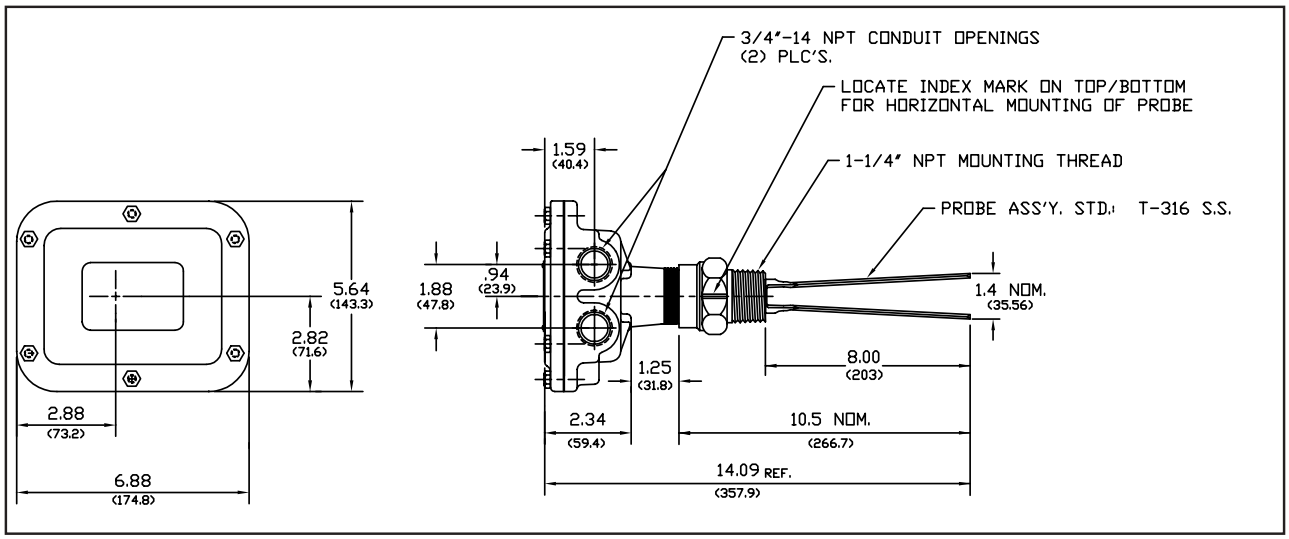


Figure 2. 1¼" LP-30 Dimensions in (mm)

2.0 HANDLING & STORAGE

2.1 Inspection and Handling

Each package should be inspected upon receipt for damage that may have occurred due to mishandling during shipping. If damage is discovered, notify the shipping carrier immediately. Do not dispose of the carton or packing materials. If you have any problems or questions, consult Bindicator Customer Care at 1-800-778-9242.

2.2 Storage

If the Pulse Point sensor is not scheduled for immediate installation following delivery, the following steps should be observed:

1. Following inspection, repackage the unit into its original packaging.
2. Select a clean dry site, free of vibration, shock, and impact hazards.
3. If storage will be extended longer than 30 days, the unit must be stored in a non-condensing atmosphere less than 100% humidity.

Do not store a non-powered unit outdoors for a prolonged period.

3.0 MECHANICAL INSTALLATION

3.1 Guidelines

The following precautions should be observed when installing and operating the Pulse Point:

·The tuning fork assembly is a precision device - handle it carefully

·Remove power from the unit before making any adjustments

CAUTION: Very high voltage is present on the fork terminals

·Do not allow moisture to enter the electronics enclosure. Conduit should slope downward from the Pulse Point housing. Install drip loops. Seal conduit with silicone rubber product.

·All wiring must conform to NEC requirements or local electrical codes.

3.2 Mounting

The Pulse Point fork must be located at the position where level indication is desired. The fork may be mounted through the top or side wall of the vessel. To ensure reliable operation, observe the following guidelines when choosing the mounting location. See Table 1 (Section 1.4) for mounting types.

·Avoid locations where high levels of vibration are present.

·The fork assembly must be horizontal or pointing downward. DO NOT mount the fork pointing upward. (See Figure 3)

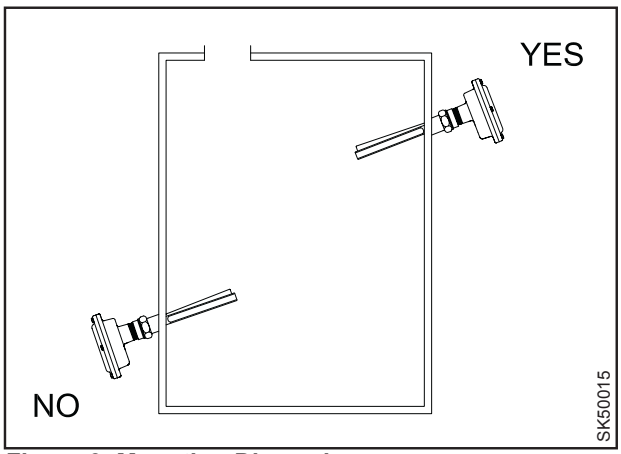


Figure 3. Mounting Dimensions

·The maximum allowable downward force on the fork assembly is 88 pounds. (See Figure 4)

·Calculate the maximum solids head height above a horizontally mounted fork as follows:

$$\text{Maximum height of material (in ft)} = \frac{2200}{\text{bulk density (lbs/ft}^3\text{)}}$$

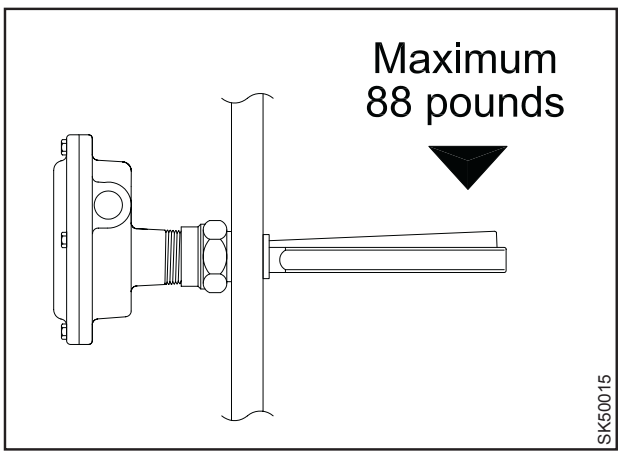


Figure 4. Maximum Downward Force

·Do not mount the fork directly in the flow of material. If necessary, use a baffle to protect the fork from falling material. The baffle should be placed 6 to 8 inches above the fork so that material will not become packed between the fork and the baffle. (See Figure 5)

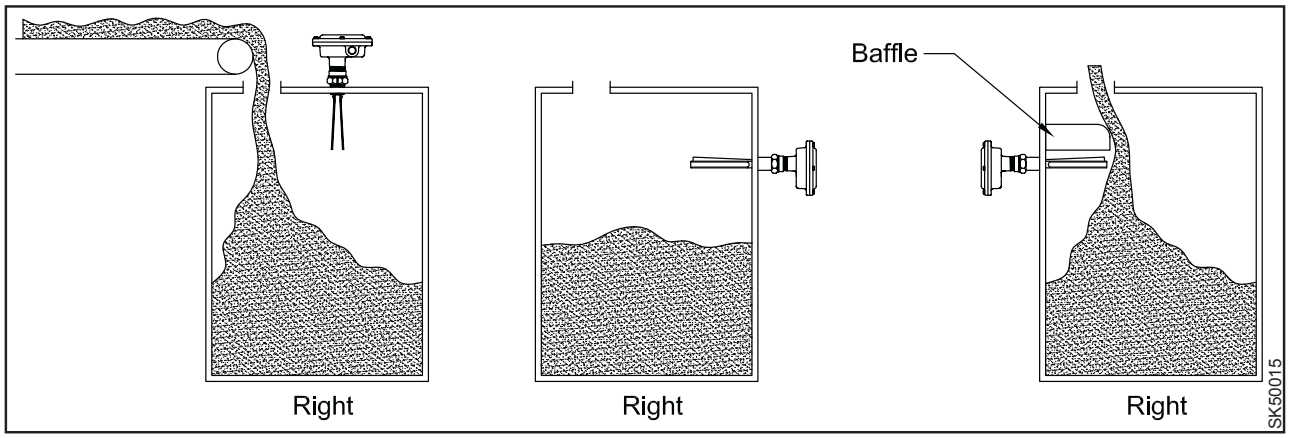


Figure 5. Mounting in Relation to Flow of Material

·If the fork is mounted horizontally, it must be positioned so that the material will not accumulate on top of or between the tines. There is an index mark on the mounting nut to assist in proper positioning of the fork. (See Figure 6)

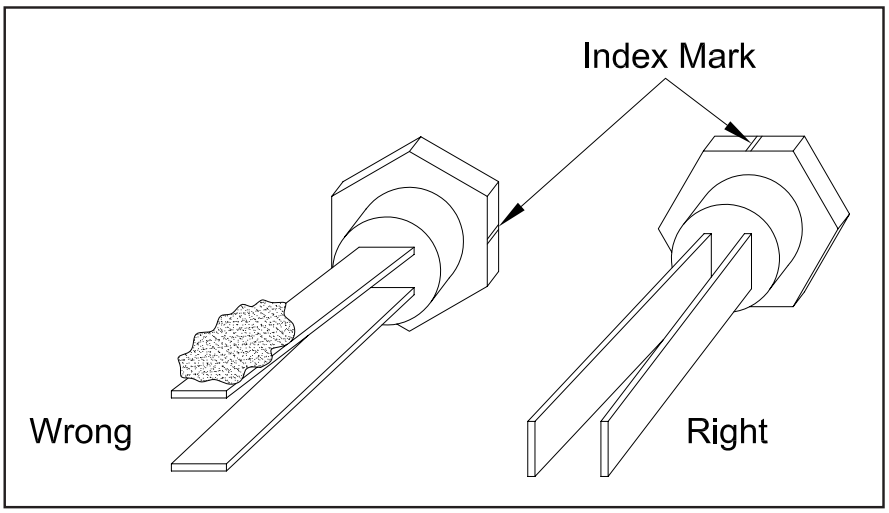


Figure 6. Index Mark

4.1 Guidelines

Electrical connections to the LP-30 Pulse Point are shown in drawing LVP180011. All wiring must be completed in accordance with applicable electrical codes.

4.2 Connection Information / Wiring Diagrams

The markings at TB-2 on the circuit board indicate the status of the relay contacts when the unit is operating in non-alarm condition, which is the powered, unalarmed state. This status may be opposite that of other brands of level controls. Contacts as marked on TB2 are not the relays nomenclautre, but are marked so contacts are in “normal” positions when unit is powered and unalarmed (see Section 5.2).

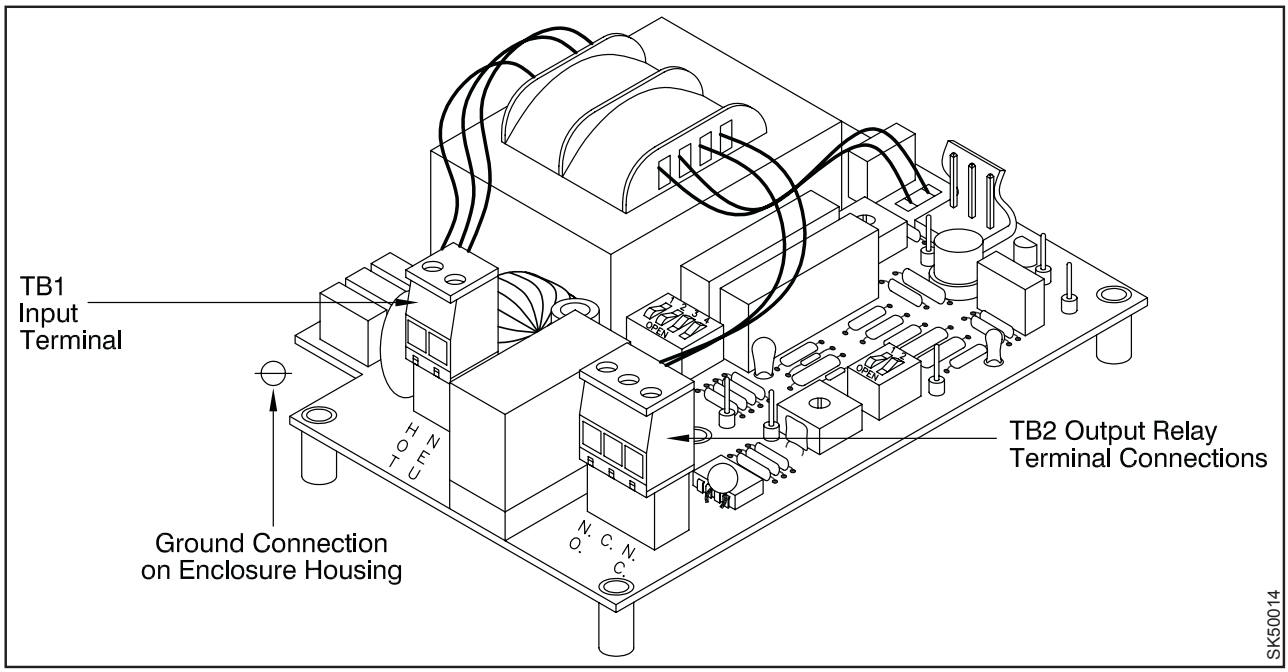


Figure 7. TB2 Output Relay Terminal Connections

5.1 Operation

The Pulse Point does not require calibration. When power is applied to the unit, the tines of the fork will begin vibrating (if the fork is not impeded by contact with material or some other object). The green light LED will be lighted whenever power is applied to the unit. The status of the red LED will be determined by the selected fail-safe mode and whether or not the fork is allowed to vibrate. (Refer to Fail-Safe Operation section below)

5.2 Set-Up / User Options

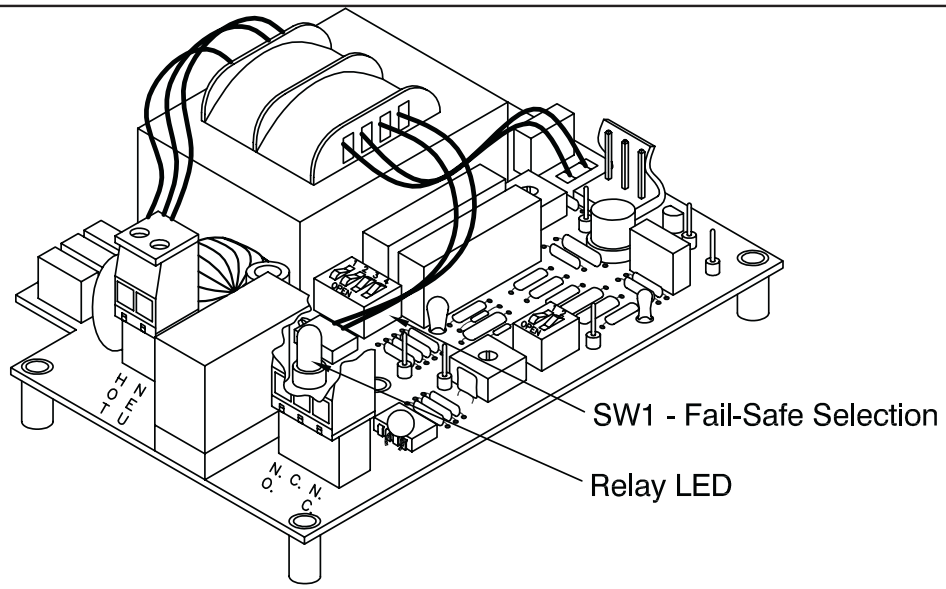
The Pulse Point allows the user to control several operating characteristics to suit individual applications.

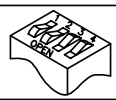
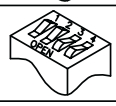
Fail-Safe Selection

The output relay on the Pulse Point is energized when the unit is operating in non-alarm state. This is known as "fail-safe" opearation; the Pulse Point will give an alarm indication in the event of power failure.

Fail-safe operation may be selected for high-level (HLFS) or low-level (LLFS) applications by setting the 4 DIP switches of SW1 as shown in Figure 8. The chart below shows the various operating conditions, which will exist in each of the fail-safe modes:

Fail-Safe Mode	Fork Status	Relay Status	Red LED	Terminal N.O. to C	Terminal N.C. to C
HLFS	Vibrating	Energized	On	Open	Closed
HLFS	Not vibrating	Not Energized	Off	Closed	Open
LLFS	Vibrating	Not Energized	Off	Closed	Open
LLFS	Not Vibrating	Energized	On	Open	Closed



Fail-Safe Mode	SW1 - Switches				Illustration
	1	2	3	4	
High Level Fail-Safe (HLFS)	Closed	Closed	Open	Open	
Low Level Fail-Safe (LLFS)	Open	Open	Closed	Closed	

SK500014

Table 2: Fail-Safe Mode Switches

Time Delay Selection

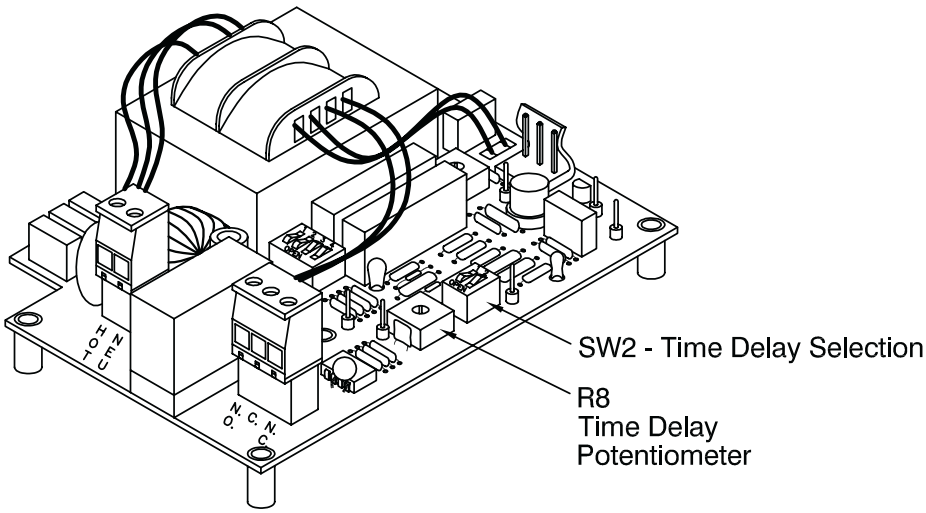
"Time delay" is the interval between change of fork status (vibrating or not vibrating) and change of output relay status (alarmed or not alarmed).

There are four modes of time delay operation as selected by setting the 2 DIP switches of SW2 as shown in Figure 9.

"A" - delay between start of fork vibration and relay change
"B" - delay between stoppage of fork vibration and relay change
"C" - delay between both start and stoppage of fork vibration and relay change
“D” - minimum delay

Potentiometer R8 adjusts the time delay interval. Minimum time delay is zero seconds (R8 fully counter-clockwise); maximum time delay is 20 seconds (R8 fully clockwise).

Note: Pulse Point units are shipped from the factory with SW2 in “minimum delay” R8 adjusted for minum time delay.



Time Delay Mode	SW2 - Switches		Illustration
	1	2	
A	Closed	Open	
B	Open	Closed	
C	Open	Open	
D	Closed	Closed	

SK50014

Figure 9. Time Delay Set-up

Sensitivity Adjustment

For most applications the sensitivity control R22 should be left in the factory default position (fully clockwise). For applications with very low density materials, the fork drive should be reduced by turning potentiometer R22 counter-clockwise (see Figure 10).

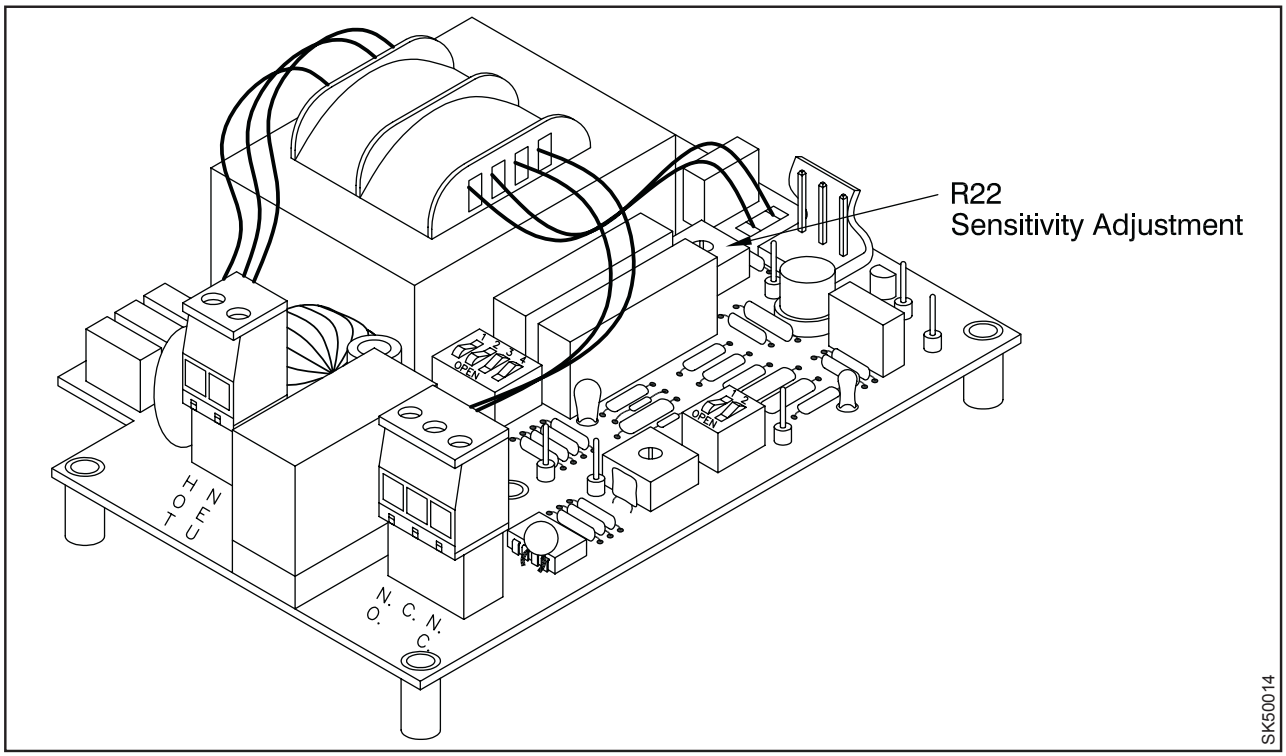


Figure 10. R22 Sensitivity Adjustment

6.0 MAINTENANCE / PARTS LIST

6.1 Preventative Maintenance

No scheduled preventative maintenance is required for Pulse Point units when properly applied and installed correctly.

6.2 Spare / Replacement Parts

Product Code	Description
Electronics	
LVP130302	120VAC Printed Circuit Board
LVP110257	240VAC Printed Circuit Board
LVP130307	100VAC Printed Circuit Board (consult factory for availability)
Tuning Forks	
LVP130300	1½" NPT Integral Tuning Fork 316 SS
LVP130301	1½" NPT Extended Tuning Fork 316 SS
LVP130310	1¼" NPT Integral Tuning Fork 316 SS
LVP130311	1¼" NPT Extended Tuning Fork 316 SS
LVP130316	1½" Standard Tuning Fork Teflon® Coated
LVP130318	1¼" Standard Tuning Fork Teflon® Coated
LVP130320	1¼" Extended Tuning Fork Teflon® Coated
LVP130325	1½" Extended Tuning Fork Teflon® Coated
Mounting Plates	
LVP110059	1½" NPT Mild Steel Mounting Plate
LVP110060	1½" NPT 304 SS Mounting Plate
LVP110130	1¼" NPT Mild Steel Mounting Plate
LVP110071	1¼" NPT 304 SS Mounting Plate
Flanges	
LUB042612	2" with 1¼" NPT Tapped Female, 316 SS
LUB042901	2" with 1¼" NPT Tapped Female, Carbon Steel
LUB042615	2" with 1½" NPT 304 SS
LUB042761	3" with 1¼" NPT Tapped Female, 316 SS
LUB042603	3" with 1¼" NPT Tapped Female, Carbon Steel
LUB042740	3" with 1½" NPT 316 SS
LUB042940	3" with 1½" NPT 304 SS
LUB042733	3" with 1½" NPT Carbon Steel
LUB042855	4" with 1¼" NPT Tapped Female, 304 SS
LUB042910	4" with 1¼" NPT Tapped Female, Carbon Steel

7.0 TROUBLESHOOTING

The following section may be used as a troubleshooting guide in the unlikely event that problems are found with operation of the Pulse Point.

Problem: Fork vibrates, but unit will not alarm

Solution: Make sure problem is not an improperly set time delay.
Test by turning R8 fully counter-clockwise to set time delay to minimum.
Verify proper setting of fail-safe switches, SW1. See section 5.2 Set-Up / User Options on page 11.

Contact your local factory representative if additional assistance is needed. Please provide the following information:

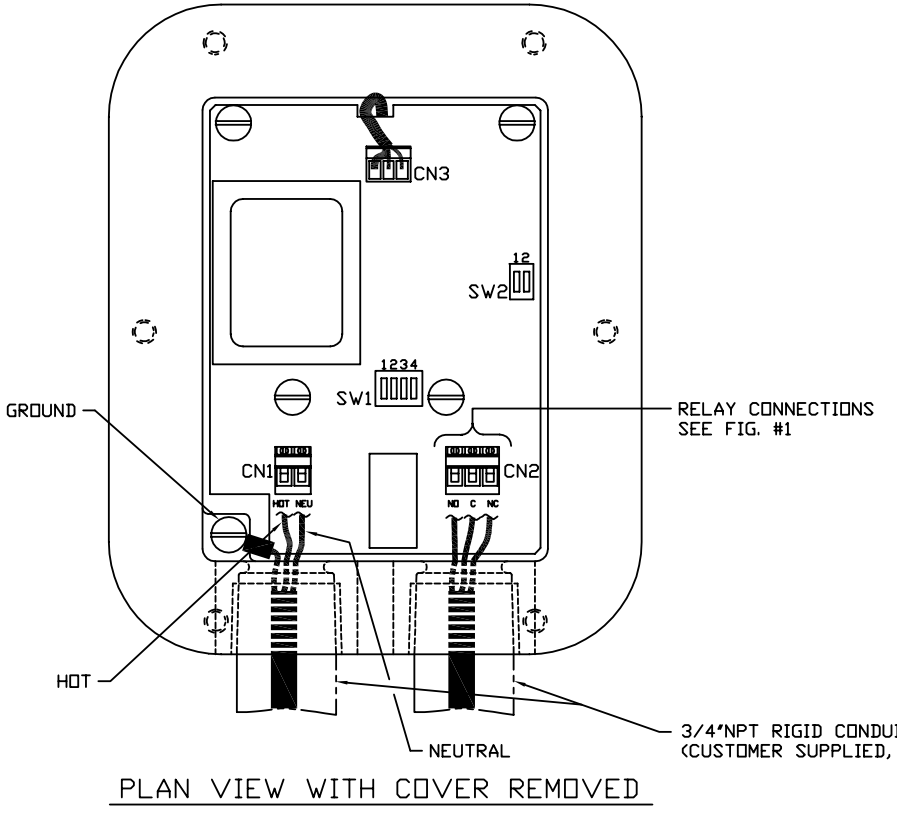
- ·Model number
- ·Date of Purchase
- ·Application information (type of material, mounting configuration, etc.)
- ·Description of problem

If your local representative is unable to determine the cause of difficulty, you will be referred to a factory engineer. Equipment shipped back to the factory without proper authorization will be refused and returned at the shipper's expense.

8.0 APPENDIX

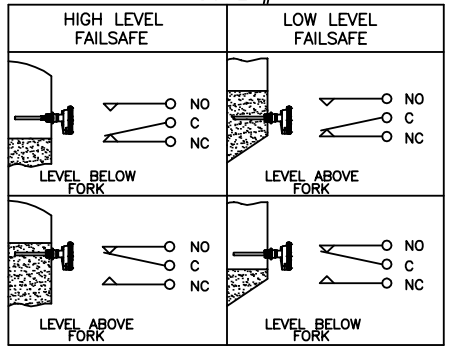
Drawing Description	Drawing Number	Page Number
LP-30 110/220 VAC Hookup	LVP180011	17
LP-30 1½" Dimensions	LVP180012	18
LP-30 1¼" Dimensions	LVP180018	19
LP-30 1½" Stainless Steel Extended Dimensions	LVP180013	20
LP-30 1¼" Stainless Steel Extended Dimensions	LVP180020	21
LP-30 1½" Galvanized Steel Extended Dimensions	LVP180014	22
LP-30 1¼" Galvanized Steel Extended Dimensions	LVP180019	23

	REVISIONS	ECN #	DRWN/CK'D BY DATE	APP'D BY DATE
A	NEW TITLEBLOCK	03-203	SE 8-27-03	JD 8-27-03



PLAN VIEW WITH COVER REMOVED

FIGURE #1



NOTES:

1) FIELD WIRING SHALL BE ACCORDING TO LOCAL STANDARDS.
2) POWER TO UNITS 18AWG. MINIMUM RECOMMENDED.
3) ON EX/P UNITS, EXPLOSION PROOF SEAL FITTING MUST BE INSTALLED WITHIN 18" OF CONDUIT OPENINGS.
4) CAUTION: HIGH VOLTAGE ON FORK TERMINALS.

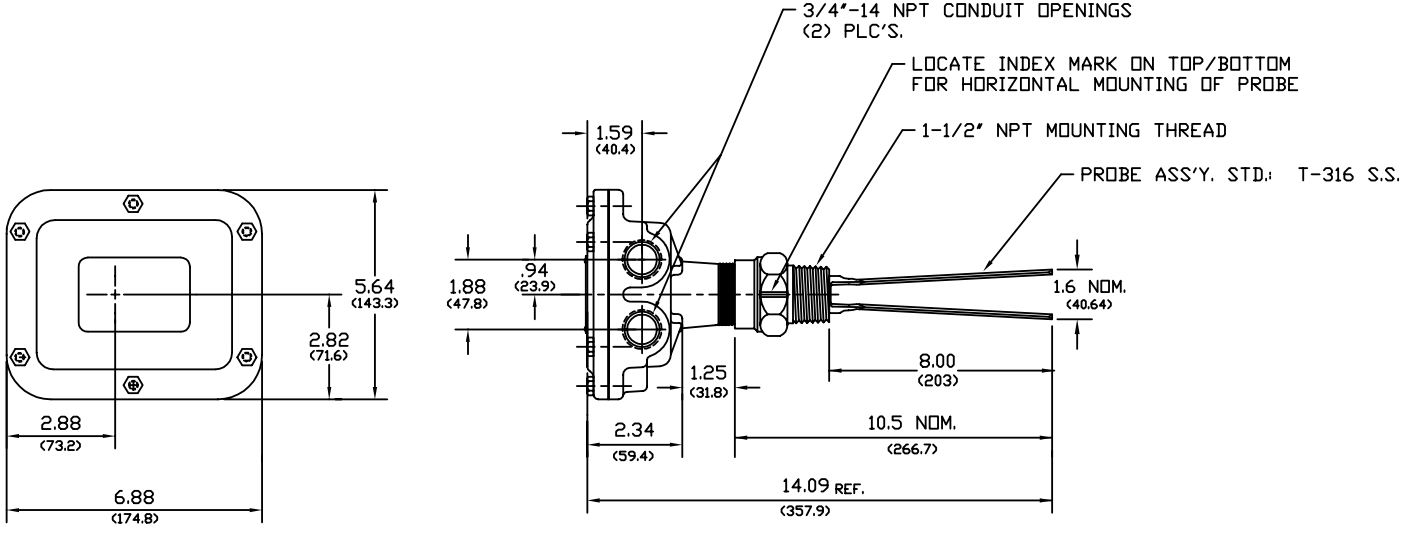
DO NOT SCALE DIM'S. ARE IN INCHES
BRACKETED DIMENSIONS ARE IN MILLIMETERS

venture MEASUREMENT
150 VENTURE BLVD.
SPARTANBURG, SC 29306

TITLE	HOOKUP, MANUAL LP30 110-220VAC
SCALE	NONE
SIZE	B
FILE	LVP180011_B_*
REF	
MATERIAL	--------
FINISH	--------
PART	LVP180011
SHEET	---

UNSPECIFIED TOL. DECIMALS: XX ±=.01 XXX ±=.005 ANGLES: ±=1/2° DEBURR & BREAK EDGES .005

	REVISIONS	ECN #	DRWN/CK'D BY DATE	APP'D BY DATE
A	UPDATED TITLE FOR 1-1/2"	99-205	--- 8-16-99	TK ---
B	REVISED TO SHOW CURRENT NEVO FORKS	03-203	SE 6-19-03	JD 8-21-03



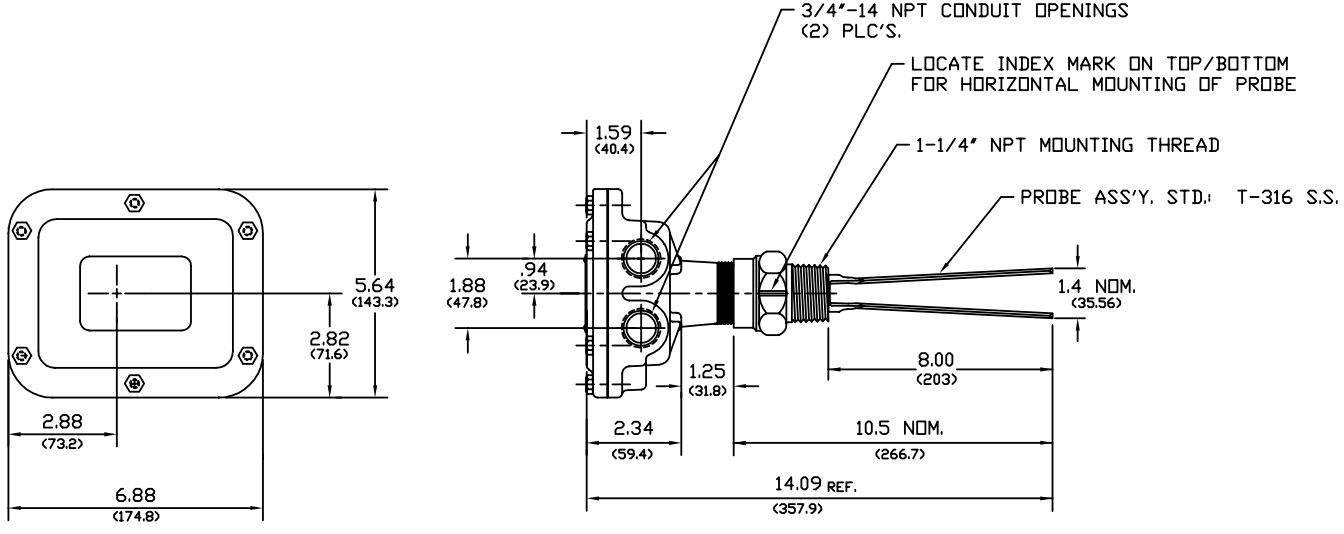
DO NOT SCALE DIM'S. ARE IN INCHES
BRACKETED DIMENSIONS ARE IN MILLIMETERS

venture MEASUREMENT
150 VENTURE BLVD.
SPARTANBURG, SC 29306

FILE LVP180012_B_* REF	TITLE: OUTLINE, MANUAL 1-1/2" PULSE POINT		SCALE: NONE
UNSPECIFIED TOLERANCES DECIMALS: XX ±=.01 XXX ±=.005 ANGLES: ±=1/2° DEBURR & BREAK EDGES .005 Ⓒ = CRITICAL DIM. OR NOTE	MATERIAL: -------- FINISH: --------	PART: LVP180012	SIZE: B SHEET: ---

BGMU Submittal Package, Part 1 of 2, 05/03/2010, Page 152 of 635

	REVISIONS	ECN #	DRWN/CK'D BY DATE	APP'D BY DATE
A	INITIAL RELEASE	99-205	--- 8-16-99	TK ---
B	REVISED TO SHOW CURRENT NIVO FORKS	03-203	SE 6-19-03	JD 8-21-03



DO NOT SCALE DIM'S. ARE IN INCHES
BRACKETED DIMENSIONS ARE IN MILLIMETERS

venture MEASUREMENT
150 VENTURE BLVD.
SPARTANBURG, SC 29306

TITLE: OUTLINE, MANUAL 1-1/4" PULSE POINT

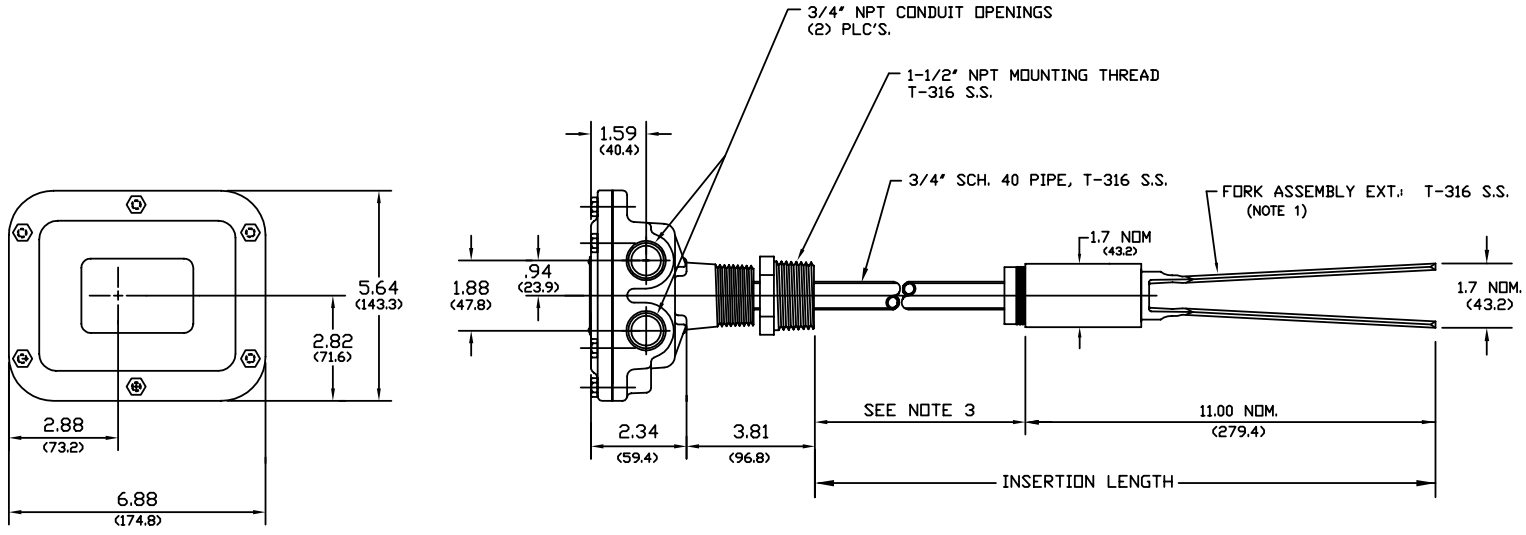
FILE: LVP180018_B_* REF

UNSPECIFIED TOLERANCES
DECIMALS: XX ±=.01
XXX ±=.005
ANGLES: ±=1/2°
DEBURR & BREAK EDGES .005
Ⓒ = CRITICAL DIM. OR NOTE

MATERIAL: --------
FINISH: --------

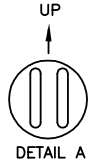
PART: LVP180018

SCALE: NONE
SIZE: B
SHEET: ---



NOTES:

1. IF FORK IS INSTALLED HORIZONTALLY THE TINES MUST ALIGN VERTICALLY AS SHOWN IN DETAIL "A"
2. IN HORIZONTAL INSTALLATIONS CONDUIT OPENING MUST FACE DOWNWARD
3. PIPE LENGTH = INSERTION LENGTH – 10.25" (260)



DETAIL A
END VIEW OF FORK SHOWING ORIENTATION OF TINES (HORIZONTAL INSTALLATION)

DO NOT SCALE DIM'S. ARE IN INCHES
BRACKETED DIMENSIONS ARE IN MILLIMETERS

	REVISIONS	ECN #	DRWN/CK'D BY DATE	APP'D BY DATE
B	UPDATED TO CURRENT NIVO FORKS SE	03-203	SE 6-19-03	JD 8-21-03
A	FORK LENGTH 10.75 WAS 11.75 JH	98-065	AC 7-22-98	BWC -----

venture MEASUREMENT
150 VENTURE BLVD.
SPARTANBURG, SC 29306

FILE LVP180013_B_* REF

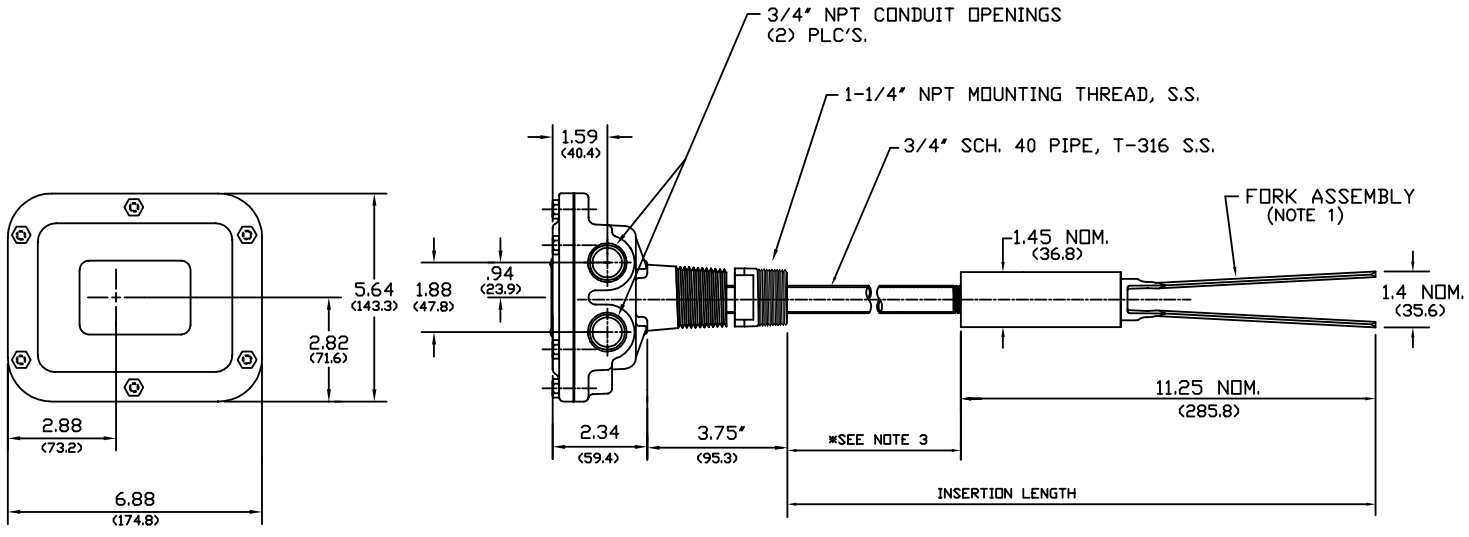
TITLE: OUTLINE, MANUAL
LP30 1–1/2" T–316SS EXTENDED

SCALE: NONE
SIZE: B
SHEET: ---

UNSPECIFIED TOL. DECIMALS: XX ±=.01, XXX ±=.005
ANGLES: ±=1/2° DEBURR & BREAK EDGES .005

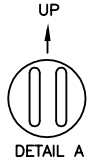
MATERIAL: _____
FINISH: _____

PART: LVP180013



NOTES:

1. IF FORK IS INSTALLED HORIZONTALLY THE TINES MUST ALIGN VERTICALLY AS SHOWN IN DETAIL "A"
2. IN HORIZONTAL INSTALLATIONS CONDUIT OPENING MUST FACE DOWNWARD
3. PIPE LENGTH = INSERTION LENGTH – 10.25" (260)



DETAIL A
END VIEW OF FORK SHOWING ORIENTATION OF TINES (HORIZONTAL INSTALLATION)

DO NOT SCALE DIM'S. ARE IN INCHES
BRACKETED DIMENSIONS ARE IN MILLIMETERS

	REVISIONS	ECN #	DRWN/CK'D BY / DATE	APP'D BY / DATE
C	UPDATED TO CURRENT NIVO FORKS SE	03-203	SE 6-19-03	JD 8-21-03
B	ADDED INSERTION LENGTH NOTE	99-205	CRD 12-1-99	TK -----
A	INITIAL RELEASE	99-222	CRD 8-24-99	TK -----

venture MEASUREMENT
150 VENTURE BLVD.
SPARTANBURG, SC 29306

FILE LVP180020_B_* REF

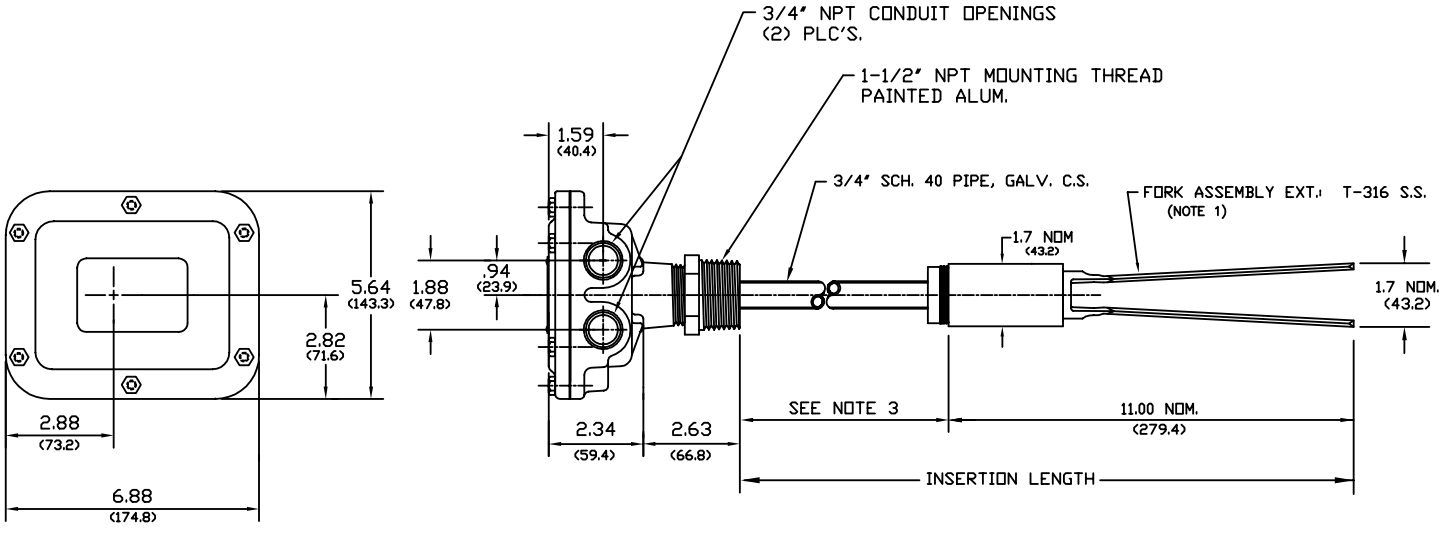
TITLE: OUTLINE, MANUAL
LP30 1–1/4" S.S. EXTENDED

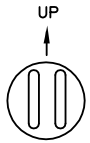
SCALE: NONE
SIZE: B
SHEET: ---

UNSPECIFIED TOL. DECIMALS: XX ±=.01 XXX ±=.005 ANGLES: ±=1/2° DEBURR & BREAK EDGES .005

MATERIAL: --------
FINISH: --------

PART: LVP180020





DETAIL A
END VIEW OF FORK SHOWING
ORIENTATION OF TINES (HORIZONTAL
INSTALLATION)

NOTES:

1. IF FORK IS INSTALLED HORIZONTALLY THE TINES MUST ALIGN VERTICALLY AS SHOWN IN DETAIL "A"
2. IN HORIZONTAL INSTALLATIONS CONDUIT OPENING MUST FACE DOWNWARD
3. PIPE LENGTH = INSERTION LENGTH – 10.25" (260)

DO NOT SCALE DIM'S. ARE IN INCHES
BRACKETED DIMENSIONS ARE IN MILLIMETERS

B	UPDATED TO CURRENT NIVO FORKS SE	03-203	SE 6-19-03	JD 8-21-03
A	REVISED & REISSUED ADDED 1-1/2" TO TITLE	99-205	CRD 8-17-99	TK ----
	REVISIONS	ECN #	DRWN/CK'D BY DATE	APP'D BY DATE

venture MEASUREMENT
150 VENTURE BLVD.
SPARTANBURG, SC 29306

TITLE: OUTLINE, MANUAL
LP30 1–1/2" GALV. EXTENDED

SCALE: NONE

FILE: LVP180014_B_*

REF:

SIZE: B

UNSPECIFIED TOL. DECIMALS: XX ±=.01 XXX ±=.005
ANGLES: ±=1/2°
DEBURR & BREAK EDGES .005

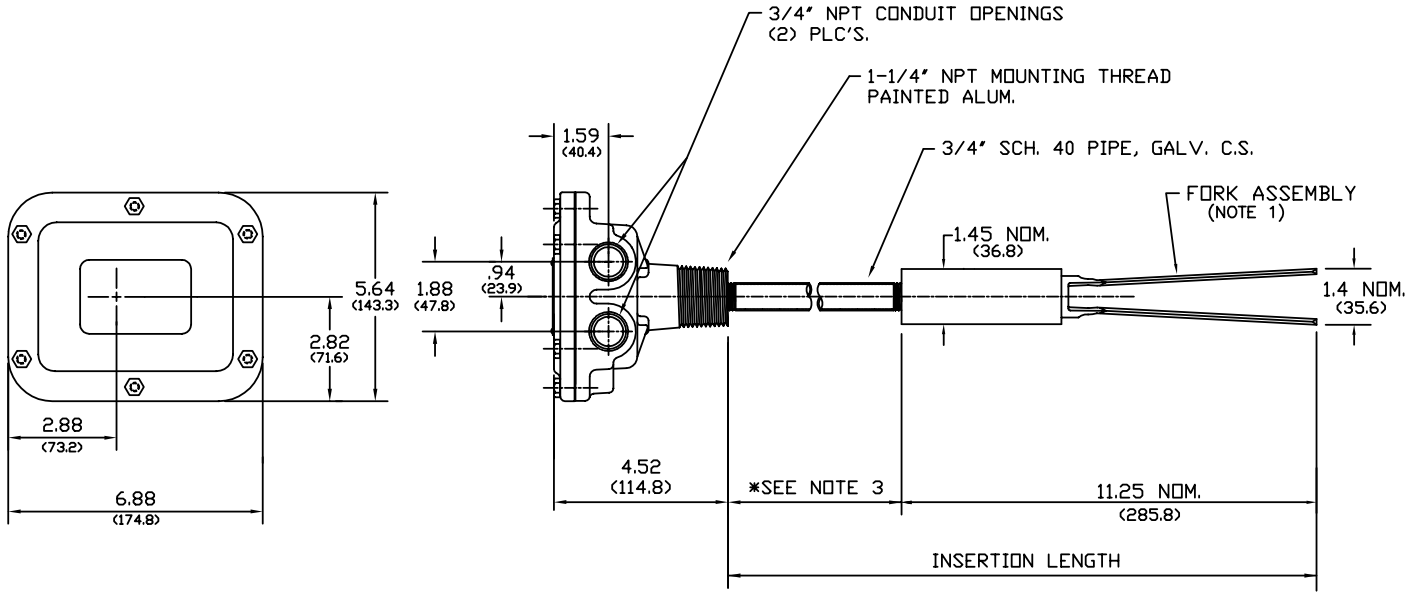
MATERIAL: --------

FINISH: --------

PART: LVP180014

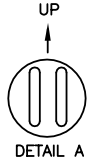
SHEET: ---

BGMU Submittal Package, Part 1 of 2, 05/03/2010, Page 156 of 635



NOTES:

1. IF FORK IS INSTALLED HORIZONTALLY THE TINES MUST ALIGN VERTICALLY AS SHOWN IN DETAIL "A"
2. IN HORIZONTAL INSTALLATIONS CONDUIT OPENING MUST FACE DOWNWARD
3. PIPE LENGTH = INSERTION LENGTH – 10.25" (260)



DETAIL A
END VIEW OF FORK SHOWING ORIENTATION OF TINES (HORIZONTAL INSTALLATION)

DO NOT SCALE DIM'S. ARE IN INCHES
BRACKETED DIMENSIONS ARE IN MILLIMETERS

C	UPDATED TO CURRENT NIVO FORKS SE	03-203	SE 6-19-03	JD 8-21-03
B	ADDED INSERTION LENGTH NOTE	99-205	CRD 12-1-99	TK -----
A	REVISED & REISSUED	99-205	CRD 8-17-99	TK -----
	REVISIONS	ECN #	DRWN/CK'D BY DATE	APP'D BY DATE

venture MEASUREMENT
150 VENTURE BLVD.
SPARTANBURG, SC 29306

TITLE: OUTLINE, MANUAL
LP30 1–1/4" GALV. EXTENDED

SCALE: NONE
SIZE: B
SHEET: ---

FILE: LVP180019_B_*
REF:

UNSPECIFIED TOL. DECIMALS: XX ±=.01 XXX ±=.005 ANGLES: ±=1/2° DEBURR & BREAK EDGES .005

MATERIAL: --------
FINISH: --------

PART: LVP180019

150 Venture Boulevard
Spartanburg, SC 29306
Phone: (864) 574-8060, Fax: (864) 574-8063
Customer Care: (800) 778-9242
Internet: http://www.bindicator.com
email: sales@bindicator.com

venture
MEASUREMENT

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LVP180007 Rev. C 5/04

Thermocouple, Type K, Omega Engineering, NB1-CASS-14U-12

- Omega Engineering Type K Thermocouple Reference Tables

Omega Engineering Type K Thermocouple Reference Tables

MAXIMUM TEMPERATURE RANGE

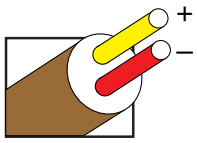
Thermocouple Grade
– 328 to 2282°F
– 200 to 1250°C

Extension Grade
32 to 392°F
0 to 200°C

LIMITS OF ERROR
(whichever is greater)
Standard: 2.2°C or 0.75% Above 0°C
2.2°C or 2.0% Below 0°C
Special: 1.1°C or 0.4%

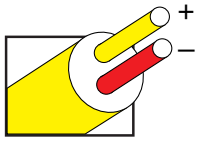
COMMENTS, BARE WIRE ENVIRONMENT:
Clean Oxidizing and Inert; Limited Use in Vacuum or Reducing; Wide Temperature Range; Most Popular Calibration

TEMPERATURE IN DEGREES °C
REFERENCE JUNCTION AT 0°C



Thermocouple Grade

Nickel-Chromium vs. Nickel-Aluminum



Extension Grade

Revised Thermocouple Reference Tables

TYPE K

Reference Tables N.I.S.T. Monograph 175 Revised to ITS-90

Z

Thermoelectric Voltage in Millivolts

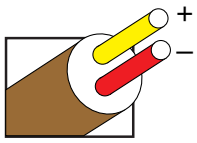
°C	-10	-9	-8	-7	-6	-5	-4	-3	-2	-1	0	°C
-260	-6.458	-6.457	-6.456	-6.455	-6.453	-6.452	-6.450	-6.448	-6.446	-6.444	-6.441	-260
-250	-6.441	-6.438	-6.435	-6.432	-6.429	-6.425	-6.421	-6.417	-6.413	-6.408	-6.404	-250
-240	-6.404	-6.399	-6.393	-6.388	-6.382	-6.377	-6.370	-6.364	-6.358	-6.351	-6.344	-240
-230	-6.344	-6.337	-6.329	-6.322	-6.314	-6.306	-6.297	-6.289	-6.280	-6.271	-6.262	-230
-220	-6.262	-6.252	-6.243	-6.233	-6.223	-6.213	-6.202	-6.192	-6.181	-6.170	-6.158	-220
-210	-6.158	-6.147	-6.135	-6.123	-6.111	-6.099	-6.087	-6.074	-6.061	-6.048	-6.035	-210
-200	-6.035	-6.021	-6.007	-5.994	-5.980	-5.965	-5.951	-5.936	-5.922	-5.907	-5.891	-200
-190	-5.891	-5.876	-5.861	-5.845	-5.829	-5.813	-5.797	-5.780	-5.763	-5.747	-5.730	-190
-180	-5.730	-5.713	-5.695	-5.678	-5.660	-5.642	-5.624	-5.606	-5.588	-5.569	-5.550	-180
-170	-5.550	-5.531	-5.512	-5.493	-5.474	-5.454	-5.435	-5.415	-5.395	-5.374	-5.354	-170
-160	-5.354	-5.333	-5.313	-5.292	-5.271	-5.250	-5.228	-5.207	-5.185	-5.163	-5.141	-160
-150	-5.141	-5.119	-5.097	-5.074	-5.052	-5.029	-5.006	-4.983	-4.960	-4.936	-4.913	-150
-140	-4.913	-4.889	-4.865	-4.841	-4.817	-4.793	-4.768	-4.744	-4.719	-4.694	-4.669	-140
-130	-4.669	-4.644	-4.618	-4.593	-4.567	-4.542	-4.516	-4.490	-4.463	-4.437	-4.411	-130
-120	-4.411	-4.384	-4.357	-4.330	-4.303	-4.276	-4.249	-4.221	-4.194	-4.166	-4.138	-120
-110	-4.138	-4.110	-4.082	-4.054	-4.025	-3.997	-3.968	-3.939	-3.911	-3.882	-3.852	-110
-100	-3.852	-3.823	-3.794	-3.764	-3.734	-3.705	-3.675	-3.645	-3.614	-3.584	-3.554	-100
-90	-3.554	-3.523	-3.492	-3.462	-3.431	-3.400	-3.368	-3.337	-3.306	-3.274	-3.243	-90
-80	-3.243	-3.211	-3.179	-3.147	-3.115	-3.083	-3.050	-3.018	-2.986	-2.953	-2.920	-80
-70	-2.920	-2.887	-2.854	-2.821	-2.788	-2.755	-2.721	-2.688	-2.654	-2.620	-2.587	-70
-60	-2.587	-2.553	-2.519	-2.485	-2.450	-2.416	-2.382	-2.347	-2.312	-2.278	-2.243	-60
-50	-2.243	-2.208	-2.173	-2.138	-2.103	-2.067	-2.032	-1.996	-1.961	-1.925	-1.889	-50
-40	-1.889	-1.854	-1.818	-1.782	-1.745	-1.709	-1.673	-1.637	-1.600	-1.564	-1.527	-40
-30	-1.527	-1.490	-1.453	-1.417	-1.380	-1.343	-1.305	-1.268	-1.231	-1.194	-1.156	-30
-20	-1.156	-1.119	-1.081	-1.043	-1.006	-0.968	-0.930	-0.892	-0.854	-0.816	-0.778	-20
-10	-0.778	-0.739	-0.701	-0.663	-0.624	-0.586	-0.547	-0.508	-0.470	-0.431	-0.392	-10
0	-0.392	-0.353	-0.314	-0.275	-0.236	-0.197	-0.157	-0.118	-0.079	-0.039	0.000	0
0	0.000	0.039	0.079	0.119	0.158	0.198	0.238	0.277	0.317	0.357	0.397	0
10	0.397	0.437	0.477	0.517	0.557	0.597	0.637	0.677	0.718	0.758	0.798	10
20	0.798	0.838	0.879	0.919	0.960	1.000	1.041	1.081	1.122	1.163	1.203	20
30	1.203	1.244	1.285	1.326	1.366	1.407	1.448	1.489	1.530	1.571	1.612	30
40	1.612	1.653	1.694	1.735	1.776	1.817	1.858	1.899	1.941	1.982	2.023	40
50	2.023	2.064	2.106	2.147	2.188	2.230	2.271	2.312	2.354	2.395	2.436	50
60	2.436	2.478	2.519	2.561	2.602	2.644	2.685	2.727	2.768	2.810	2.851	60
70	2.851	2.893	2.934	2.976	3.017	3.059	3.100	3.142	3.184	3.225	3.267	70
80	3.267	3.308	3.350	3.391	3.433	3.474	3.516	3.557	3.599	3.640	3.682	80
90	3.682	3.723	3.765	3.806	3.848	3.889	3.931	3.972	4.013	4.055	4.096	90
100	4.096	4.138	4.179	4.220	4.262	4.303	4.344	4.385	4.427	4.468	4.509	100
110	4.509	4.550	4.591	4.633	4.674	4.715	4.756	4.797	4.838	4.879	4.920	110
120	4.920	4.961	5.002	5.043	5.084	5.124	5.165	5.206	5.247	5.288	5.328	120
130	5.328	5.369	5.410	5.450	5.491	5.532	5.572	5.613	5.653	5.694	5.735	130
140	5.735	5.775	5.815	5.856	5.896	5.937	5.977	6.017	6.058	6.098	6.138	140
150	6.138	6.179	6.219	6.259	6.299	6.339	6.380	6.420	6.460	6.500	6.540	150
160	6.540	6.580	6.620	6.660	6.701	6.741	6.781	6.821	6.861	6.901	6.941	160
170	6.941	6.981	7.021	7.060	7.100	7.140	7.180	7.220	7.260	7.300	7.340	170
180	7.340	7.380	7.420	7.460	7.500	7.540	7.579	7.619	7.659	7.699	7.739	180
190	7.739	7.779	7.819	7.859	7.899	7.939	7.979	8.019	8.059	8.099	8.138	190
200	8.138	8.178	8.218	8.258	8.298	8.338	8.378	8.418	8.458	8.499	8.539	200
210	8.539	8.579	8.619	8.659	8.699	8.739	8.779	8.819	8.860	8.900	8.940	210
220	8.940	8.980	9.020	9.061	9.101	9.141	9.181	9.222	9.262	9.302	9.343	220
230	9.343	9.383	9.423	9.464	9.504	9.545	9.585	9.626	9.666	9.707	9.747	230
240	9.747	9.788	9.828	9.869	9.909	9.950	9.991	10.031	10.072	10.113	10.153	240
°C	0	1	2	3	4	5	6	7	8	9	10	°C

°C	0	1	2	3	4	5	6	7	8	9	10	°C
250	10.153	10.194	10.235	10.276	10.316	10.357	10.398	10.439	10.480	10.520	10.561	250
260	10.561	10.602	10.643	10.684	10.725	10.766	10.807	10.848	10.889	10.930	10.971	260
270	10.971	11.012	11.053	11.094	11.135	11.176	11.217	11.259	11.300	11.341	11.382	270
280	11.382	11.423	11.465	11.506	11.547	11.588	11.630	11.671	11.712	11.753	11.795	280
290	11.795	11.836	11.877	11.919	11.960	12.001	12.043	12.084	12.126	12.167	12.209	290
300	12.209	12.250	12.291	12.333	12.374	12.416	12.457	12.499	12.540	12.582	12.624	300
310	12.624	12.665	12.707	12.748	12.790	12.831	12.873	12.915	12.956	12.998	13.040	310
320	13.040	13.081	13.123	13.165	13.206	13.248	13.290	13.331	13.373	13.415	13.457	320
330	13.457	13.498	13.540	13.582	13.624	13.665	13.707	13.749	13.791	13.833	13.874	330
340	13.874	13.916	13.958	14.000	14.042	14.084	14.126	14.167	14.209	14.251	14.293	340
350	14.293	14.335	14.377	14.419	14.461	14.503	14.545	14.587	14.629	14.671	14.713	350
360	14.713	14.755	14.797	14.839	14.881	14.923	14.965	15.007	15.049	15.091	15.133	360
370	15.133	15.175	15.217	15.259	15.301	15.343	15.385	15.427	15.469	15.511	15.554	370
380	15.554	15.596	15.638	15.680	15.722	15.764	15.806	15.849	15.891	15.933	15.975	380
390	15.975	16.017	16.059	16.102	16.144	16.186	16.228	16.270	16.313	16.355	16.397	390
400	16.397	16.439	16.482	16.524	16.566	16.608	16.651	16.693	16.735	16.778	16.820	400
410	16.820	16.862	16.904	16.947	16.989	17.031	17.074	17.116	17.158	17.201	17.243	410
420	17.243	17.285	17.328	17.370	17.413	17.455	17.497	17.540	17.582	17.624	17.667	420
430	17.667	17.709	17.752	17.794	17.837	17.879	17.921	17.964	18.006	18.049	18.091	430
440	18.091	18.134	18.176	18.218	18.261	18.303	18.346	18.388	18.431	18.473	18.516	440
450	18.516	18.558	18.601	18.643	18.686	18.728	18.771	18.813	18.856	18.898	18.941	450
460	18.941	18.983	19.026	19.068	19.111	19.154	19.196	19.239	19.281	19.324	19.366	460
470	19.366	19.409	19.451	19.494	19.537	19.579	19.622	19.664	19.707	19.750	19.792	470
480	19.792	19.835	19.877	19.920	19.962	20.005	20.048	20.090	20.133	20.175	20.218	480
490	20.218	20.261	20.303	20.346	20.389	20.431	20.474	20.516	20.559	20.602	20.644	490
500	20.644	20.687	20.730	20.772	20.815	20.857	20.900	20.943	20.985	21.028	21.071	500
510	21.071	21.113	21.156	21.199	21.241	21.284	21.326	21.369	21.412	21.454	21.497	510
520	21.497	21.540	21.582	21.625	21.668	21.710	21.753	21.796	21.838	21.881	21.924	520
530	21.924	21.966	22.009	22.052	22.094	22.137	22.179	22.222	22.265	22.307	22.350	530
540	22.350	22.393	22.435	22.478	22.521	22.563	22.606	22.649	22.691	22.734	22.776	540
550	22.776	22.819	22.862	22.904	22.947	22.990	23.032	23.075	23.117	23.160	23.203	550
560	23.203	23.245	23.288	23.331	23.373	23.416	23.458	23.501	23.544	23.586	23.629	560
570	23.629	23.671	23.714	23.757	23.799	23.842	23.884	23.927	23.970	24.012	24.055	570
580	24.055	24.097	24.140	24.182	24.225	24.267	24.310	24.353	24.395	24.438	24.480	580
590	24.480	24.523	24.565	24.608	24.650	24.693	24.735	24.778	24.820	24.863	24.905	590
600	24.905	24.948	24.990	25.033	25.075	25.118	25.160	25.203	25.245	25.288	25.330	600
610	25.330	25.373	25.415	25.458	25.500	25.543	25.585	25.627	25.670	25.712	25.755	610
620	25.755	25.797	25.840	25.882	25.924	25.967	26.009	26.052	26.094	26.136	26.179	620
630	26.179	26.221	26.263	26.306	26.348	26.390	26.433	26.475	26.517	26.560	26.602	630
640	26.602	26.644	26.687	26.729	26.771	26.814	26.856	26.898	26.940	26.983	27.025	640
650	27.025	27.067	27.109	27.152	27.194	27.236	27.278	27.320	27.363	27.405	27.447	650
660	27.447	27.489	27.531	27.574	27.616	27.658	27.700	27.742	27.784	27.826	27.869	660
670	27.869	27.911	27.953	27.995	28.037	28.079	28.121	28.163	28.205	28.247	28.289	670
680	28.289	28.332	28.374	28.416	28.458	28.500	28.542	28.584	28.626	28.668	28.710	680
690	28.710	28.752	28.794	28.835	28.877	28.919	28.961	29.003	29.045	29.087	29.129	690
700	29.129	29.171	29.213	29.255	29.297	29.338	29.380	29.422	29.464	29.506	29.548	700
710	29.548	29.589	29.631	29.673	29.715	29.757	29.798	29.840	29.882	29.924	29.965	710
720	29.965	30.007	30.049	30.090	30.132	30.174	30.216	30.257	30.299	30.341	30.382	720
730	30.382	30.424	30.466	30.507	30.549	30.590	30.632	30.674	30.715	30.757	30.798	730
740	30.798	30.840	30.881	30.923	30.964	31.006	31.047	31.089	31.130	31.172	31.213	740
750	31.213	31.255	31.296	31.338	31.379	31.421	31.462	31.504	31.545	31.586	31.628	750
760	31.628	31.669	31.710	31.752	31.793	31.834	31.876	31.917	31.958	32.000	32.041	760
770	32.041	32.082	32.124	32.165	32.206	32.247	32.289	32.330	32.371	32.412	32.453	770
780	32.453	32.495	32.536	32.577	32.618	32.659	32.700	32.742	32.783	32.824	32.865	780
790	32.865	32.906	32.947	32.988	33.029	33.070	33.111	33.152	33.193	33.234	33.275	790
°C	0	1	2	3	4	5	6	7	8	9	10	°C

Revised Thermocouple Reference Tables

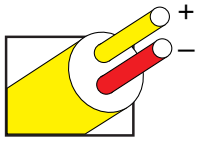
TYPE K

Reference Tables
N.I.S.T. Monograph 175
Revised to ITS-90



Thermocouple Grade

Nickel-Chromium vs. Nickel-Aluminum



Extension Grade

MAXIMUM TEMPERATURE RANGE
Thermocouple Grade
– 328 to 2282°F
– 200 to 1250°C
Extension Grade
32 to 392°F
0 to 200°C

LIMITS OF ERROR
(whichever is greater)
Standard: 2.2°C or 0.75% Above 0°C
2.2°C or 2.0% Below 0°C
Special: 1.1°C or 0.4%

COMMENTS, BARE WIRE ENVIRONMENT:
Clean Oxidizing and Inert; Limited Use in Vacuum or Reducing; Wide Temperature Range; Most Popular Calibration

TEMPERATURE IN DEGREES °C
REFERENCE JUNCTION AT 0°C

Thermoelectric Voltage in Millivolts

°C	0	1	2	3	4	5	6	7	8	9	10	°C
800	33.275	33.316	33.357	33.398	33.439	33.480	33.521	33.562	33.603	33.644	33.685	800
810	33.685	33.726	33.767	33.808	33.848	33.889	33.930	33.971	34.012	34.053	34.093	810
820	34.093	34.134	34.175	34.216	34.257	34.297	34.338	34.379	34.420	34.460	34.501	820
830	34.501	34.542	34.582	34.623	34.664	34.704	34.745	34.786	34.826	34.867	34.908	830
840	34.908	34.948	34.989	35.029	35.070	35.110	35.151	35.192	35.232	35.273	35.313	840
850	35.313	35.354	35.394	35.435	35.475	35.516	35.556	35.596	35.637	35.677	35.718	850
860	35.718	35.758	35.798	35.839	35.879	35.920	35.960	36.000	36.041	36.081	36.121	860
870	36.121	36.162	36.202	36.242	36.282	36.323	36.363	36.403	36.443	36.484	36.524	870
880	36.524	36.564	36.604	36.644	36.685	36.725	36.765	36.805	36.845	36.885	36.925	880
890	36.925	36.965	37.006	37.046	37.086	37.126	37.166	37.206	37.246	37.286	37.326	890
900	37.326	37.366	37.406	37.446	37.486	37.526	37.566	37.606	37.646	37.686	37.725	900
910	37.725	37.765	37.805	37.845	37.885	37.925	37.965	38.005	38.044	38.084	38.124	910
920	38.124	38.164	38.204	38.243	38.283	38.323	38.363	38.402	38.442	38.482	38.522	920
930	38.522	38.561	38.601	38.641	38.680	38.720	38.760	38.799	38.839	38.878	38.918	930
940	38.918	38.958	38.997	39.037	39.076	39.116	39.155	39.195	39.235	39.274	39.314	940
950	39.314	39.353	39.393	39.432	39.471	39.511	39.550	39.590	39.629	39.669	39.708	950
960	39.708	39.747	39.787	39.826	39.866	39.905	39.944	39.984	40.023	40.062	40.101	960
970	40.101	40.141	40.180	40.219	40.259	40.298	40.337	40.376	40.415	40.455	40.494	970
980	40.494	40.533	40.572	40.611	40.651	40.690	40.729	40.768	40.807	40.846	40.885	980
990	40.885	40.924	40.963	41.002	41.042	41.081	41.120	41.159	41.198	41.237	41.276	990
1000	41.276	41.315	41.354	41.393	41.431	41.470	41.509	41.548	41.587	41.626	41.665	1000
1010	41.665	41.704	41.743	41.781	41.820	41.859	41.898	41.937	41.976	42.014	42.053	1010
1020	42.053	42.092	42.131	42.169	42.208	42.247	42.286	42.324	42.363	42.402	42.440	1020
1030	42.440	42.479	42.518	42.556	42.595	42.633	42.672	42.711	42.749	42.788	42.826	1030
1040	42.826	42.865	42.903	42.942	42.980	43.019	43.057	43.096	43.134	43.173	43.211	1040
1050	43.211	43.250	43.288	43.327	43.365	43.403	43.442	43.480	43.518	43.557	43.595	1050
1060	43.595	43.633	43.672	43.710	43.748	43.787	43.825	43.863	43.901	43.940	43.978	1060
1070	43.978	44.016	44.054	44.092	44.130	44.169	44.207	44.245	44.283	44.321	44.359	1070
1080	44.359	44.397	44.435	44.473	44.512	44.550	44.588	44.626	44.664	44.702	44.740	1080
1090	44.740	44.778	44.816	44.853	44.891	44.929	44.967	45.005	45.043	45.081	45.119	1090
°C	0	1	2	3	4	5	6	7	8	9	10	°C

°C	0	1	2	3	4	5	6	7	8	9	10	°C
1100	45.119	45.157	45.194	45.232	45.270	45.308	45.346	45.383	45.421	45.459	45.497	1100
1110	45.497	45.534	45.572	45.610	45.647	45.685	45.723	45.760	45.798	45.836	45.873	1110
1120	45.873	45.911	45.948	45.986	46.024	46.061	46.099	46.136	46.174	46.211	46.249	1120
1130	46.249	46.286	46.324	46.361	46.398	46.436	46.473	46.511	46.548	46.585	46.623	1130
1140	46.623	46.660	46.697	46.735	46.772	46.809	46.847	46.884	46.921	46.958	46.995	1140
1150	46.995	47.033	47.070	47.107	47.144	47.181	47.218	47.256	47.293	47.330	47.367	1150
1160	47.367	47.404	47.441	47.478	47.515	47.552	47.589	47.626	47.663	47.700	47.737	1160
1170	47.737	47.774	47.811	47.848	47.884	47.921	47.958	47.995	48.032	48.069	48.105	1170
1180	48.105	48.142	48.179	48.216	48.252	48.289	48.326	48.363	48.399	48.436	48.473	1180
1190	48.473	48.509	48.546	48.582	48.619	48.656	48.692	48.729	48.765	48.802	48.838	1190
1200	48.838	48.875	48.911	48.948	48.984	49.021	49.057	49.093	49.130	49.166	49.202	1200
1210	49.202	49.239	49.275	49.311	49.348	49.384	49.420	49.456	49.493	49.529	49.565	1210
1220	49.565	49.601	49.637	49.674	49.710	49.746	49.782	49.818	49.854	49.890	49.926	1220
1230	49.926	49.962	49.998	50.034	50.070	50.106	50.142	50.178	50.214	50.250	50.286	1230
1240	50.286	50.322	50.358	50.393	50.429	50.465	50.501	50.537	50.572	50.608	50.644	1240
1250	50.644	50.680	50.715	50.751	50.787	50.822	50.858	50.894	50.929	50.965	51.000	1250
1260	51.000	51.036	51.071	51.107	51.142	51.178	51.213	51.249	51.284	51.320	51.355	1260
1270	51.355	51.391	51.426	51.461	51.497	51.532	51.567	51.603	51.638	51.673	51.708	1270
1280	51.708	51.744	51.779	51.814	51.849	51.885	51.920	51.955	51.990	52.025	52.060	1280
1290	52.060	52.095	52.130	52.165	52.200	52.235	52.270	52.305	52.340	52.375	52.410	1290
1300	52.410	52.445	52.480	52.515	52.550	52.585	52.620	52.654	52.689	52.724	52.759	1300
1310	52.759	52.794	52.828	52.863	52.898	52.932	52.967	53.002	53.037	53.071	53.106	1310
1320	53.106	53.140	53.175	53.210	53.244	53.279	53.313	53.348	53.382	53.417	53.451	1320
1330	53.451	53.486	53.520	53.555	53.589	53.623	53.658	53.692	53.727	53.761	53.795	1330
1340	53.795	53.830	53.864	53.898	53.932	53.967	54.001	54.035	54.069	54.104	54.138	1340
1350	54.138	54.172	54.206	54.240	54.274	54.308	54.343	54.377	54.411	54.445	54.479	1350
1360	54.479	54.513	54.547	54.581	54.615	54.649	54.683	54.717	54.751	54.785	54.819	1360
1370	54.819	54.852	54.886									1370
°C	0	1	2	3	4	5	6	7	8	9	10	°C

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Pressure Transducer, Dwyer, 645-10

- Dwyer 645 Series Specifications
- Dwyer 645 Series Installation & Operating Instructions
- Dwyer 645 Series Dimensions

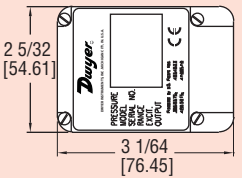
Series 645

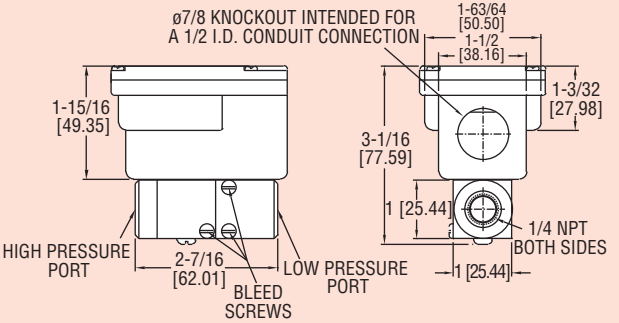
Wet/Wet Differential Pressure Transmitter

±0.25% Accuracy, Quick Response, 2-Wire Design

CE

Optional 3-Valve Manifold Assembly





Series 645 Wet/Wet Differential Pressure Transmitters are designed for use with compatible gases and liquids which can be applied to both the pressure and reference ports. Quick response capacitance sensor delivers a 4 to 20 mA output signal proportional to differential pressure with ±.25% accuracy. The Series 645 transmitters are ideal for process control, filter condition monitoring, refrigeration equipment, pump speed control, HVAC equipment, and liquid level measurement. For ease of installation and maintenance, order optional 3-valve manifold assembly. Bleed ports allow for total elimination of air in the line and pressure cavities.

Price — All Series 645 models listed below **$541.00**

Model*	Range	Model	Range
645-0	0 to 1 psid	**645-10**	±0.5 psid
645-1	0 to 2 psid	**645-11**	±1 psid
645-2	0 to 5 psid	**645-12**	±2.5 psid
645-3	0 to 10 psid	**645-13**	±5 psid
645-4	0 to 25 psid	**645-14**	±10 psid
645-5	0 to 50 psid	**645-15**	±25 psid
645-6	0 to 100 psid	**645-16**	±50 psid

* For optional 3-Valve Manifold Assembly, specify -3V as suffix and **add $385.00**

SPECIFICATIONS

Service: Compatible gases or liquids on both pressure and reference sides.
Wetted Materials: 17-4 PH stainless steel, 300 Series stainless steel, Fluoroelastomer and Silicone O-rings and bleed screw seals.
Accuracy: ±0.25% FS (RSS).
Temperature Limits: Operating: 0 to 175°F (-22 to 80°C), Storage: -65 to 260°F (-54 to 126°C).
Pressure Limits: (High side) 1 to 5 psi: 20 x FS, 10 to 25 psi: 10 x FS, 50 psi: 5 x FS, 100 psi: 2.5 x FS; (Low side) 2.5 x FS.
Thermal Effects: (includes zero and span) ±0.02% FS/°F, 30 to 150°F (-1 to 65°C).
Power Requirements: 11 to 30 VDC.
Output Signal: 4 to 20 mA, 2-wire.
Zero and Span Adjustments: Adjustable, ±1 mA, non-interactive.
Response Time: 30 to 50 msec.
Loop Resistance: 0 to 1000Ω.
Electrical Connection: Barrier strip terminal block with conduit enclosure and .875˝ (22 mm) diameter conduit opening.
Process Connection: 1/4˝-18 female NPT.
Housing: Stainless steel/ Aluminum, NEMA 4X (IP66).
Weight: 14.4 oz (0.4 kg).
Agency Approvals: CE.

3-Valve Manifold Assembly
Manifold: Brass.
Valve Type: 90° On/Off.
Process Connection: 1/4˝-18 female NPT.

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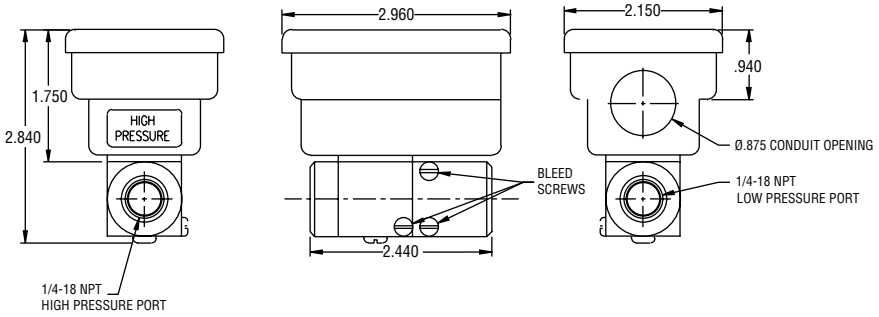
Series 645 Wet/Wet Differential Pressure Transmitter

Specifications - Installation and Operating Instructions



GENERAL

The Series 645 Wet/Wet Differential Pressure Transmitter is designed for use with any gas or liquid compatible with 17-4 PH stainless steel, 300 Series stainless steel, Viton and Silicone O-rings and bleed screw seals. Units can accurately measure the differential pressure even when liquid is applied to both ports. The transmitter contains a fast response capacitance sensor and a unique isolation system.

The isolation system transmits the motion of the differential pressure sensing diaphragm from the high line pressure environment to the dry enclosure where it moves one of a pair of capacitance plates proportionally to the diaphragm movement. The variable capacitance is converted to a current proportional to the differential pressure by the capacitance sensing and signal conditioning circuit located in the enclosure. The electronic circuit linearizes output versus pressure, standardizes the output, and compensates thermal effects of the sensor.

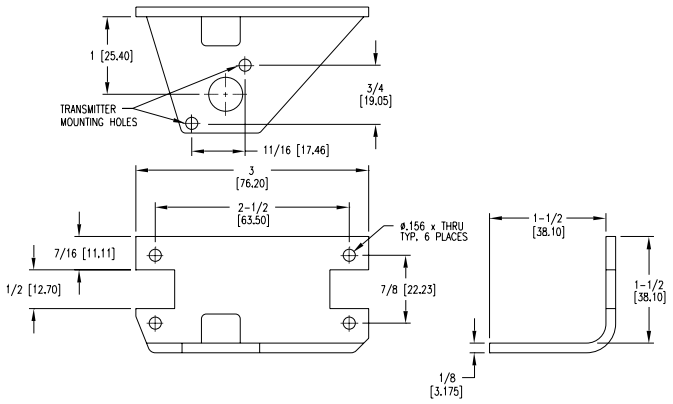
INSTALLATION

The Series 645 Differential Pressure Transmitter is supplied with a mounting bracket and two 6-32 × 3/8 hex head screws. First attach the bracket to mounting location using holes or band clamp notches available on large section of the bracket. Attach the transmitter to the bracket by using the two 6-32 × 3/8 hex head screws and the two tapped holes located on the underside of the transmitter. See Figure 1 at right.

SPECIFICATIONS

Service: Compatible gases or liquids applied to both pressure and reference ports.
Output: 4 to 20 mA, two-wire.
Supply Voltage: 11 to 30 VDC.
Loop Resistance: 0 to 1000Ω.
Maximum Line Pressure: 250 psig.
Maximum Overload Pressure: (High side) 1 to 5 psi: 20 × FS, 10 to 25 psi: 10 × FS, 50 psi: 5 × FS, 100 psi: 2.5 × FS; (Low side) 2-3 × FS.
Zero and Span: Adjustable, non-interactive, ±1 mA.
Accuracy: ±0.25% FS.
Temperature Limits: Operating: 0 to 175°F (-22 to 80°C), Storage: -65 to 260°F (-54 to 126°C).
Response Time: 30 to 50 msec.
Thermal Effects: (includes zero and span) ±0.02% FS/°F, 30 to 150°F (-1 to 65°C).
Wetted Parts: 17-4 PH stainless steel, 300 Series stainless steel, Viton and Silicone O-rings and bleed screw seals.
Housing: Stainless steel/Aluminum.
Process Connection: 1/4 - 18 NPT(F).
Electrical Connection: Barrier strip terminal block with conduit enclosure and .875 (22 mm) diameter conduit opening.
Weight: 14.4 oz (0.4 kg).

Mounting



DWYER INSTRUMENTS, INC.
P. O. BOX 373 MICHIGAN CITY, INDIANA 46361, U.S.A.
Telephone 219/879-8000
Fax 219/872-9057

NOTE:
For differential pressure measurements at high line pressure (250 psig max.), it is recommended that the pressure sensor be installed with a valve in each line, plus a shunt valve across the high and low (reference) pressure ports as indicated in Figure 2 below. The high pressure port is labeled with the word “HIGH”.

System Set-up

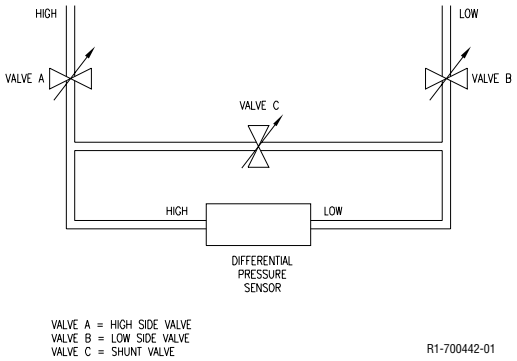


Figure 2

Valve C should be open and Valves A and B closed whenever the system is first being wetted or pressurized. Valves A and B should then be opened slowly to avoid hammering. Valve C can then be closed and the system is operating. When removing the differential pressure sensor, open Valve C first, then close Valves A and B.

Bleeding the Pressure Ports

Three bleed screws are located on the side of the unit (two for low pressure port, one for high pressure port).

Install the transmitter in its intended location and pressurize the ports. Back off the first bleed screw mounted on the flat side of the sensor body (2 turns max.) until liquid begins to flow out. After only bubble-free liquid flows out, retighten the bleed screw. Repeat the same procedure for the second set of bleed screws located on the round section of the low pressure fitting.

Electrical Connections

The Series 645 Wet/Wet Differential Pressure Transmitters are true 2-wire, 4-20 mA current output devices and deliver rated current into any external load of 0 to 800 ohms.

The units are supplied with a 7/8″ diameter knockout intended for a 1/2″ ID conduit connection. It is suggested that any electrical cable shield be connected to the system’s loop circuit ground to improve electrical noise reduction.

When making electrical connections, be sure to observe polarity—units are designed to have current flow in one direction only. The minimum supply voltage is 11 +.02 × (Resistance of receiver plus line. The maximum supply voltage is 30 + .004 × (Resistance of receiver plus line). To access electrical connections, remove cover on top of the unit. See Figure 3 for correct electrical connections.

Wiring

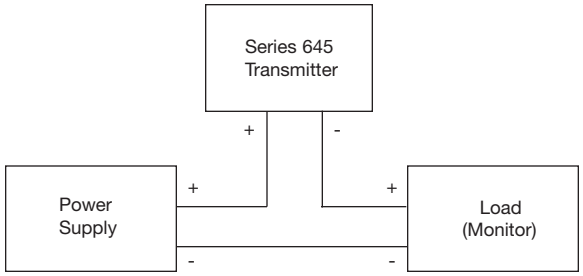


Figure 3

OPERATION

The Series 645 Wet/Wet Differential Pressure Transmitters are carefully calibrated to the specific input pressure range versus current output at the factory. Little or no field calibrating is necessary.

Zero and Span Adjustment

To gain access to the zero and span adjustments, remove the top cover of the transmitter. Loosen the 6-32 seal screws in the plastic terminal block. The zero and span adjustments are located under the plastic terminal block. Be careful not to disconnect any internal wiring. After all adjustments are made, remember to re-install the 6-32 seal screws. The Series 645 transmitters with 4-20 mA output are factory calibrated using a 250 ohm load at 24 VDC. Zero and span adjustments are approximately ±1 mA, individually.

MAINTENANCE

After final installation of the Series 645 Wet/Wet Differential Pressure Transmitter, no routine maintenance is required. Periodic checks of connections is recommended. Please contact Dwyer Instruments, Inc. before returning unit for repair to review information relative to your application. When returning a product to the factory, carefully package and ship freight prepaid. Be sure to include a complete description of the application and problem and identify any hazardous material used with the product.

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DWYER INSTRUMENTS, INC.
P.O. Box 373, Michigan City, Indiana 46360, U.S.A.
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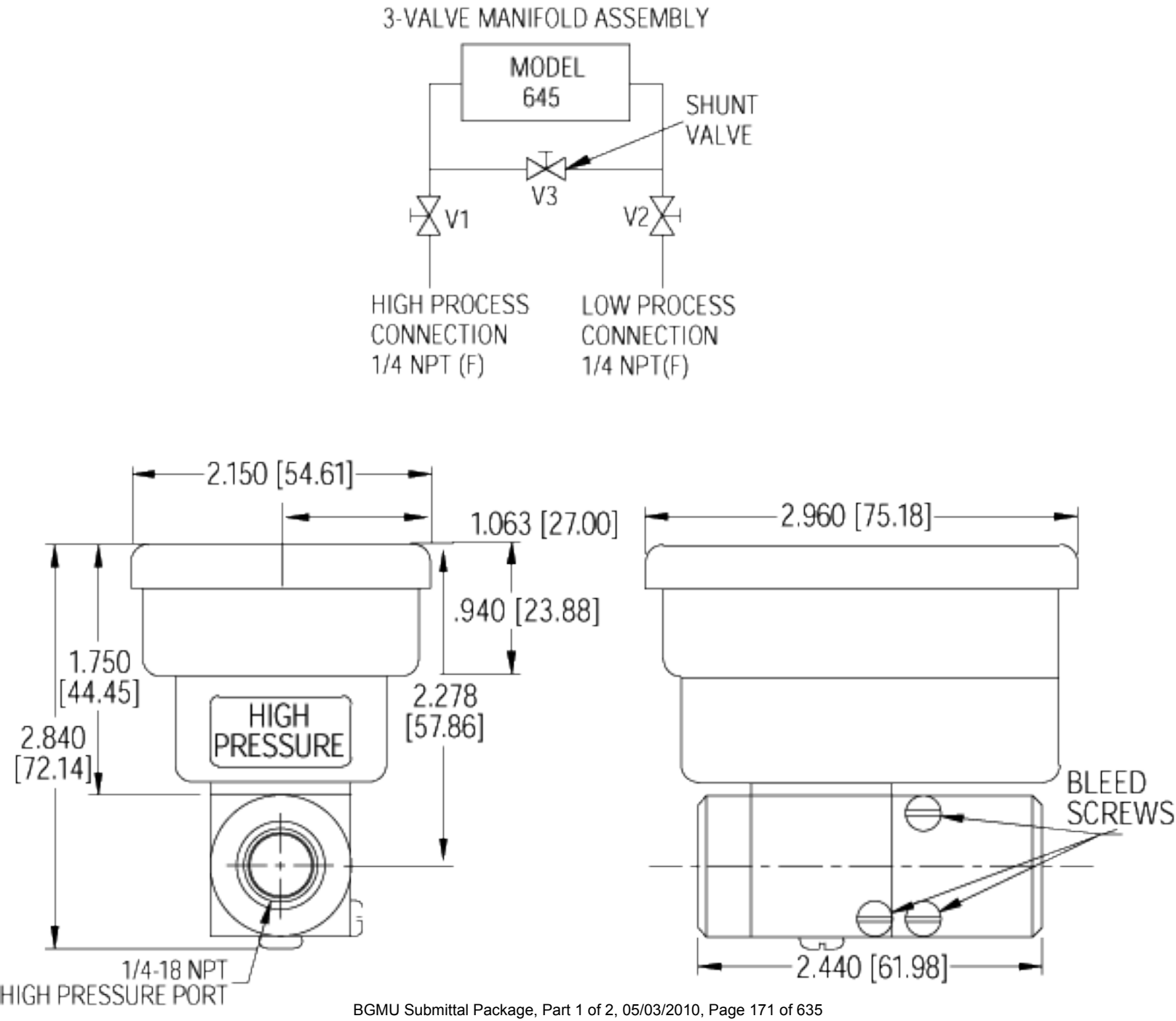
Dwyer 645 Series Dimensions


3-VALVE MANIFOLD ASSEMBLY
MODEL
645
SHUNT
VALVE
V3
V1
V2
HIGH PROCESS
CONNECTION
1/4 NPT (F)
LOW PROCESS
CONNECTION
1/4 NPT(F)
2.150 [54.61]
1.063 [27.00]
.940 [23.88]
1.750
[44.45]
2.840
[72.14]
HIGH
PRESSURE
2.278
[57.86]
1/4-18 NPT
HIGH PRESSURE PORT
2.960 [75.18]
BLEED
SCREWS
2.440 [61.98]

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- Weksler 3.5” Industrial Gauge Specifications & Order Guide

WEKSLER

3½˝ Regal Industrial Gauge ±1.0% Accuracy

STANDARD FEATURES

Available in 3½˝ dial sizes, Regal pressure gauges are liquid fillable and field convertible for panel mounting. Both zero and span adjustments are standard. The gauge is available dry, liquid-filled weatherproof or hermetically sealed.

- Designed for safety and long life
- All stainless, all-welded construction for long life
- ASME Grade 1A, 1% accuracy full scale
- No stop pin to mask false zero reading – ensures safety and process control
- 5-year limited warranty

BA43

PRESSURE RANGES

CODE NO.	DIAL RANGES	FIGURE INTERVALS	SMALLEST GRADUATION
PC	0-15 psi	1 psi	.25 psi
PD	0-30 psi	5 psi	.5 psi
PE	0-60 psi	10 psi	1 psi
PF	0-100 psi	10 psi	1 psi
PG	0-160 psi	20 psi	2 psi
PH	0-200 psi	20 psi	2 psi
PJ	0-300 psi	50 psi	5 psi
PK	0-400 psi	50 psi	5 psi
PM	0-600 psi	100 psi	10 psi
PO	0-800 psi	100 psi	10 psi
PP	0-1000 psi	100 psi	10 psi
PR	0-1500 psi	200 psi	10 psi
PS	0-2000 psi	200 psi	20 psi
PT	0-3000 psi	500 psi	20 psi
PV	0-5000 psi	500 psi	50 psi
PY	0-10,000 psi	1000 psi	100 psi
PZ	0-15,000 psi	3000 psi	100 psi

VACUUM RANGES

CODE NO.	DIAL RANGES	FIGURE INTERVALS	SMALLEST GRADUATION
VC	30˝-0 Hg. Vac	3˝	.2˝

BOURDON TUBE AND SOCKET

CATALOG NO.	BOURDON TUBE & SOCKET MATERIAL	DIAL SIZE	GAUGE TYPE	OPTIONAL CASE STYLE	
				LOWER CONNECT	BACK CONNECT
BA13	Brass/Bronze(1)	3½˝	Dry	"X" Style SS	"X" Style SS
BS13			Herm. Sealed		Back Flanged
BY13			Liquid Fill		"U" Style SS
BA43	316 SS		Dry	Back Flanged	U-Clamp
BS43			Herm. Sealed		"V" Style SS
BY43			Liquid Fill		Front Flanged

COMPOUND RANGES

CODE NO.	DIAL RANGES	FIGURE INTERVALS	SMALLEST GRADUATION
CA	30˝-0- 15 psi	5˝ & 3 psi	.5˝/.2 psi
CB	30˝-0- 30 psi	10˝ & 5 psi	1˝/.5 psi
CC	30˝-0- 60 psi	10˝ & 10 psi	1˝/ 1 psi
CD	30˝-0-100 psi	30˝ & 10 psi	2˝/ 1 psi
CE	30˝-0-150 psi	30˝ & 20 psi	5˝/ 2 psi
CF	30˝-0-200 psi	30˝ & 20 psi	5˝/ 2 psi
CG	30˝-0-300 psi	30˝ & 50 psi	10˝/ 5 psi
CI	30˝-0-600 psi	30˝ & 100 psi	10˝/10 psi

NOTES:

1. Brass/Bronze maximum range is 1000 psi.

HOW TO ORDER

B A 4 3 Y P F 4 L W ( )

1. Basic 4-digit Catalog No. From Table Above
2. Stainless Steel Case Style "Y" Standard
3. Range Code From Range Tables Above
4. Thread Size: 4 = ¼ Npt Male (only)
5. Connection Location: L = Lower (Bottom), R = Back (Rear)
6. Dial Color: W = White
7. If Any Gauge Options Are Desired – Specify Option Code(s) From Page 37

DRESSER Instruments

Nitrogen Flow Indicator, Dwyer, RMC-108-CPF

- Dwyer RM Rate Master Flowmeter Installation & Operating Instructions

Series RM Rate-Master® Flowmeters

Specifications - Installation and Operating Instructions

Fig. 1

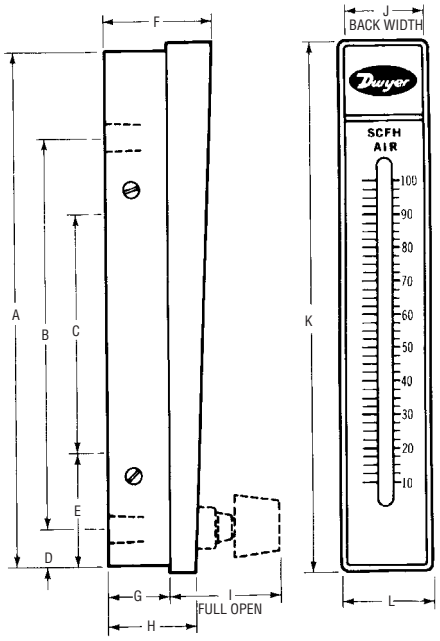

Fig. 2

Dimensions in Inches (Centimeters)			
	Model RMA	Model RMB	Model RMC
A	4 -9/16 (11.59)	8-1/2 (21.59)	15 -1/8 (38.42)
B	3 (7.62) 1/8 NPT CONN.	6-7/16 (16.35) 1/4 NPT CONN.	12 -1/4 (31.12) 1/2 NPT CONN.
C	1-5/8 (4.13) 10 - 32 Thds.	3-15/16 (10.00) 1/4 - 20 Thds.	8-3/4 (22.23) 10 - 32 Thds.
D	3/8 (.95)	5/8 (1.59)	1 (2.54)
E	1-1/16 (2.70)	1-7/8 (4.76)	2-3/4 (6.99)
F	1-3/16 (3.02)	1-3/4 (4.45)	2-1/2 (6.35)
G	11/16 (1.75)	1 (2.54)	1-7/16 (3.65)
H	61/64 (2.42)	1-7/16 (3.65)	1-31/32 (5.00)
I (OPEN)	1-3/8 (3.49)	1-13/16 (4.60)	2-1/2 (6.35)
J	3/4 (1.91)	1-1/4 (3.18)	2 (5.08)
K	4-13/16 (12.22)	8-3/4 (22.23)	15-3/8 (39.05)
L	1 (2.54)	1-1/2 (3.81)	2-1/4 (5.72)

Panel Cutout For Flush Mounting			
High	4-5/8 (11.75)	8-9/16 (21.75)	15 -3/16 (38.58)
Wide	7/8 (2.22)	1-5/16 (3.33)	2-1/16 (5.24)
Panel Hole Sizes for Surface Mounting			
Pipe	7/16 (1.11)	5/8 (1.59)	15/16 (2.38)
Bolt	1/4 (0.64)	9/32 (0.71)	13/32 (1.03)

The Series RM Rate-Master® Flowmeters are furnished in three models (see Fig. 2), each available in a broad array of flow ranges with direct reading scales for air, gas or water. Installation, operation and maintenance are very simple. Only a few common-sense precautions must be observed to assure long, trouble-free service.

CAUTION: Rate-Master® Flowmeters are designed to provide satisfactory long-term service when used with air, water or other compatible media. Refer to factory for information on questionable gases or liquids. Avoid solutions of acids, bases or salts having a pH below 5.0 or above 8.5. Caustic solutions, antifreeze (ethylene glycol) and aromatic solvents should definitely not be used.

Calibration

Each Rate-Master® Flowmeter is calibrated at the factory. If at any time during the meter's life, you wish to re-check its calibration, do so only with devices of certified accuracy. DO NOT attempt to check a Rate-Master® Flowmeter with a similar flowmeter, as seemingly unimportant variations in piping and back pressure may cause noticeable differences in the indicated reading. If in doubt, return your Rate-Master® Flowmeter to the factory. Its calibration will be checked for you at no charge. Before proceeding with installation, check to be sure you have the Rate-Master® flowmeter model and flow range you require.

LOCATION: Temperature, Pressure, Atmosphere and Vibration: Rate-Master® Flowmeters are exceptionally tough and strong. They are designed for use at pressures up to 100 psi (6.89 bar) and temperatures up to 130°F (54°C).

DO NOT EXCEED THESE LIMITS! The installation should not be exposed to strong chlorine atmospheres or solvents such as benzene, acetone, carbon tetrachloride, etc. The mounting panel should be free of excessive vibration, as it may prevent the unit from operating properly.

Inlet Piping Run: It is good practice to approach the flowmeter inlet with as few elbows and restrictions as possible. In every case, the inlet piping should be at least as large as the connection to the flowmeter; i.e.,1/8″ Iron Pipe Size for RMA models 1/4″ IPS for RMB models,1/2″ IPS for RMC models. Length of inlet piping makes little difference for normal pressure-fed flowmeters.

For flowmeters on vacuum air service, the inlet piping should be as short and open as possible. This will allow operation near atmospheric pressure and thereby insure the accuracy of the device. (**Note:** for vacuum air service, the flow control valve, if any, should be on the discharge side of the flowmeter. Either the TMV unit or a separate in-line valve may be applied.).

Discharge Piping: As on the inlet, discharge piping should be at least as large as the flowmeter connection. Also, for pressure-fed flowmeters on air or gas service, the discharge piping should be as short and open as possible. This will allow operation of the flow tube at near atmospheric pressure and insure the accuracy of the device. This is of less importance on water or liquid flowmeters, as the flowing medium is generally incompressible and moderate back pressure will not affect the accuracy of the instrument as calibrated.

POSITIONING AND MOUNTING

All Rate-Master® Flowmeters must be mounted in a vertical position with inlet connection at the bottom rear and outlet at the top rear.

Bezel or Through-Panel Mounting: Make panel cutout using appropriate dimensions from Fig. 2. Flowmeter must fit into panel freely without forcing or squeezing. Insert the flowmeter from the front of the panel and install the mounting clamps from the rear. Insert and tighten the clamp bolts in the locations shown in Fig. 3. Do not exceed 5 in./lbs. Make connections to inlet and outlet ports using pipe thread sealant tape to avoid leakage. Avoid excess torque, which may damage the flowmeter body.

DWYER INSTRUMENTS, INC.
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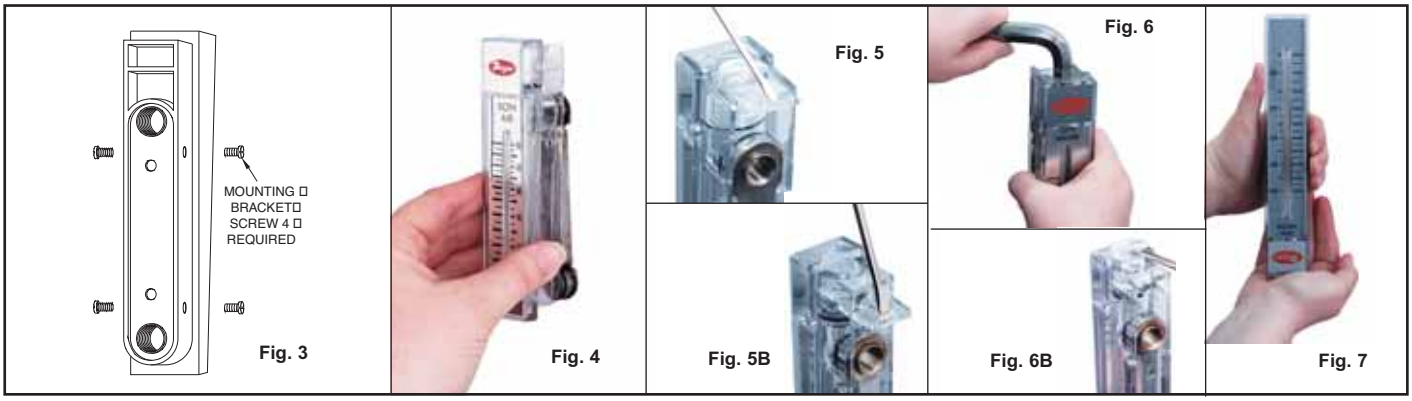


Surface Mounting: Drill appropriate holes in panel, using the dimensions shown in Fig. 2. Hold the flowmeter in position in front of the panel and install the clamp bolts from the rear. (The mounting clamps may be used as washers, if desired, by installing them backwards or straightening them out.) Pipe up inlet and discharge following the directions in the previous sections.

Surface Mounting on Piping Only: An alternate method of surface mounting, omitting the clamp bolts and supporting the flowmeter solely on the connecting piping, is possible. For this method, extra-long or straight pipe threads should be used so that nuts may be run onto the pipe and later tightened against the back of the panel to retain the unit in proper position. Use appropriate hole layout in formation from Fig. 2, but omit the small holes.

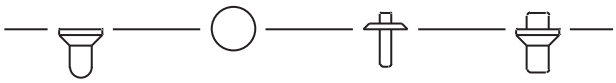
Surface Mounting on Piping Only Without Panel: For a temporary or laboratory type installation, the panel may be omitted altogether and the flowmeter installed directly in rigid piping. Its light weight permits this without difficulty.

OPERATION

To start system, open valve slowly to avoid possible damage. Control valves on BV and SSV models are turned clockwise to reduce flow, counter-clockwise to increase flow. A nylon insert is provided in the threaded section of the valve stem to give a firm touch to valve and to prevent change of setting due to vibration.

The performance of low range units used in air or gas applications may be affected by static electricity. Excessive static charge may cause the ball float to behave erratically or provide a false reading. To ensure the proper function of the unit, the application should be designed to minimize or dispel static electricity.

The standard technique for reading a Variable Area Flowmeter is to locate the highest point of greatest diameter on the float, and then align that with the theoretical center of the scale graduation. In the event that the float is not aligned with a grad, an extrapolation of the float location must be made by the operator as to its location between the two closest grads. The following are some sample floats shown with reference to the proper location to read the float.



Variable Area Flowmeters used for gases are typically labeled with the prefix “S” or “N”, which represents “Standard” for English units or “Normal” for metric units. Use of this prefix designates that the flowmeter is calibrated to operate at a specific set of conditions, and deviation from those standard conditions will require correction for the calibration to be valid. In practice, the reading taken from the flowmeter scale must be corrected back to standard conditions to be used with the scale units. The correct location to measure the actual pressure and temperature is at the exit of the flowmeter, except when using the Top Mounted Valve under vacuum applications, where they should be measured at the flowmeter inlet. The equation to correct for nonstandard operating conditions is as follows:

$$Q_2 = Q_1 \times \sqrt{\frac{P_1 \times T_2}{P_2 \times T_1}}$$

Where: Q_1 = Actual or Observed Flowmeter Reading
Q_2 = Standard Flow Corrected for Pressure and Temperature
P_1 = Actual Pressure (14.7 psia + Gage Pressure)
P_2 = Standard Pressure (14.7 psia, which is 0 psig)
T_1 = Actual Temperature (460 R + Temp °F)
T_2 = Standard Temperature (530 R, which is 70°F)

Example: A flowmeter with a scale of 10-100 SCFH Air. The float is sitting at the 60 grad on the flowmeter scale. Actual Pressure is measured at the exit of the meter as 5 psig. Actual Temperature is measured at the exit of the meter as 85°F.

$$Q_2 = 60.0 \times \sqrt{\frac{(14.7 + 5) \times 530}{14.7 \times (460 + 85)}}$$

Q_2 = 68.5 SCFH Air

CAUTION: Do not completely unscrew valve stem unless the flowmeter is unpressurized and drained of any liquid. Removal while in service will allow gas or liquid to flow out the front of the valve body and could result in serious personal injury. For applications involving high pressure and/or toxic gases or fluids, special non-removable valves are available on special order. Please contact factory for details.

MAINTENANCE

The only maintenance normally required is occasional cleaning to assure reliable operation and good float visibility.

Disassembly: The flowmeter can be disassembled for cleaning simply as follows:

1. Remove valve knob from RMB or RMC -BV or -SSV units by pulling the knob forward. It is retained by spring pressure on the stem half-shaft so that a gentle pull will remove it. On RMA-BV or -SSV models, turn the valve knob counter-clockwise until the threads are disengaged. Then withdraw the stem from the valve by gently pulling on the knob.

2. Remove the four mounting bracket screws located in the sides of the flowmeter. See Fig. 3. Pull the flowmeter body gently forward away from the back plate to avoid undue strain on the body. Leave the piping connections intact. There is no need to disturb them. See Fig. 4.

3. Threaded body style flowmeters - Remove the slip cap with a push on a screwdriver as shown in Fig. 5. Remove the plug ball stop as shown in Fig. 6 using allen wrench sizes as follows: Model RMA - 1/4˝, Model RMB - 1/2˝ and Model RMC - 3/4˝ Threadless body style flowmeters - Release the plastic retaining clip with a screw driver (Figure 5B), it will unclip from the valve body (TMV Option) or the plug ball stop, slide the clip back until the valve body or ball stop can be removed. The clip will remain in the body for convenience. Using a screwdriver gently lift up on the plug in the groove as shown in Figure 6B until the o-ring seal is released and remove the plug. For the TMV option gently pull up on the valve knob to release the valve body seals and remove the valve.

4. Take out the ball or float by inverting the body and allowing the float to fall into your hand, as shown in Fig. 7. (Note: It is best to cover the discharge port to avoid losing the float through that opening.)

Cleaning: The flow tube and flowmeter body can best be cleaned with a little pure soap and water. Use of a bottle brush or other soft brush will aid the cleaning. Avoid benzene, acetone, carbon tetrachloride, alkaline detergents, caustic soda, liquid soaps (which may contain chlorinated solvents), etc. Also, avoid prolonged immersion, which may harm or loosen the scale.

Reassembly: Simply reverse steps 1 through 4 and place the flowmeter back in service. A little stopcock grease or petroleum jelly on the “O” rings will help maintain a good seal as well as facilitate assembly. No other special care is required.

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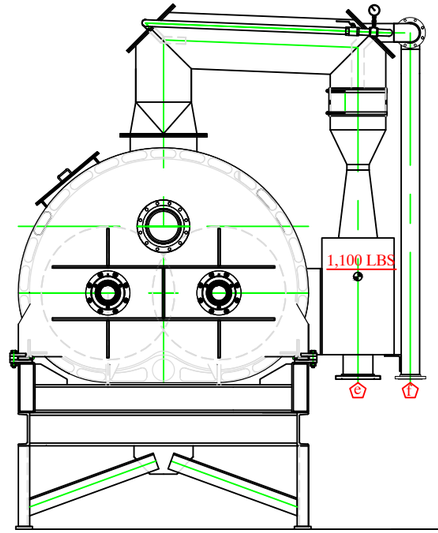
E. Frames & Support Structure

- Foundation Loading / Thermal Expansion for Bowling Green Municipal Utilities WWTP IC 10,000 Biosolids Dryer, Drawing No.: TFL5412-10000 S 3 of 3
- Hilti HIT HY-150MAX Adhesive Anchoring System Technical Guide
- Hilti HIT HY-150 MAX Injection Adhesive Anchor Product Data Block

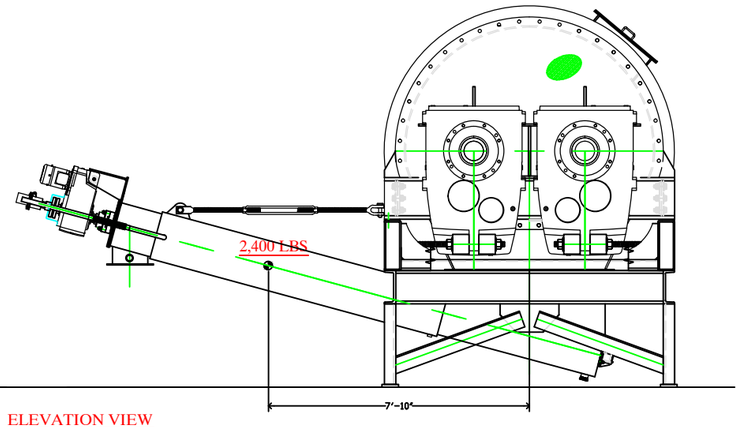
Foundation Loading / Thermal Expansion for Bowling Green Municipal Utilities WWTP IC 10,000 Biosolids Dryer, Drawing No.: TFL5412-10000 S 3 of 3

FOOT	FOUNDATION LOADING (Z DIRECTION)
A	APPROX. 15,240 LBS
B	APPROX. 15,240 LBS
C	APPROX. 15,240 LBS
D	APPROX. 15,240 LBS
E	APPROX. 15,250 LBS
F	APPROX. 15,250 LBS
G	APPROX. 15,970 LBS
H	APPROX. 15,970 LBS
I	APPROX. 2,000 LBS
J	APPROX. 2,000 LBS
K	APPROX. 2,000 LBS
L	APPROX. 2,000 LBS

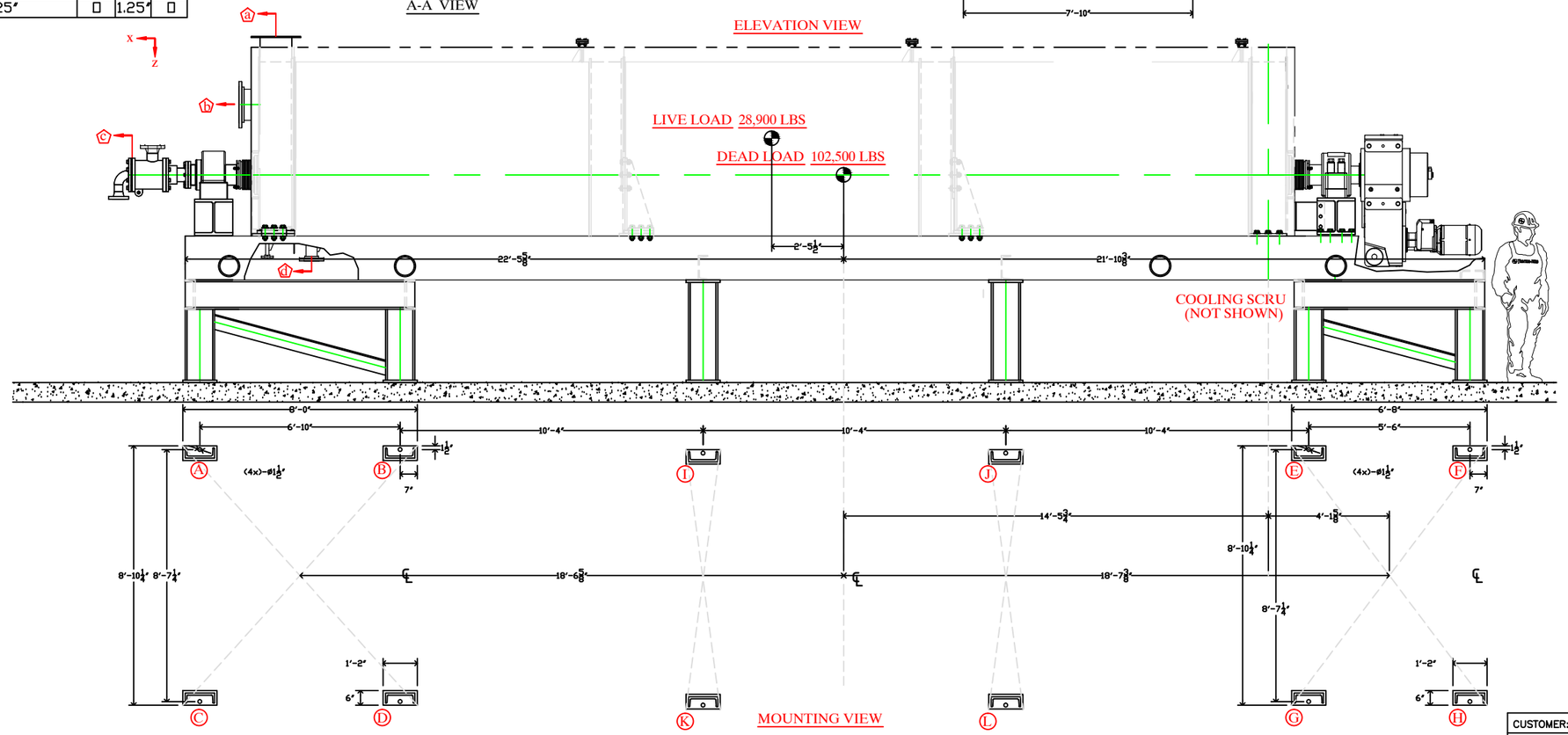
NOZZLE	THERMAL EXPANSION	X	Y	Z
a	APPROX. 1.25"	1.25"	0	0
b	APPROX. 1.375"	1.38"	0	0
c	APPROX. 1.5"	1.5"	0	0
d	APPROX. 1.125"	1.13"	0	0
d	APPROX. 1.125"	0	1.25"	0
d	APPROX. 1.125"	0	1.25"	0



A-A VIEW



ELEVATION VIEW



MOUNTING VIEW

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No.	MADE BY	CHECKED BY	DATE	DESCRIPTION
0	RDN		1/05/10	ISSUED FOR INFORMATION ONLY
1	RDN		2/1/10	REVISED WEIGHT DISTRIBUTION / EXPANSION
2	RDN		3/9/10	CHANGE REMOVABLE ENDPLATE / ADD LIVE LOADS

JOB No:	TFL5412
DRAWN BY:	RDN
CHECKED BY:	
APPROVED BY:	
DATE	1/05/10

FOUNDATION LOADING / THERMAL EXPANSION
"BIO-SCRU" DRYER MODULE
FOR
BOWLING GREEN MUNICIPAL UTILITIES

CUSTOMER: BGMU
PROJECT No: S07-653

Therma-Flite
The Screw Heat Exchange Company
P.O.Box 847
849 Jackson Street,
Benicia, CA 94510
Telephone: (707) 747-5949
Fax: (707) 747-5951

SHEET: 3 OF 3 DWG. No: TFL5412-10000 REV 2

Hilti HIT HY-150 MAX Injection Adhesive Anchor Product Data Block

HILTI HIT HY–150 MAX Injection Adhesive Anchor

1. Drill holes with ANSI B212.15 matched tolerance carbide tipped drill bits with drill in roto–hammer mode. Diamond coring holes is not permitted.
2. Drilled hole specifications (diameter & depth) shall comply with Hilti specifications or ICC ESR–1967.
3. Allowable loads may be increased by up to 33–1/3% for short–term wind or seismic load resistance IAW ICC ESR–1967 unless not permitted by the applicable building code.
4. When conducted, proof test anchors in the field to 150–200% of Hilti published allowable tension load unless noted otherwise in a proof test load table. Torque testing is not permitted.
5. Anchors may be installed in damp holes IAW ICC ESR–1967. Installation in holes with standing water is not permitted.
6. Anchors shall be tightened with a calibrated torque wrench. Use of an impact wrench is not permitted.
7. Contact Hilti Technical Support at 1–800–879–8000 for additional assistance with HIT HY–150 MAX anchor installations.
8. Installation instructions:

a. For HIT HY–150 Adhesive with All–Thread Rod or Rebar Dowel:
   1. Drill anchor hole with a carbide bit (see note 1 above), to specified embedment depth.
   2. Clean Hole in accordance with Hilti specifications or ICC ESR–1967.
   3. Put adhesive refill pack into dispenser holder. Remove cap covering threaded projection.
   4. Screw on static mixer nozzle.
   5. Put holder/cartridge into appropriate dispenser and discard the first two trigger pulls of adhesive from each refill pack/cartridge.
   6. Inject adhesive into hole starting at the bottom until 1/2 to 2/3 full. Use mixer filler tube extensions when needed to reach the bottom of the hole.
   7. Unlock dispenser.
   8. Insert All–Thread rod or rebar dowel. Twist during installation.
   9. Anchor may be adjusted during specified gel time. Do not disturb anchor between specified gel and cure times.
   10. After full cure time, apply specified torque as required to secure fastened item. Do not exceed specified maximum torque.
   11. Reference tables below for acceptable specifications.

HY 150 MAX Installation Specification Table for HAS Rods

Details \ Rod Size			in. (mm)	3/8 (9.5)	1/2 (12.7)	5/8 (15.9)	3/4 (19.1)	7/8 (22.2)	1 (25.4)	1–1/4 (31.8)
d_{bit}: bit diameter			in.	7/16	9/16	11/16	13/16	1	1–1/8	1–3/8
$h_{ef} = h_{nom}$ standard embedment			in. (mm)	3–3/8 (86)	4–1/2 (114)	5–5/8 (143)	6–3/4 (172)	7–7/8 (200)	9 (229)	11–1/4 (286)
T_{max} max. tightening torque	All Hilti Threaded Rods	$h_{ef} \geq h_{nom}$	ft–lb (Nm)	18 (24)	30 (41)	75 (102)	150 (203)	175 (237)	235 (319)	400 (540)
		$h_{ef} < h_{nom}$	ft–lb (Nm)	15 (20)	20 (27)	50 (68)	105 (142)	125 (169)	165 (224)	280 (375)
h minimum base material thickness		$h_{ef} = h_{nom}$	in. (mm)	5–3/8 (136)	6–1/2 (165)	7–5/8 (195)	8–3/4 (222)	9–7/8 (250)	11–1/4 (286)	14–1/4 (362)
		$h_{ef} \neq h_{nom}$	in. (mm)	1.0 h_{ef}+ 2 (51)	1.0 h_{ef}+ 2 (51)	1.0 h_{ef}+ 2 (51)	1.0 h_{ef}+ 2 (51)	1.0 h_{ef}+ 2 (51)	1.0 h_{ef}+ 2–1/4 (57)	1.0 h_{ef}+ 3 (76)

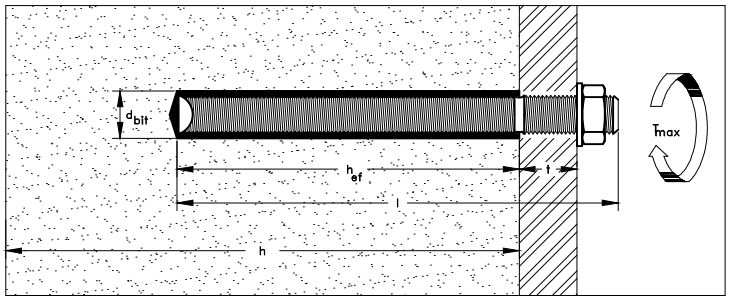
HIT HY 150 MAX Installation Specification Table for Rebar

Details: \ Rebar Size:		#3	#4	#5	#6	#7	#8	#9	#10
d_{bit} : nominal bit diameter	in.	1/2	5/8	3/4	7/8	1	1–1/8	1–3/8	1–1/2

Final Cure Time Table (Approximate)

Approx. Curing Time	Base Material Temperature
20 Minutes	104°F/40°C
25 Minutes	86°F/30°C
30 Minutes	68°F/20°C
1 Hour	50°F/10°C
2 Hours	32°F/0°C
4 Hours	23°F/–5°C
12 Hours	14°F/–10°C

HILTI HIT HY–150 MAX Injection Adhesive Anchor



Attached are page(s) from the 2008 Hilti North American Product Technical Guide. For complete details on this product, including data development, product specifications, general suitability, installation, corrosion, and spacing & edge distance guidelines, please refer to the Technical Guide, or contact Hilti.

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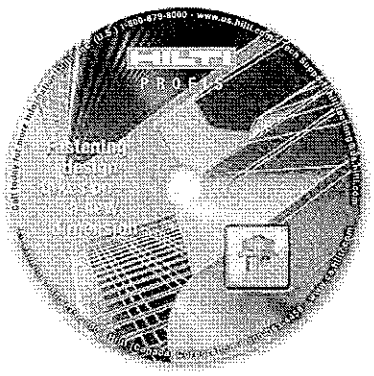

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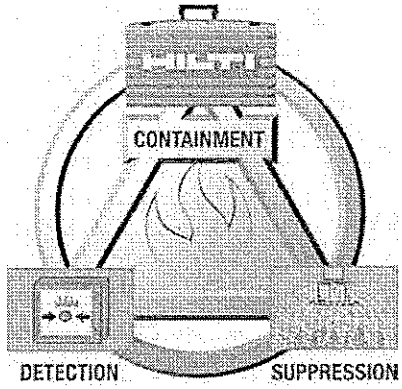
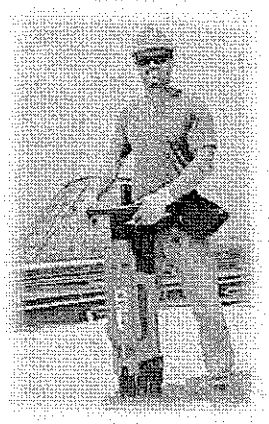


Firestop Systems

When it comes to Life Safety and building code compliance, Hilti provides complete solutions with a wide range of products and unmatched technical support.

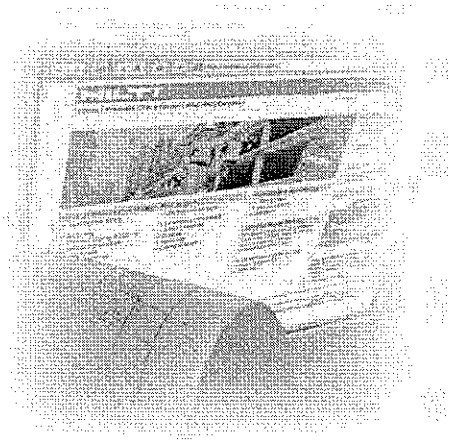
- Firestop Systems Guides
  - Through Penetrations
  - Joint Penetrations
- FACT Program
- FS 411
- BASIC Training
- Engineering Judgements
- Firestop Design Center online at **www.us.hilti.com** or **www.hilti.ca**



Hilti Diaphragm Deck Design

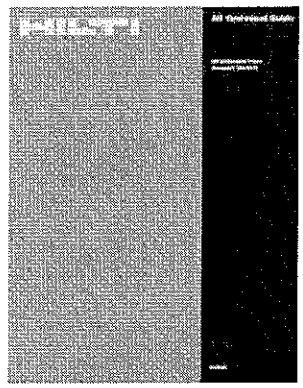
The Hilti Diaphragm Deck Design Program allows designers to quickly and accurately design roof deck and composite floor deck diaphragms.

- Ability to design with innovative Hilti fasteners for frame and sidelap connection
- Creates easy to use load tables with span ranges based on user input
- Allows for different safety factors depending on load type, building code and field quality control
- Direct link to Hilti website



Hilti Online

- Technical Library
- Design Centers
- Interactive Product Advisors
- Full-line Product Catalog
- Online Ordering
- Maps to Hilti locations
- "Contact Us" program to answer your questions



MI – Industrial Pipe Support Technical Guide

A guide to specifying the Hilti modular pipe support system for medium to heavy loads without welding.

- MI System is the ideal solution for pipes up to 24 in. diameter
- Reliable fastenings without welds
- Easily installed

4.2.4 HIT-HY 150 MAX Adhesive Anchoring System

4.2.4.1	Product Description
4.2.4.2	Material Specifications
4.2.4.3	Technical Data
4.2.4.4	Installation Instructions
4.2.4.5	Ordering Information

HY 150 MAX
Foil Pack

Listings/Approvals

ICC-ES (International Code Council)
ESR-1967

City of Los Angeles
RR 25652

NSF/ANSI Standard 61
Certification for use of HIT HY 150 MAX in potable water

Metro-Dade County
NOA No. 09-0224.06

Code Compliance

IBC®/IRC® 2006 (ICC-ES AC58)

IBC®/IRC® 2003 (ICC-ES AC58)

IBC®/IRC® 2000 (ICC-ES AC58)

UBC® 1997 (ICC-ES AC58)

LEED®: Credit 4.1-Low Emitting Materials

The Leadership in Energy and Environmental Design (LEED®) Green Building Rating system™ is the nationally accepted benchmark for the design, construction and operation of high performance green buildings.

4.2.4.1 Product Description

Hilti HIT HY 150 MAX is a hybrid adhesive mortar combining urethane methacrylate resin, hardener, cement and water. The components are kept separate from the hardener and water by means of a dual-cylinder foil cartridge attached to a manifold. It is formulated for fast curing and installation in a wide range of solid and hollow base material temperatures from 14°F (-10°C) up to 104°F (40°C).

The system consists of adhesive cartridges, a mixing nozzle, a HIT dispenser and either a threaded rod, rebar, HIS internally threaded inserts or other fastening element. HIT-HY 150 MAX is designed for fastenings into solid base materials such as concrete, stone, and grout-filled block and is also suitable for fastening into base materials containing voids and holes such as hollow block, lightweight hollow block, brick with holes, and clay tile (with use of screen tubes).

The Hilti HIT-TZ is an innovative threaded rod installed with HIT HY 150 MAX hybrid adhesive. With the combination of HIT HY 150 MAX and the innovative design of the HIT-TZ rod, anchoring into uncleaned holes, wet holes (including standing water) and/or Hilti matched tolerance diamond-cored holes does not adversely affect tensile capacity.

Product Features of HIT HY 150 MAX

- Average 20% higher load capacities than HIT HY 150
- May be used for oversized holes up to 1/4" larger than threaded rod size
- May be used in solid and hollow base materials
- Quick cure saves time
- Complete system available, including HAS-E, HIS, HIT-TZ
- Contains no styrene, virtually odorless
- Extended temperature range IBC/IRC 2006
- Seismic qualified per IBC®/IRC® 2006, IBC®/IRC® 2003, IBC®/IRC® 2003, IBC®/IRC® 2000 and UBC® 1997 (ICC-ES AC58). Please refer to ESR-1967

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HIT-HY 150 MAX Adhesive Anchoring System 4.2.4

Guide Specifications

Master Format Section:
03250 (Concrete accessories)
Related Sections:
03200 (Concrete Reinforcing)
05050 (Metal Fabrication)
05120 (Structural Steel)

Injectable adhesive: Shall be used for installation of all reinforcing steel dowels or threaded rods and inserts into new or existing solid concrete or masonry. For hollow base materials an injectable adhesive shall be used with a cylindrical mesh screen tube per the adhesive manufacturer's specifications.

Adhesive: Shall be furnished in containers which keep component A and component B separate. Containers shall be designed to accept static mixing nozzle which thoroughly blends component A and component B and allows injection directly into drilled hole. Only injection tools and static mixing nozzles supplied by manufacturer shall be used. Manufacturer's installation instructions shall be followed. Injection adhesives shall be formulated to include resin and hardener to provide optimal curing speed as well as high strength and stiffness. Typical curing time at 68°F shall be 30 minutes. Injection adhesive shall be HIT-HY 150 MAX, as furnished by Hilti.

Anchor Rods: Shall be furnished with chamfered ends so that either end will accept a nut and washer. Alternatively, anchor rods shall be furnished with a 45 degree chisel point on one end to allow for easy installation into the adhesive-filled hole. Anchor rods shall be manufactured to meet the following requirements:

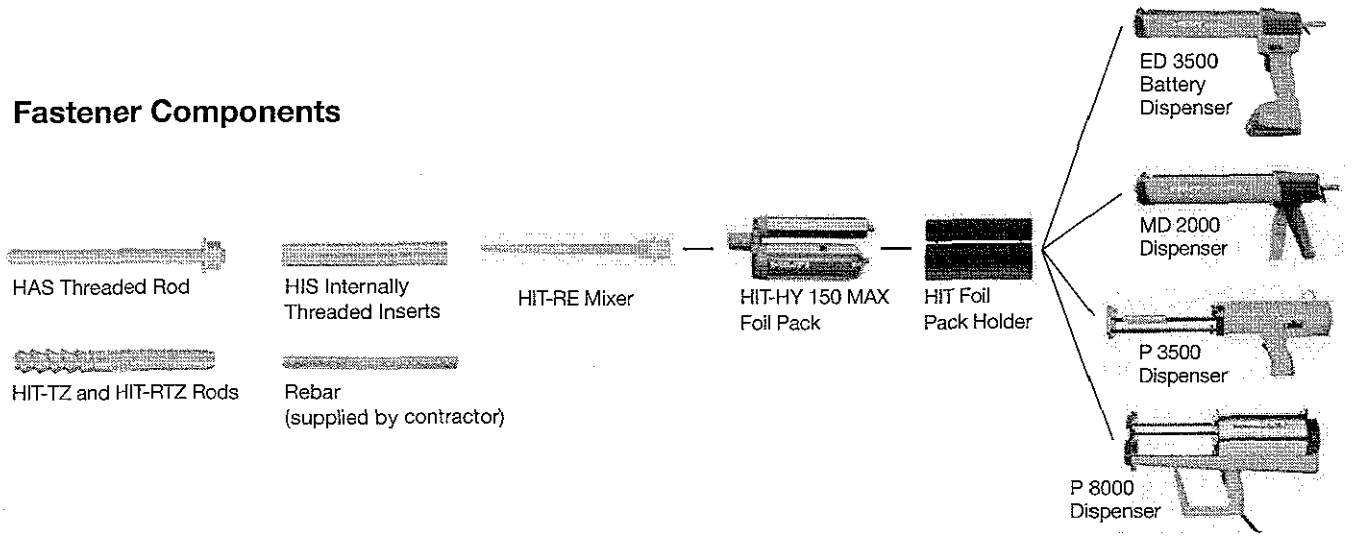
1. ISO 898 Class 5.8;
2. ASTM A 193, Grade B7 (high strength carbon steel anchor);
3. AISI 304 or AISI 316 stainless steel, meeting the requirements of ASTM F 593 (condition CW). Special order of HAS or HIT rods may vary from standard product.

Mesh Screen Tube: Shall be formed into a cylindrical shape, with one end closed to prevent extrusion of adhesive through that end. Screen tube shall be manufactured with a mesh size, length and diameter as specified by the adhesive manufacturer. Mesh shall be manufactured from:

1. Low carbon steel with zinc electro-plating or
2. AISI 304 stainless steel or
3. plastic. Anchor rods and screens shall be the Hilti HIT system as manufactured by Hilti (refer to page 197).

Nuts and Washers: Shall be furnished to meet the requirements of the above anchor rod specifications.

Fastener Components



4.2.4 HIT-HY 150 MAX Adhesive Anchoring System

4.2.4.2 Material Specifications

Material Properties for Cured Adhesive

Compressive Strength ASTM C 579	> 50 MPa	>7252 psi
Flexural Strength ASTM C 580	> 20 MPa	> 2900 psi
Modulus of Elasticity ASTM C 307	> 3500 MPa	> 5.07 x 10^5 psi
Water Absorption ASTM D 570	< 2%	< 2%
Electrical Resistance DIN/VDE 0303T3	~ 2 x 10^{11} OHM/cm	~ 5.1 x 10^{11} OHM/in.

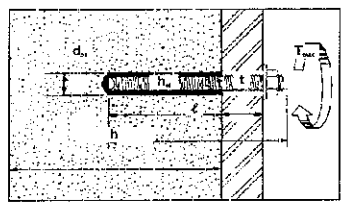
Material	Mechanical Properties			
	f_u ksi	f_u (MPa)	min. f_u ksi	min. f_u (MPa)
Standard HAS-E rod material meets the requirements of ISO 898 Class 5.8	58	(400)	72.5	(500)
High Strength or 'Super HAS' rod material meets the requirements of ASTM A 193, Grade B7	105	(724)	125	(862)
HIS-R Insert X5CrNiMo17122 K700 Stainless Steel conforming to DIN EN 10088-3	50.8	(350)	101.5	(700)
HIS & HIT-I Insert 11SMnPb30+C Carbon Steel conforming to DIN 10277-3	54.4	(375)	66.7	(460)
Stainless HAS Rod material meets the requirements of ASTM F 593 (AISI 304/316) Condition CW 3/8" to 5/8"	65	(448)	100	(689)
Stainless HAS Rod material meets the requirements of ASTM F 593 (AISI 304/316) Condition CW 3/4" to 1-1/4"	45	(310)	85	(586)
HIT-A Rod material ASTM A 36 9SMNPB36K &/or 9SMN36K conforming to DIN 1651. Mechanical properties meet or exceed values for ASTM A 36	36	(248)	58	(400)
HAS Super & HAS-E Standard Nut material meets the requirements of ASTM A 563, Grade DH				
HAS Stainless Steel Nut material meets the requirements of ASTM F 594				
HAS & HIT Standard and Stainless Steel Washers meet dimensional requirements of ANSI B18.22.1 Type A Plain				
HAS Stainless Steel Washers meet the requirements of AISI 304 or AISI 316 conforming to ASTM A 240				
HAS Super & HAS-E Standard Washers meet the requirements of ASTM F 436				
All HAS Super Rods (except 7/8"), HIT & HAS-E Standard, HIS inserts, Nuts & Washers are zinc plated to ASTM B 633 SC 1				
7/8" HAS Super Rods hot-dip galvanized in accordance with ASTM A 153				
HIT and HAS-E Nut material meets dimensional requirements of ASTM A 563				

Note: Special Order threaded rods may vary from standard materials.

4.2.4.3 Technical Data

HIT-HY 150 MAX Installation Specification Table for HAS Rods

Details			HAS Rod Size in. (mm)	3/8 (9.5)	1/2 (12.7)	5/8 (15.9)	3/4 (19.1)	7/8 (22.2)	1 (25.4)	1-1/4 (31.8)
d_{bit} bit diameter[1]			in.	7/16	9/16	3/4	7/8	1	1-1/8	1-3/8
$h_{nf} = h_{nom}$ standard embedment[2]			in. (mm)	3-3/8 (86)	4-1/2 (114)	5-5/8 (143)	6-3/4 (172)	7-7/8 (200)	9 (229)	11-1/4 (286)
$T_{inst,max}$ max. tightening torque	All Hilti Threaded Rods	$h_{nf} \geq h_{nom}$	ft lb (Nm)	18 (24)	30 (41)	75 (102)	150 (203)	175 (237)	235 (319)	400 (540)
		$h_{nf} < h_{nom}$	ft lb (Nm)	15 (20)	20 (27)	50 (68)	105 (142)	125 (169)	165 (224)	280 (375)
h minimum base material thickness[3]		$h_{nf} = h_{min}$	in. (mm)	5-3/8 (136)	6-1/2 (165)	7-5/8 (195)	8-3/4 (222)	9-7/8 (250)	11-1/4 (286)	14-1/4 (362)
		$h_{nf} \neq h_{min}$	in. (mm)	1.0 h_{nf}+ 2 (51)	1.0 h_{nf}+ 2 (51)	1.0 h_{nf}+ 2 (51)	1.0 h_{nf}+ 2 (51)	1.0 h_{nf}+ 2 (51)	1.0 h_{nf}+ 2-1/4 (57)	1.0 h_{nf}+ 3 (76)



1 Use Hilti matched tolerance carbide tipped drill bits

2 Data available for varying embedment depths see load tables.

3 Minimum base material thickness given to avoid back side blowout during drilling process Ability of base material to withstand loads applied (e.g. bending of concrete slab) should be determined by design engineer.

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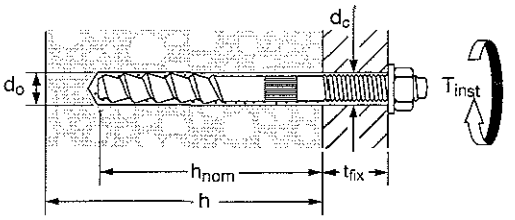
HIT-HY 150 MAX Adhesive Anchoring System 4.2.4

HIT-HY 150 MAX Installation Specification Table for HIT-TZ Rods

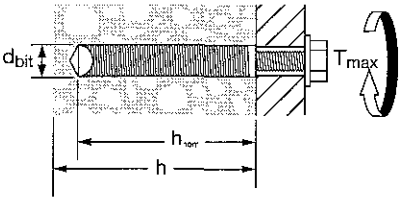
Details		HIT-TZ Rod in. (mm)	3/8 (9.5)	1/2 (12.7)	5/8 (15.9)	3/4 (19.1)
d_{bit}	bit diameter	in.	7/16	9/16	11/16	13/16
h_{nom}	standard depth of embedment[1]	in. (mm)	2-7/8 (73)	3-1/2 (89)	4 (102)	5-1/4 (133)
l	length of anchor	in. (mm)	4-1/2 (114.3)	5-11/16 (144.5)	7-1/16 (179.4)	10-1/2 (267)
T_{inst}	max. tightening torque	ft lb (Nm)	18 (24)	30 (40)	75 (100)	150 (200)
h	min. base material thickness	in. (mm)	3-3/4 (95)	5-1/4 (133)	6 (152)	7-7/8 (200)
h_{fix}	max. thickness fastened	in. (mm)	1 (25.4)	1-1/2 (38.1)	2-1/4 (57.2)	2-1/4 (57.2)



1 For uncleaned holes in floor applications add 3/8" (10 mm) to drilled hole depth

HIT-HY 150 MAX Installation Specification Table for HIS Inserts

Details		HIS Insert in. (mm)	3/8 (9.5)	1/2 (12.7)	5/8 (15.9)	3/4 (19.1)
d_{bit}	bit diameter	in.	11/16	7/8	1-1/8	1-1/4
h_{nom}	standard depth of embedment	in. (mm)	4 1/4 (110)	5 (127)	6-5/8 (168)	8-1/4 (210)
ℓ_{th}	usable thread length	in. (mm)	1 (25)	1-3/16 (30)	1-1/2 (38)	2 (51)
T_{max}	max. tightening torque	ft lb (Nm)	18 (24)	35 (47)	80 (108)	160 (217)
h	min. base material thickness	in. (mm)	6-3/8 (162)	7-1/2 (191)	10 (254)	12-3/8 (314)
Recommended Hilti Rotary Hammer Drill			TE 6, 16, 25, 35	TE 16 25, 35, 46	TE 46, 56, 76	



HIT-HY 150 MAX Installation Specification Table for Rebar in Concrete

Details		Rebar Size:	No. 3	No. 4	No. 5	No. 6	No. 7	No. 8	No. 9	No. 10
d_{bit}	bit diameter[1, 2]	in.	1/2	5/8	3/4	7/8	1	1-1/8	1-3/8	1-1/2

1 Rebar diameters may vary. Use smallest drill bit which will accommodate rebar.

2 Use Hilti matched tolerance carbide tipped drill bits

HIT-HY 150 MAX Installation Specification Table for Metric Rebar in Concrete (Canada Only)

Details		Rebar Size:	10M	15M	20M	25M	30M	35M
d_{bit}	bit diameter[1, 2]		14 mm	3/4"	24mm	1-1/8"	37mm	1-9/16"

1 Rebar diameters may vary. Use smallest drill bit which will accommodate rebar

2 Use Hilti matched tolerance carbide tipped drill bits.

Combined Shear and Tension Loading

$$\left(\frac{N_d}{N_{rec}}\right)^{5/3} + \left(\frac{V_d}{V_{rec}}\right)^{5/3} \leq 1.0 \quad \text{(Ref. Section 4.1.8.3)}$$

4.2.4 HIT-HY 150 MAX Adhesive Anchoring System

HIT-HY 150 MAX Installation Specification for HIT-A Rods in Hollow Block, Tile & Brick with Holes

Details		Anchor Size in. (mm)	Tile	Hollow and Lightweight Block			Brick w/Holes, Clay Tile		
			1/4 x 2-1/2 (6.4 x 64)	5/16 x 2-1/2 (7.9 x 64)	3/8 x 3 (9.5 x 75)	1/2 x 3-1/8 (12.7 x 80)	5/16 x 4 (7.9 x 100)	3/8 x 4-3/8 (9.5 x 110)	1/2 x 4-1/2 (12.7 x 115)
d_{bit}	bit diameter	in.	1/2	5/8	5/8	5/8	5/8	5/8	5/8
h_1	min. depth of hole	in. (mm)	2-3/8[1] (60)	2-3/8[1] (60)	2-3/8[1] (60)	2-3/8[1] (60)	3-3/4 (95)	3-3/4 (95)	3-3/4 (95)
h_{min}	min. base material thickness	in. (mm)	3-1/2 (89)	3-1/2 (89)	3-1/2 (89)	3-1/2 (89)	5 (127)	5 (127)	5 (127)
	required screen tube		HIT S - 12A	HIT S - 16/2			HIT S - 16		
t	max. thickness fastened	in. (mm)	1/4 (6)	1/4 (6)	5/8 (16)	3/4 (19)	5/8 (16)	3/4 (19)	3/4 (19)
T_{max}	max. tightening torque	ft-lb (Nm)	Finger Tight	3 (4)	5 (7)	7 (9)	3 (4)	5 (7)	7 (9)

1 Bore hole should be through face of base material

HIT-HY 150 MAX Installation Specification for HIT-I Inserts in Hollow Block, Tile & Brick with Holes

Details		Anchor Size in. (mm)	Tile	Hollow and Lightweight Block			Brick w/Holes, Clay Tile		
			#14 Screw	5/16 x 2 (7.9 x 50)	3/8 x 2 (9.5 x 50)	1/2 x 2 (12.7 x 50)	5/16 x 3-3/16 (7.9 x 80)	3/8 x 3-3/16 (9.5 x 80)	1/2 x 3-3/16 (12.7 x 80)
d_{bit}	bit diameter	in.	1/2	5/8	27/32	27/32	5/8	27/32	27/32
h_1	min. depth of hole	in. (mm)	2-3/8[1] (60)	2-3/8[1] (60)	2-3/8[1] (60)	2-3/8[1] (60)	3-3/4 (95)	3-3/4 (95)	3-3/4 (95)
h_{min}	min. base material thickness	in. (mm)	3-1/2 (89)	3-1/2 (89)	3-1/2 (89)	3-1/2 (89)	5 (127)	5 (127)	5 (127)
	required screen tube		HIT S - 12I	HIT S - 16/2	HIT S - 22/2		HIT S - 16/2	HIT S - 22/2	
h_s	max. usable thread length	in. (mm)	min 1-1/4 - 1-1/2 (min 30-40)	min 1/2 – 1-1/2 (min 12-35)			min 1/2 – 3 (min 12-75)		
T_{max}	max. tightening torque	ft-lb (Nm)	Finger Tight	3 (4)	5 (7)	7 (9)	3 (4)	5 (7)	7 (9)

1 Bore hole should be through face of base material.

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HIT-HY 150 MAX Adhesive Anchoring System 4.2.4

HIT-HY 150 MAX Allowable and Ultimate Bond/Concrete Capacity for HAS Rods in Normal Weight Concrete [1, 2, 3]

Anchor Diameter in (mm)	Embedment Depth in (mm)	HIT-HY 150 MAX Allowable Bond/Concrete Capacity				HIT-HY 150 MAX Ultimate Bond/Concrete Capacity			
		Tensile		Shear		Tensile		Shear	
		f'_c = 2000 psi (13.8 MPa) lb (kN)	f'_c = 4000 psi (27.6 MPa) lb (kN)	f'_c = 2000 psi (13.8 MPa) lb (kN)	f'_c = 4000 psi (27.6 MPa) lb (kN)	f'_c = 2000 psi (13.8 MPa) lb (kN)	f'_c = 4000 psi (27.6 MPa) lb (kN)	f'_c = 2000 psi (13.8 MPa) lb (kN)	f'_c = 4000 psi (27.6 MPa) lb (kN)
	1 3/4	725	1155	1675	2360	2900	4620	5020	7080
	(44)	(3.2)	(5.1)	(7.5)	(10.5)	(12.9)	(20.6)	(22.3)	(31.5)
3/8	3 3/8	2110	3055	3155	4460	8440	12220	9460	13380
(9.5)	(86)	(9.4)	(13.6)	(14.0)	(19.8)	(37.5)	(54.4)	(42.1)	(59.5)
	4 1/2	2150	3055	4855	6860	8600	12220	14560	20580
	(114)	(9.6)	(13.6)	(21.6)	(30.5)	(38.3)	(54.4)	(64.8)	(91.5)
	2 1/4	1385	2090	2750	3890	5540	8360	8240	11660
	(57)	(6.2)	(9.3)	(12.2)	(17.3)	(24.6)	(37.2)	(36.7)	(51.9)
1/2	4 1/2	4000	4980	5610	7935	16000	19920	16820	23800
(12.7)	(114)	(17.8)	(22.2)	(25.0)	(35.3)	(71.2)	(88.6)	(74.8)	(105.9)
	6	4705	4980	8635	12210	18820	19920	25900	36620
	(152)	(20.9)	(22.2)	(38.4)	(54.3)	(83.7)	(88.6)	(115.2)	(162.9)
	2 7/8	1940	2730	4095	5790	7760	10920	12280	17360
	(73)	(8.6)	(12.1)	(18.2)	(25.8)	(34.5)	(48.6)	(54.6)	(77.2)
5/8	5 5/8	5955	8410	8760	12395	23820	33640	26280	37180
(15.9)	(143)	(26.5)	(37.4)	(39.0)	(55.1)	(106.0)	(149.6)	(116.9)	(165.4)
	7 1/2	7320	8410	13495	19080	29280	33640	40480	57240
	(190)	(32.6)	(37.4)	(60.0)	(84.9)	(130.2)	(149.6)	(180.1)	(254.6)
	3 3/8	2625	4295	6110	8635	10500	17180	18320	25900
	(86)	(11.7)	(19.1)	(27.2)	(38.4)	(46.7)	(76.4)	(81.5)	(115.2)
3/4	6 3/4	6460	9985	12615	17840	25840	39940	37840	53520
(19.1)	(172)	(28.7)	(44.4)	(56.1)	(79.4)	(114.9)	(177.7)	(168.3)	(238.1)
	9	11175	11175	19430	27470	44700	44700	58280	82400
	(229)	(49.7)	(49.7)	(86.4)	(122.2)	(198.8)	(198.8)	(259.2)	(366.5)
	4	3375	5300	7670	10840	13500	21200	23000	32520
	(101)	(15.0)	(23.6)	(34.1)	(48.2)	(60.1)	(94.3)	(102.3)	(144.7)
7/8	7 7/8	9910	14815	17175	24290	39640	59260	51520	72860
(22.2)	(200)	(44.1)	(65.9)	(76.4)	(108.0)	(176.3)	(263.6)	(229.2)	(324.1)
	10 1/2	14385	15345	26440	37390	57540	61380	79320	112160
	(267)	(64.0)	(68.3)	(117.6)	(166.3)	(255.9)	(273.0)	(352.8)	(498.9)
	4 1/2	5210	6570	9990	14120	20840	26280	29960	42360
	(114)	(23.2)	(29.2)	(44.4)	(62.8)	(92.7)	(116.9)	(133.3)	(188.4)
1	9	11595	17475	22435	31720	46380	69900	67300	95160
(25.4)	(229)	(51.6)	(77.7)	(99.8)	(141.1)	(206.3)	(310.9)	(299.4)	(423.3)
	12	17340	18685	34535	48830	69360	74740	103600	146480
	(305)	(77.1)	(83.1)	(153.6)	(217.2)	(308.5)	(332.5)	(460.8)	(651.6)
	5 5/8	6985	9935	13180	18640	27940	39740	39540	55920
	(143)	(31.1)	(44.2)	(58.6)	(82.9)	(124.3)	(176.8)	(175.9)	(248.7)
1 1/4	11 1/4	18345	30085	35050	49570	73380	120340	105140	148700
(31.8)	(286)	(81.6)	(133.8)	(155.9)	(220.5)	(326.4)	(535.3)	(467.7)	(661.4)
	15	25575	30085	53960	76300	102300	120340	161880	228900
	(381)	(113.8)	(133.8)	(240.0)	(339.4)	(455.1)	(535.3)	(720.1)	(1018.2)

1 Influence factors for spacing and edge distance are applied to concrete/bond values above, and then compared to the steel value. The lesser of the values is to be used for the design

2 For $h_{ef} \geq h_{nom}$ average ultimate concrete shear capacity based on Concrete Capacity Design (CCD) method For $h_{ef} < h_{nom}$ average ultimate concrete shear values based on testing.

3 All values based on holes drilled with carbide bit and cleaned with compressed air and wire brush per manufacturer's instructions.

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4.2.4 HIT-HY 150 MAX Adhesive Anchoring System

Allowable Steel Strength for HAS Rods, HIT-TZ (ASTM A 510) and HIT-RTZ Rods[1]

Anchor Diameter in. (mm)	HAS-E Standard ISO 898 Class 5.8		HAS Super ASTM A 193 B7		HAS SS AISI 304/316 SS		HIT-TZ (ASTM A 510) & HIT-RTZ Rods	
	Tensile lb (kN)	Shear lb (kN)	Tensile lb (kN)	Shear lb (kN)	Tensile lb (kN)	Shear lb (kN)	Tensile lb (kN)	Shear lb (kN)
3/8 (9.5)	2640 (11.7)	1360 (6.0)	4555 (20.3)	2345 (10.4)	3645 (16.2)	1875 (8.3)	3170 (14.1)	1635 (7.3)
1/2 (12.7)	4700 (20.9)	2420 (10.8)	8100 (36.0)	4170 (18.5)	6480 (28.8)	3335 (14.8)	5636 (25.1)	2900 (12.9)
5/8 (15.9)	7340 (32.6)	3780 (16.8)	12655 (56.3)	6520 (29.0)	10125 (45.0)	5215 (23.2)	8805 (39.2)	4535 (20.2)
3/4 (19.1)	10570 (47.0)	5445 (24.2)	18225 (81.1)	9390 (41.8)	12390 (55.1)	6385 (28.4)	12685 (56.4)	6535 (29.1)
7/8 (22.2)	14385 (64.0)	7410 (33.0)	24805 (110.3)	12780 (56.9)	16865 (75.0)	8690 (38.7)	- -	- -
1 (25.4)	18790 (83.6)	9680 (43.1)	32400 (144.1)	16690 (74.2)	22030 (98.0)	11350 (50.5)	- -	- -
1-1/4 (31.8)	29360 (130.6)	15125 (67.3)	50620 (225.2)	26080 (116.0)	34425 (153.1)	17735 (78.9)	- -	- -

1 Steel strength as defined in AISC Manual of Steel Construction (ASD):

Tensile = 0.33 x F_u x Nominal Area
Shear = 0.17 x F_u x Nominal Area

Ultimate Steel Strength for HAS Rods, HIT-TZ (ASTM A 510) and HIT-RTZ Rods[1]

Anchor Diameter in. (mm)	HAS-E Standard ISO 898 Class 5.8			HAS Super ASTM A 193 B7			HAS SS AISI 304/316 SS			HIT-TZ (ASTM A 510) & HIT-RTZ Rods		
	Yield lb (kN)	Tensile lb (kN)	Shear lb (kN)	Yield lb (kN)	Tensile lb (kN)	Shear lb (kN)	Yield lb (kN)	Tensile lb (kN)	Shear lb (kN)	Yield lb (kN)	Tensile lb (kN)	Shear lb (kN)
3/8 (9.5)	4495 (20.0)	6005 (26.7)	3605 (16.0)	8135 (36.2)	10350 (46.0)	6210 (27.6)	5035 (22.4)	8280 (36.8)	4970 (22.1)	5690 (25.3)	7210 (32.1)	4325 (19.2)
1/2 (12.7)	8230 (36.6)	10675 (47.5)	6405 (28.5)	14900 (66.3)	18405 (81.9)	11040 (49.1)	9225 (41.0)	14720 (65.5)	8835 (39.3)	10105 (44.9)	12810 (57.0)	7685 (34.2)
5/8 (15.9)	13110 (58.3)	16680 (75.1)	10010 (44.5)	23730 (105.6)	28760 (127.9)	17260 (76.8)	14690 (65.3)	23010 (102.4)	13805 (61.4)	15795 (70.3)	20020 (89.1)	12010 (53.4)
3/4 (19.1)	19400 (86.3)	24020 (106.8)	14415 (64.1)	35120 (156.2)	41420 (184.2)	24850 (110.5)	15050 (66.9)	28165 (125.3)	16800 (74.7)	22750 (101.2)	28825 (128.2)	17295 (76.9)
7/8 (22.2)	26780 (119.1)	32695 (145.4)	19620 (87.3)	48480 (215.6)	56370 (250.7)	33825 (150.5)	20775 (92.3)	38335 (170.5)	23000 (102.3)	- -	- -	- -
1 (25.4)	35130 (156.3)	42705 (190.0)	25625 (114.0)	63600 (282.9)	73630 (327.5)	44180 (196.5)	27255 (121.2)	50070 (222.7)	30040 (133.6)	- -	- -	- -
1-1/4 (31.8)	56210 (250.0)	66730 (296.8)	40035 (178.1)	101755 (452.6)	115050 (511.8)	69030 (307.1)	43610 (194.0)	78235 (348.0)	46940 (208.8)	- -	- -	- -

1 Steel strength as defined in AISC Manual of Steel Construction 2nd Ed. (LRFD):

Yield = F_y x Tensile Stress Area
Tensile = 0.75 x F_u x Nominal Area
Shear = 0.45 x F_u x Nominal Area

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HIT-HY 150 MAX Adhesive Anchoring System 4.2.4

HIT-HY 150 MAX Allowable and Ultimate Bond/Concrete Capacity for HIT-TZ and HIT-RTZ Rods in Normal Weight Concrete[1]

Anchor Diameter in. (mm)	Embedment Depth in. (mm)	HIT-HY 150 MAX Allowable Bond/Concrete Capacity				HIT-HY 150 MAX Ultimate Bond/Concrete Capacity			
		Tensile		Shear		Tensile		Shear	
		f'c= 2000 psi (13.8 MPa) lb (kN)	f'c= 4000 psi (27.6 MPa) lb (kN)	f'c= 2000 psi (13.8 MPa) lb (kN)	f'c= 4000 psi (27.6 MPa) lb (kN)	f'c= 2000 psi (13.8 MPa) lb (kN)	f'c= 4000 psi (27.6 MPa) lb (kN)	f'c= 2000 psi (13.8 MPa) lb (kN)	f'c= 4000 psi (27.6 MPa) lb (kN)
3/8 (9.5)	2-7/8 (73)	1800 (8.0)	2255 (10.0)	1710 (7.6)	2415 (10.7)	7200 (32.0)	9020 (40.1)	6840 (30.4)	9660 (43.0)
1/2 (12.7)	3-1/2 (89)	2720 (12.1)	3020 (13.4)	2600 (11.6)	3680 (16.4)	10880 (48.4)	12080 (53.7)	10400 (46.3)	14720 (65.5)
5/8 (15.9)	4 (102)	3850 (17.1)	5750 (25.6)	3490 (15.5)	4935 (22.0)	15400 (68.5)	23000 (102.3)	13960 (62.1)	19740 (87.8)
3/4 (19.1)	5-1/4 (133)	5405 (24.0)	7275 (32.4)	5850 (26.0)	8275 (36.8)	21620 (96.2)	29100 (129.4)	23400 (104.1)	33100 (147.2)

1 *Influence factors for spacing and edge distance are applied to concrete/bond values above and then compared to the steel value* The lesser of the values is to be used for the design

HIT-HY 150 MAX Allowable Bond/Concrete Capacity and Steel Strength for HIS Carbon Steel and HIS-R Stainless Steel Internally Threaded Inserts

Anchor Diameter in. (mm)	Embedment Depth in. (mm)	HIT-HY 150 MAX Allowable Bond/Concrete Capacity		Allowable Bolt Strength[1,2]			
		Tensile f'c ≥ 2000 psi (13.8 MPa) lb (kN)	Shear f'c ≥ 2000 psi (13.8 MPa) lb (kN)	ASTM A 325 Carbon Steel		ASTM F 593 Stainless Steel	
				Tensile lb (kN)	Shear lb (kN)	Tensile lb (kN)	Shear lb (kN)
3/8 (9.5)	4-1/4 (108)	2875 (12.8)	1605 (7.1)	4370 (19.4)	2250 (10.0)	3645 (16 2)	1875 (8.3)
1/2 (12.7)	5 (127)	4890 (21.8)	3040 (13.5)	7775 (34.6)	4005 (17.8)	6480 (28.8)	3335 (14.8)
5/8 (15.9)	6-5/8 (168)	7430 (33.1)	4575 (20.4)	12150 (54.0)	6260 (27.8)	10125 (45.0)	5215 (23.2)
3/4 (19.1)	8-1/4 (210)	9920 (44.1)	6305 (28.0)	17495 (77.8)	9010 (40.1)	12395 (55.1)	6385 (28.4)

HIT-HY 150 MAX Ultimate Bond/Concrete Capacity and Steel Strength for HIS Carbon Steel and HIS-R Stainless Steel Internally Threaded Inserts

Anchor Diameter in. (mm)	Embedment Depth in. (mm)	HIT-HY 150 MAX Ultimate Bond/Concrete Capacity[2]		Ultimate Bolt Strength[1,2]			
		Tensile f'c ≥ 2000 psi (13.8 MPa) lb (kN)	Shear f'c ≥ 2000 psi (13.8 MPa) lb (kN)	ASTM A 325 Carbon Steel		ASTM F 593 Stainless Steel	
				Tensile lb (kN)	Shear lb (kN)	Tensile lb (kN)	Shear lb (kN)
3/8 (9.5)	4-1/4 (108)	11495 (51.1)	6425 (28.6)	9935 (44.2)	5960 (26.5)	8280 (36 8)	4970 (22.1)
1/2 (12.7)	5 (127)	19570 (87.1)	12170 (54.1)	17665 (78.6)	10600 (47.2)	14720 (65.5)	8835 (39.3)
5/8 (15.9)	6-5/8 (168)	29720 (132 2)	18310 (81.4)	27610 (122.8)	16565 (73.7)	23010 (102.4)	13805 (61.4)
3/4 (19.1)	8-1/4 (210)	39675 (176.5)	25215 (112.2)	39760 (176.9)	23855 (106.1)	28165 (125.3)	16900 (75.2)

1 Steel values in accordance with AISC
ASTM A 325 bolts: F_y = 92 ksi F_u = 120 ksi
ASTM F 593 (AISI 304/316): F_y = 65 ksi F_u = 100 ksi for 3/8" thru 5/8"
F_y = 45 ksi F_u = 85 ksi for 3/4"

Ultimate Load Values
Tension = 0 75 x F_y x A_{nom}
Shear = 0 45 x F_y x A_{nom}

Allowable Load Values
Tension = 0 33 x F_u x A_{nom}
Shear = 0 17 x F_y x A_{nom}

2 Use lower value of either bond/concrete capacity or steel strength.

4.2.4 HIT-HY 150 MAX Adhesive Anchoring System

HIT-HY 150 MAX Allowable and Ultimate Bond/Concrete Capacity for HAS Rods installed in Lightweight Concrete ≥ 3000 psi (20.7 MPa) [1, 2]

Anchor Diameter in. (mm)	Embedment Depth in. (mm)	Allowable Bond/Concrete Capacity lb (kN)		Ultimate Bond/Concrete Capacity lb (kN)	
		Tensile	Shear	Tensile	Shear
3/8 (9.5)	1-3/4 (44)	855 (3.8)	1510 (6.7)	3420 (15.2)	6040 (26.9)
	3-3/8 (86)	2210 (9.8)	1590 (7.1)	8840 (39.3)	6360 (28.3)
1/2 (12.7)	2-1/4 (57)	1515 (6.7)	2405 (10.7)	6060 (27.1)	9620 (42.8)
	4-1/2 (114)	3815 (17.0)	2440 (10.9)	15260 (67.9)	9760 (43.4)
5/8 (15.9)	2-7/8 (73)	2110 (9.4)	4755 (21.2)	8440 (37.5)	19020 (84.6)
	5-5/8 (143)	4655 (20.7)	4755 (21.2)	18620 (82.8)	19020 (84.6)
3/4 (19.1)	3-3/8 (86)	2560 (1.4)	6160 (27.4)	10240 (45.5)	24640 (109.6)
	6-3/4 (172)	6765 (30.1)	6160 (27.4)	27060 (120.4)	24640 (109.6)

1 Influence factors for spacing and edge distance are applied to concrete/bond values above and then compared to the allowable steel value. The lesser of these values is to be used for design

2 All values based on holes drilled with carbide tipped bit and cleaned with a wire brush.

HIT-HY 150 MAX Allowable Bond/Concrete Capacity for Sill Plate Applications

Allowable Loads for Attachment of Sill Plates to f'_c= 2000 psi Normal Weight Concrete with HIT-HY 150 MAX

Anchor Diameter in. (mm)	Embedment Depth in. (mm)	Edge Distance in. (mm)	Tension lb (kN)	Shear lb (kN)	
				Load ll to Edge	Load⊥to Edge
1/2 (12.7)	4-1/2 (114)	1-3/4 (44.5)	1790 (8.0)	1555 (6.9)	555 (2.5)
		2-3/4 (69.9)	2240 (10.0)	1815 (8.1)	940 (4.2)
5/8 (15.9)	5-5/8 (143)	1-3/4 (44.5)	2275 (10.1)	2550 (11.3)	555 (2.5)
		2-3/4 (69.9)	2525 (11.2)	2670 (11.9)	940 (4.2)
	10 (254)	1-3/4 (44.5)	4410 (19.6)	2550 (11.3)	855 (3.8)
		2-3/4 (69.9)	5045 (22.4)	2670 (11.9)	975 (4.3)
3/4 (19.1)	6-3/4 (172)	1-3/4 (44.5)	2660 (11.8)	2620 (11.7)	910 (4.0)
		2-3/4 (69.9)	3150 (14.0)	3375 (15.0)	1105 (4.9)
7/8 (22.2)	7-7/8 (200)	1-3/4 (44.5)	3420 (15.2)	3980 (17.7)	1070 (4.8)
		2-3/4 (69.9)	4320 (19.2)	4320 (19.2)	1300 (5.8)
	15 (381)	1-3/4 (44.5)	7980 (35.5)	3980 (17.7)	1070 (4.8)
		2-3/4 (69.9)	8085 (36.0)	4320 (19.2)	1300 (5.8)

Allowable Loads for Attachment of Sill Plates to Top of Grout Filled Block Wall with HIT-HY 150 MAX[1]

Anchor Diameter in. (mm)	Embedment Depth in. (mm)	Edge Distance in. (mm)	Tension lb (kN)	Shear lb (kN)	
				Load ll to Edge	Load⊥to Edge
1/2 (12.7)	4-1/2 (114)	1-3/4 (44.5)	1095 (4.8)	815 (3.6)	295 (1.3)
5/8 (15.9)	5-5/8 (143)	1-3/4 (44.5)	1240 (5.5)	965 (4.3)	400 (1.8)

1 Loads are based on concrete or masonry failure Steel strength must be checked separately Values based on safety factor of 5 0

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HIT-HY 150 MAX Adhesive Anchoring System 4.2.4

HIT-HY 150 MAX Allowable Loads for Threaded Rods in Grout-Filled Concrete Masonry Units (ASTM C 90 Block) [1, 2, 3, 4]

Anchor Diameter in. (mm)	Embedment Depth in. (mm)	Distance from Edge in. (mm)	Tension[5] lb (kN)	Shear[5] lb (kN)
3/8 (9.5)	3-3/8 (86)	4 (101.6)	880 (3.9)	1135 (5.0)
		≥ 20 (508)	950 (4.2)	1135 (5.0)
1/2 (12.7)	4-1/2 (114)	4 (101.6)	1055 (4.7)	1745 (7.8)
		≥ 20 (508)	1265 (5.6)	1870 (8.3)
5/8 (15.9)	5-5/8 (143)	4 (101.6)	1370 (6.1)	2120 (9.4)
		≥ 20 (508)	1850 (8.2)	2590 (11.5)
3/4 (19.1)	6-3/4 (172)	4 (101.6)	1580 (8.8)	2205 (9.8)
		≥ 20 (508)	2440 (13.6)	2785 (12.4)

HIT-HY 150 MAX Ultimate Loads for Threaded Rods in Grout-Filled Concrete Masonry Units (ASTM C 90 Block) [1, 2, 3, 4]

Anchor Diameter in. (mm)	Embedment Depth in. (mm)	Distance from Edge in. (mm)	Tension[5] lb (kN)	Shear[5] lb (kN)
3/8 (9.5)	3-3/8 (86)	4 (101.6)	4400 (19.6)	5675 (25.2)
		≥ 20 (508)	4750 (21.1)	5675 (25.2)
1/2 (12.7)	4-1/2 (114)	4 (101.6)	5275 (23.5)	8725 (38.8)
		≥ 20 (508)	6325 (28.1)	9350 (41.6)
5/8 (15.9)	5-5/8 (143)	4 (101.6)	6850 (30.5)	10600 (47.2)
		≥ 20 (508)	9250 (41.1)	12950 (57.6)
3/4 (19.1)	6-3/4 (172)	4 (101.6)	7900 (35.1)	11025 (49.0)
		≥ 20 (508)	12200 (54.3)	13925 (61.9)

1 Values are for lightweight, medium weight or normal weight concrete masonry units conforming to ASTM C 90 with 1500 psi grout conforming to ASTM C 476.

2 Embedment depth is measured from the outside face of the concrete masonry unit

3 Values are for anchors located in the grouted cell head joint bed joint 'T' joint cross web or any combination of the above

4 Values for edge distance between 4 inches and 20 inches can be calculated by linear interpolation.

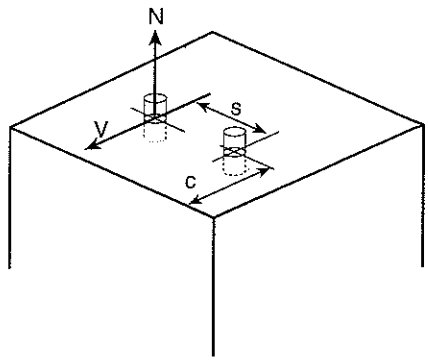
5 Loads are based on the lesser of bond strength steel strength or base material strength.

Anchor Spacing and Edge Distance Guidelines for Grout-Filled Block

Influence of Anchor Spacing and Edge Distance

Anchor Size	in. (mm)	3/8 (9.5)	1/2 (12.7)	5/8 (15.8)	3/4 (19.1)
h_{min}	in. (mm)	3-3/8 (86)	4-1/2 (114)	5-5/8 (143)	6-3/4 (172)

h_{min} = standard embedment depth



Edge Distance for Shear and Tension:
Grout Filled, Normal Weight and Lightweight Block

c_{ac} = 20 in. (508 mm) minimum from free edge

c_{min} = 4 in. (102 mm) minimum from free edge

Anchor Spacing for Shear and Tension:
Grout Filled, Normal Weight and Lightweight Block

s_{cr} = s_{min} = One (1) anchor per cell (max), and 8 in. (203mm) (min)

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4.2.4 HIT-HY 150 MAX Adhesive Anchoring System

HIT-HY 150 MAX Allowable Loads for Threaded HIT-A Rods in Hollow Concrete Block, Lightweight Concrete Block, Brick with Holes, Clay Tile [1, 2]

Anchor Type	Anchor Diameter in. (mm)	HIT-A Short 2" (51mm) Embedment		HIT-A Standard 3-3/8" (86mm) Embedment			
		L/W or N/W Hollow Concrete Block		Brick with Holes		Clay Tile	
		Tension lb (kN)	Shear lb (kN)	Tension lb (kN)	Shear lb (kN)	Tension lb (kN)	Shear lb (kN)
HIT-A Rod Anchor	1/4[3] (6.4)	190 (0.8)	340 (1.5)	365 (1.6)	305 (1.4)	130 (0.6)	100 (0.4)
	5/16 (7.9)	275 (1.2)	505 (2.2)	565 (2.5)	530 (2.4)	150 (0.7)	220 (1.0)
	3/8 (9.5)	395 (1.8)	790 (3.5)	775 (3.4)	930 (4.1)	150 (0.7)	220 (1.0)
	1/2 (12.7)	395 (1.8)	1230 (5.5)	775 (3.4)	1375 (6.1)	150 (0.7)	500 (2.2)

1 Based on using a safety factor of 6 for tension and 4 for shear.

2 Due to wide strength variations encountered in masonry these values should be considered as guide values

3 1/4" anchor diameter installed at 2" embedment in brick with holes and clay tile.

HIT-HY 150 MAX Allowable Loads for Internally Threaded HIT-I Inserts in Hollow Concrete Block, Lightweight Concrete Block, Brick with Holes, Clay Tile [1, 2]

Anchor Type	Anchor Diameter in. (mm)	HIT-I Short 2" (51mm) Embedment		HIT-I Standard 3-3/8" (86mm) Embedment			
		L/W or N/W Hollow Concrete Block		Brick with Holes		Clay Tile	
		Tension lb (kN)	Shear lb (kN)	Tension lb (kN)	Shear lb (kN)	Tension lb (kN)	Shear lb (kN)
HIT-I Insert Anchor	No 14 screw w/ insert[3] (6.4)	180 (0.8)	510 (2.3)	300 (1.3)	530 (2.4)	85 (0.4)	150 (0.7)
	5/16 (7.9)	300 (1.3)	780 (3.5)	585 (2.6)	750 (3.3)	175 (0.8)	220 (1.0)
	3/8 (9.5)	300 (1.3)	1425 (6.3)	1160 (5.2)	1380 (6.1)	185 (0.8)	435 (1.9)
	1/2 (12.7)	300 (1.3)	1800 (8.0)	1160 (5.2)	1635 (7.3)	185 (0.8)	500 (2.2)

1 Based on using a safety factor of 6 for tension and 4 for shear

2 Due to wide strength variations encountered in masonry these values should be considered as guide values

3 1/4" anchor diameter installed at 2" embedment in brick with holes and clay tile.

Anchor Spacing and Edge Distance Guidelines

Brick with Holes & Multi-Wythe Brick Walls

Spacing:

$s_c = s_{min}$ = Two (2) complete bricks in any direction

Edge Distance:

$c_c = c_{min}$ = Two (2) complete bricks (max), and 16" (406 mm) in any direction (min) (whichever is less)

Clay Tile

Spacing:

$s_c = s_{min}$ = One (1) anchor per tile cell

Edge Distance:

$c_c = c_{min}$ = 12" (305 mm) from free edge

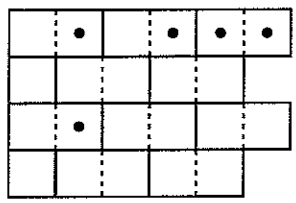
Hollow, Normal Weight & Lightweight Concrete Block

Spacing:

$s_c = s_{min}$ = One (1) anchor per block cell

Edge Distance:

$c_{cr} = c_{min}$ = 12" (305 mm) min. from free edge



Wall Elevation

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HIT-HY 150 MAX Adhesive Anchoring System 4.2.4

HIT-HY 150 MAX Ultimate Bond Strength and Steel Strength for Rebar in Concrete

Nominal Rebar Size	Embed. Depth in. (mm)	Concrete Compressive Strength						Grade 60 Rebar	
		f'_c = 2000 psi			f'_c = 4000 psi				
		Ultimate Bond Strength lb (kN)	Embed. to Develop Yield Strength[1] in. (mm)	Embed. to Develop Tensile Strength[1] in. (mm)	Ultimate Bond Strength lb (kN)	Embed. to Develop Yield Strength[1] in. (mm)	Embed. to Develop Tensile Strength[1] in. (mm)	Yield Strength lb (kN)	Tensile Strength lb (kN)
#3	3-3/8 (86)	8100 (36.0)	3-3/8 (86)	5 (127)	8240 (36.7)	3-3/8 86)	4 (102)	6600 (29.4)	9900 (44 0)
	4-1/2 (114)	8700 (38.7)			11380 (50.6)				
#4	4-1/2 (114)	13840 (61.6)	4-1/2 (114)	5-7/8 (149)	14840 (66.0)	4-1/2 (114)	5 3/8 (137)	12000 (53.4)	18000 (80 1)
	6 (152)	18800 (83.6)			20620 (91.7)				
#5	5-5/8 (143)	20200 (89.9)	5-5/8 (143)	7-3/8 (187)	25060 (111.5)	5-5/8 (143)	6 3/4 (172)	18600 (82 7)	27900 (124.1)
	7-1/2 (190)	28600 (127.2)			29900 (133 0)				
#6	6-3/4 (172)	27080 (120.5)	6-3/4 (172)	10 (254)	27080 (120.5)	6-3/4 (172)	8 1/2 (216)	26400 (117 4)	39600 (176.2)
	9 (229)	36680 (163 2)			43820 (194.9)				
#7	7-7/8 (200)	36200 (161.0)	7-7/8 (200)	11-5/8 (295)	40360 (179.5)	7-7/8 (200)	10 (254)	36000 (160 1)	54000 (240.2)
	10-1/2 (267)	49940 (222 1)			57760 (256.9)				
#8	9 (229)	45860 (204.0)	9-3/8 (238)	13-3/8 (340)	58860 (261.8)	9 (229)	11 1/2 (292)	47450 (211.1)	71100 (316 3)
	12 (305)	66680 (296.6)			73800 (328.3)				
#9	10-1/8 (257)	54660 (243.1)	10-3/4 (273)	15 (381)	68580 (305.1)	10-1/8 (257)	14 3/8 (365)	60000 (266.9)	90000 (400 3)
	13-1/2 (343)	88000 (391.4)			88000 (391 4)				
#10	11-1/4 (286)	68200 (303.4)	12-1/4 (311)	16-7/8 (429)	80520 (358.2)	11-1/4 (286)	15 (381)	76200 (339 0)	114300 (508 4)
	15 (381)	101720 (452 5)			115160 (512 3)				

1 Based on comparison of average ultimate adhesive bond test values or ultimate bond stress calculated strength values versus ultimate tensile strength of rebar For more information contact Hilti

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4.2.4 HIT-HY 150 MAX Adhesive Anchoring System

HIT-HY 150 MAX Bond Strength and Steel Strength for Rebar in Concrete [1, 4, 5]

Rebar Size	Concrete Compressive Strength [2, 3, 4]					Strength Properties of Metric Rebar [2, 3]	
		f'_c = 14 MPa		f'_c = 28 MPa		f_y = 400 MPa	
	Embedment Depth mm	Ultimate Bond kN	Allowable Bond kN	Ultimate Bond kN	Allowable Bond kN	Yield Strength kN	Tensile Strength kN
10M	85 115	36 0 38 7	9 9 7	36.7 50 6	9 2 12 7	40	60
15M	145 190	89.9 127 2	22 5 31.8	111.5 133	27 9 33.3	80	120
20M	170 230	120 5 163.2	30 1 40 8	120 5 194 9	30 1 48 7	120	180
25M	230 305	204 0 296 6	51 74.2	261.8 328.3	65 5 82 1	200	300
30M	260 345	243.1 391.4	60 8 97 9	305 1 391 4	76.3 97 9	280	420

1 For anchoring to grout filled block or bond beams please refer to table for loads in grout filled concrete masonry units for HIT-HY 150 MAX

2 Use lesser values of bond strength or rebars steel strength for tensile capacity

3 Actual bond test data developed for imperial-sized rebar. Yield and ultimate rebar strengths are for metric sizes

4 Test data developed for hammer drilled holes For diamond cored holes contact Hilti Engineering

5 For HIT-HY 150 MAX anchor spacing and edge distance guidelines please refer to section 4 2 4.

HIT-HY 150 MAX Adhesive Anchoring System 4.2.4

Anchor Spacing and Edge Distance Guidelines in Concrete for HIT-HY 150 MAX

Load Adjustment Factors for 3/8" and 1/2" Diameter Anchors

Anchor Diameter	3/8" diameter												1/2" diameter											
Adjustment Factor	Spacing Tension/Shear f_A			Edge Distance Tension f_{RN}			Edge Distance Shear, f_{RV1} (⊥ toward edge)			Edge Distance Shear, f_{RV2} (II to or away from edge)			Spacing Tension/Shear f_A			Edge Distance Tension f_{RN}			Edge Distance Shear, f_{RV1} (⊥ toward edge)			Edge Distance Shear, f_{RV2} (II to or away from edge)		
Embedment Depth, in.	1-3/4	3-3/8	4-1/2	1-3/4	3-3/8	4-1/2	1-3/4	3-3/8	4-1/2	1-3/4	3-3/8	4-1/2	2-1/4	4-1/2	6	2-1/4	4-1/2	6	2-1/4	4-1/2	6	2-1/4	4-1/2	6
Spacing (s)/Edge Distance (c), in.																								
7/8	0.75			0.60			0.17			0.45														
1	0.76			0.63			0.20			0.47														
1-1/8	0.78			0.66			0.23			0.49			0.75			0.60			0.17			0.45		
1-11/16	0.83	0.75		0.79	0.60		0.36	0.17		0.58	0.45		0.80			0.70			0.27			0.52		
2	0.86	0.77		0.86	0.64		0.44	0.22		0.63	0.48		0.82			0.76			0.33			0.56		
2-1/4	0.88	0.78	0.75	0.91	0.67	0.60	0.50	0.26	0.17	0.67	0.51	0.45	0.84	0.75		0.80	0.60		0.38	0.17		0.59	0.45	
2-1/2	0.91	0.79	0.76	0.97	0.70	0.62	0.56	0.30	0.20	0.70	0.54	0.47	0.86	0.76		0.84	0.62		0.42	0.20		0.62	0.47	
2-5/8	0.92	0.80	0.77	1.00	0.71	0.63	0.59	0.32	0.22	0.72	0.55	0.48	0.87	0.77		0.87	0.63		0.45	0.22		0.63	0.48	
3	0.95	0.82	0.78		0.76	0.67	0.67	0.39	0.26	0.78	0.59	0.51	0.90	0.78	0.75	0.93	0.67	0.60	0.52	0.26	0.17	0.68	0.51	0.45
3-3/8	1.00	0.84	0.79		0.80	0.70	0.76	0.45	0.31	0.84	0.63	0.54	0.92	0.79	0.76	1.00	0.70	0.63	0.59	0.31	0.20	0.72	0.54	0.47
4		0.87	0.82		0.87	0.76	0.91	0.55	0.39	0.94	0.70	0.59	0.97	0.82	0.78		0.76	0.67	0.70	0.39	0.26	0.80	0.59	0.51
4-3/8		0.88	0.83		0.92	0.79	1.00	0.61	0.43	1.00	0.74	0.62	1.00	0.83	0.79		0.79	0.69	0.77	0.43	0.30	0.85	0.62	0.53
5		0.91	0.85		0.99	0.84		0.71	0.51		0.81	0.67		0.85	0.81		0.84	0.73	0.88	0.51	0.35	0.92	0.67	0.57
5-1/16		0.92	0.86		1.00	0.85		0.72	0.52		0.82	0.68		0.86	0.81		0.85	0.74	0.90	0.52	0.36	0.93	0.68	0.58
5-1/4		0.93	0.86			0.87		0.75	0.54		0.84	0.69		0.86	0.81		0.87	0.75	0.93	0.54	0.38	0.95	0.69	0.59
5-5/8		0.95	0.88			0.90		0.82	0.59		0.88	0.72		0.88	0.82		0.90	0.78	1.00	0.59	0.41	1.00	0.72	0.61
6		0.96	0.89			0.93		0.88	0.63		0.92	0.76		0.89	0.84		0.93	0.80		0.63	0.45		0.76	0.63
6-3/4		1.00	0.92			1.00		1.00	0.72		1.00	0.82		0.92	0.86		1.00	0.85		0.72	0.52		0.82	0.68
7			0.93						0.75			0.84		0.93	0.86			0.87		0.75	0.54		0.84	0.69
8			0.96						0.88			0.92		0.96	0.89			0.93		0.88	0.63		0.92	0.76
8-1/2			0.98						0.94			0.96		0.98	0.90			0.97		0.94	0.68		0.96	0.79
9			1.00						1.00			1.00		1.00	0.92			1.00		1.00	0.72		1.00	0.82
10															0.95						0.82			0.88
11															0.97						0.91			0.94
12															1.00						1.00			1.00

Note:

Tables apply for listed embedment depths. Reduction factors for other embedment depths must be calculated using equations below.

Spacing
for $s_{cr} > s > s_{min}$
Tension and Shear
$s_{min} = 0.5\ h_{ef}$, $s_{cr} = 2.0\ h_{ef}$
$f_{AN} = 0.165\ (s/h_{ef}) + 0.67$

Edge Distance	
for $c_{cr} > c > c_{min}$	
Tension	
$c_{min} = 0.5\ h_{ef}$, $c_{cr} = 1.5\ h_{ef}$	
$f_{RN} = 0.40\ (c/h_{ef}) + 0.4$	
Shear, where $h_{ef} < 9.0 \times d$[1]	
$c_{min} = 0.5\ h_{ef}$, $c_{cr} = 2.5\ h_{ef}$	
⊥ toward edge	**II or away from edge**
$f_{RV1} = 0.415\ (c/h_{ef}) - 0.0375$	$f_{RV2} = 0.275\ (c/h_{ef}) + 0.312$
Shear, where $h_{ef} \geq 9.0 \times d$[1]	
$c_{min} = 0.5\ h_{ef}$, $c_{cr} = 2.0\ h_{ef}$	
⊥ toward edge	**II or away from edge**
$f_{RV1} = 0.554\ (c/h_{ef}) - 0.107$	$f_{RV2} = 0.366\ (c/h_{ef}) + 0.267$

1 d = nominal bolt diameter

4.2.4 HIT-HY 150 MAX Adhesive Anchoring System

Anchor Spacing and Edge Distance Guidelines in Concrete for HIT-HY 150 MAX

Load Adjustment Factors for 5/8" and 3/4" Diameter Anchors

Anchor Diameter		5/8" diameter												3/4" diameter											
Adjustment Factor		Spacing Tension/Shear f_A			Edge Distance Tension f_{RN}			Edge Distance Shear, f_{RV1} (⊥ toward edge)			Edge Distance Shear f_{RV2} (II to or away from edge)			Spacing Tension/Shear f_A			Edge Distance Tension f_{RN}			Edge Distance Shear f_{RV1} (⊥ toward edge)			Edge Distance Shear, f_{RV2} (II to or away from edge)		
Embedment Depth, in.		2-7/8	5-5/8	7-1/2	2-7/8	5-5/8	7-1/2	2-7/8	5-5/8	7-1/2	2-7/8	5-5/8	7-1/2	3-3/8	6-3/4	9	3-3/8	6-3/4	9	3-3/8	6-3/4	9	3-3/8	6-3/4	9
Spacing (s)/Edge Distance (c), in.	1-7/16	0.75			0.60			0.17			0.45														
	1-11/16	0.77			0.63			0.21			0.47			0.75			0.60			0.17			0.45		
	2	0.78			0.68			0.25			0.50			0.77			0.64			0.21			0.47		
	2-1/4	0.80			0.71			0.29			0.53			0.79			0.67			0.24			0.50		
	2-1/2	0.81			0.75			0.32			0.55			0.80			0.70			0.27			0.52		
	2-13/16	0.83	0.75		0.79	0.60		0.37	0.17		0.58	0.45		0.81			0.73			0.31			0.54		
	3	0.84	0.76		0.82	0.61		0.40	0.19		0.60	0.46		0.82			0.76			0.33			0.56		
	3-3/8	0.86	0.77		0.87	0.64		0.45	0.23		0.63	0.49		0.84	0.75		0.80	0.60		0.38	0.17		0.59	0.45	
	3-3/4	0.89	0.78	0.75	0.92	0.67	0.60	0.50	0.26	0.17	0.67	0.51	0.45	0.86	0.76		0.84	0.62		0.42	0.20		0.62	0.47	
	4-5/16	0.92	0.80	0.76	1.00	0.71	0.63	0.59	0.32	0.21	0.72	0.55	0.48	0.89	0.78		0.91	0.66		0.49	0.25		0.66	0.50	
	4-1/2	0.93	0.80	0.77		0.72	0.64	0.61	0.34	0.23	0.74	0.56	0.49	0.90	0.78	0.75	0.93	0.67	0.60	0.52	0.26	0.17	0.68	0.51	0.45
	4-3/4	0.94	0.81	0.77		0.74	0.65	0.65	0.36	0.24	0.77	0.58	0.50	0.91	0.79	0.76	0.96	0.68	0.61	0.55	0.28	0.19	0.70	0.52	0.46
	5-1/16	0.96	0.82	0.78		0.76	0.67	0.69	0.39	0.27	0.80	0.60	0.51	0.92	0.79	0.76	1.00	0.70	0.63	0.59	0.31	0.20	0.72	0.54	0.47
	5-3/4	1.00	0.84	0.80		0.81	0.71	0.79	0.46	0.32	0.86	0.64	0.55	0.96	0.81	0.78		0.74	0.66	0.67	0.36	0.25	0.78	0.58	0.50
	6-3/4		0.87	0.82		0.88	0.76	0.94	0.56	0.39	0.96	0.71	0.60	1.00	0.84	0.79		0.80	0.70	0.79	0.45	0.31	0.86	0.63	0.54
	7-3/16		0.88	0.83		0.91	0.78	1.00	0.60	0.42	1.00	0.73	0.62		0.85	0.80		0.83	0.72	0.85	0.48	0.34	0.90	0.66	0.56
	7-1/2		0.89	0.84		0.93	0.80		0.63	0.45		0.76	0.63		0.85	0.81		0.84	0.73	0.88	0.51	0.35	0.92	0.67	0.57
	8		0.90	0.85		0.97	0.83		0.68	0.48		0.79	0.66		0.87	0.82		0.87	0.76	0.95	0.55	0.39	0.96	0.70	0.59
	8-7/16		0.92	0.86		1.00	0.85		0.72	0.52		0.82	0.68		0.88	0.82		0.90	0.78	1.00	0.59	0.41	1.00	0.72	0.61
	9		0.93	0.87			0.88		0.78	0.56		0.85	0.71		0.89	0.84		0.93	0.80		0.63	0.45		0.76	0.63
	10-1/8		0.97	0.89			0.94		0.89	0.64		0.93	0.76		0.92	0.86		1.00	0.85		0.72	0.52		0.82	0.68
	11-1/4		1.00	0.92			1.00		1.00	0.72		1.00	0.82		0.95	0.88			0.90		0.82	0.59		0.88	0.72
	12			0.93						0.78			0.85		0.96	0.89			0.93		0.88	0.63		0.92	0.72
	13			0.96						0.85			0.90		0.99	0.91			0.98		0.96	0.69		0.97	0.80
	13-1/2			0.97						0.89			0.93		1.00	0.92			1.00		1.00	0.72		1.00	0.82
	14			0.98						0.93			0.95			0.93						0.75			0.84
	15			1.00						1.00			1.00			0.95						0.82			0.88
	16															0.96						0.88			0.92
	18															1.00						1.00			1.00

Note:

Tables apply for listed embedment depths. Reduction factors for other embedment depths must be calculated using equations below.

Spacing
for $s_{cr} > s > s_{min}$
Tension and Shear
$s_{min} = 0.5\ h_{ef}$, $s_{cr} = 2.0\ h_{ef}$
$f_{AN} = 0.165\ (s/h_{ef}) + 0.67$

Edge Distance	
for $c_{cr} > c > c_{min}$	
Tension	
$c_{min} = 0.5\ h_{ef}$, $c_{cr} = 1.5\ h_{ef}$	
$f_{RN} = 0.40\ (c/h_{ef}) + 0.4$	
Shear, where $h_{ef} < 9.0 \times d$[1]	
$c_{min} = 0.5\ h_{ef}$, $c_{cr} = 2.5\ h_{ef}$	
⊥ toward edge	**II or away from edge**
$f_{RV1} = 0.415\ (c/h_{ef}) - 0.0375$	$f_{RV2} = 0.275\ (c/h_{ef}) + 0.312$
Shear, where $h_{ef} \geq 9.0 \times d$[1]	
$c_{min} = 0.5\ h_{ef}$, $c_{cr} = 2.0\ h_{ef}$	
⊥ toward edge	**II or away from edge**
$f_{RV1} = 0.554\ (c/h_{ef}) - 0.107$	$f_{RV2} = 0.366\ (c/h_{ef}) + 0.267$

1 d = nominal bolt diameter

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HIT-HY 150 MAX Adhesive Anchoring System 4.2.4

Anchor Spacing and Edge Distance Guidelines in Concrete for HIT-HY 150 MAX

Load Adjustment Factors for 7/8" Diameter Anchors													
Anchor Diameter		7/8" diameter											
Adjustment Factor		Spacing Tension/Shear f_A			Edge Distance Tension f_{RN}			Edge Distance Shear, f_{RV1} (⊥ toward edge)			Edge Distance Shear, f_{RV2} (II to or away from edge)		
Embedment Depth, in.		4	7-7/8	10-1/2	4	7-7/8	10-1/2	4	7-7/8	10-1/2	4	7-7/8	10-1/2
Spacing (s)/Edge Distance (c), in.	2	0.75			0.60			0.17			0.45		
	2-1/4	0.76			0.63			0.20			0.47		
	2-1/2	0.77			0.65			0.22			0.48		
	3	0.79			0.70			0.27			0.52		
	3-1/2	0.81			0.75			0.33			0.55		
	3-15/16	0.83	0.75		0.79	0.60		0.37	0.17		0.58	0.45	
	4-1/2	0.86	0.76		0.85	0.63		0.43	0.21		0.62	0.48	
	4-3/4	0.87	0.77		0.88	0.64		0.46	0.23		0.64	0.49	
	5	0.88	0.77		0.90	0.65		0.48	0.24		0.66	0.50	
	5-1/4	0.89	0.78	0.75	0.93	0.67	0.60	0.51	0.26	0.17	0.67	0.51	0.45
	6	0.92	0.80	0.76	1.00	0.70	0.63	0.59	0.32	0.21	0.72	0.55	0.48
	6-3/4	0.95	0.81	0.78		0.74	0.66	0.66	0.37	0.25	0.78	0.58	0.50
	7-1/2	0.98	0.83	0.79		0.78	0.69	0.74	0.42	0.29	0.83	0.62	0.53
	8	1.00	0.84	0.80		0.81	0.70	0.79	0.46	0.32	0.86	0.64	0.55
	8-1/2		0.85	0.80		0.83	0.72	0.84	0.49	0.34	0.90	0.66	0.56
	9		0.86	0.81		0.86	0.74	0.90	0.53	0.37	0.93	0.69	0.58
	10		0.88	0.83		0.91	0.78	1.00	0.60	0.42	1.00	0.73	0.62
	11		0.90	0.84		0.96	0.82		0.67	0.47		0.78	0.65
	11-1/2		0.91	0.85		0.98	0.84		0.70	0.50		0.80	0.67
	11-13/16		0.92	0.86		1.00	0.85		0.72	0.52		0.82	0.68
	12		0.92	0.86			0.86		0.74	0.53		0.82	0.69
	13		0.94	0.87			0.90		0.81	0.58		0.87	0.72
	14		0.96	0.89			0.93		0.88	0.63		0.92	0.76
	15		0.98	0.91			0.97		0.95	0.68		0.96	0.79
	15-3/4		1.00	0.92			1.00		1.00	0.72		1.00	0.82
	18			0.95						0.84			0.89
	20			0.98						0.95			0.96
	21			1.00						1.00			1.00

Note:

Tables apply for listed embedment depths. Reduction factors for other embedment depths must be calculated using equations below.

Spacing
for $s_{cr} > s > s_{min}$
Tension and Shear
$s_{min} = 0.5\ h_{ef}$, $s_{cr} = 2.0\ h_{ef}$
$f_{AN} = 0.165\ (s/h_{ef}) + 0.67$

Edge Distance	
for $c_{cr} > c > c_{min}$	
Tension	
$c_{min} = 0.5\ h_{ef}$, $c_{cr} = 1.5\ h_{ef}$	
$f_{RN} = 0.40\ (c/h_{ef}) + 0.4$	
Shear, where $h_{ef} < 9.0 \times d$[1]	
$c_{min} = 0.5\ h_{ef}$, $c_{cr} = 2.5\ h_{ef}$	
⊥ toward edge	**II or away from edge**
$f_{RV1} = 0.415\ (c/h_{ef}) - 0.0375$	$f_{RV2} = 0.275\ (c/h_{ef}) + 0.312$
Shear, where $h_{ef} \geq 9.0 \times d$[1]	
$c_{min} = 0.5\ h_{ef}$, $c_{cr} = 2.0\ h_{ef}$	
⊥ toward edge	**II or away from edge**
$f_{RV1} = 0.554\ (c/h_{ef}) - 0.107$	$f_{RV2} = 0.366\ (c/h_{ef}) + 0.267$

1 d = nominal bolt diameter

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4.2.4 HIT-HY 150 MAX Adhesive Anchoring System

Anchor Spacing and Edge Distance Guidelines in Concrete for HIT-HY 150 MAX

Load Adjustment Factors for 1" and 1-1/4" Diameter Anchors

Anchor Diameter		1" diameter												1-1/4" diameter											
Adjustment Factor		Spacing Tension/Shear, f_A			Edge Distance Tension f_{RN}			Edge Distance Shear, f_{RV1} (⊥ toward edge)			Edge Distance Shear, f_{RV2} (II to or away from edge)			Spacing Tension/Shear f_A			Edge Distance Tension f_{RN}			Edge Distance Shear, f_{RV1} (⊥ toward edge)			Edge Distance Shear, f_{RV2} (II to or away from edge)		
Embedment Depth, in.		4-1/2	9	12	4-1/2	9	12	4-1/2	9	12	4-1/2	9	12	5-5/8	11-1/4	15	5-5/8	11-1/4	15	5-5/8	11-1/4	15	5-5/8	11-1/4	15
Spacing (s)/Edge Distance (c), in.	2-1/4	0.75			0.60			0.17			0.45														
	2-1/2	0.76			0.62			0.19			0.46														
	2-13/16	0.77			0.65			0.22			0.48			0.75			0.60			0.17			0.45		
	3	0.78			0.67			0.24			0.50			0.76			0.61			0.18			0.46		
	3-1/2	0.80			0.71			0.29			0.53			0.78			0.65			0.22			0.48		
	4	0.82			0.76			0.33			0.56			0.79			0.68			0.26			0.51		
	4-1/2	0.84	0.75		0.80	0.60		0.38	0.17		0.59	0.45		0.81			0.72			0.29			0.53		
	5	0.85	0.76		0.84	0.62		0.42	0.20		0.62	0.47		0.82			0.76			0.33			0.56		
	5-5/8	0.88	0.77		0.90	0.65		0.48	0.24		0.66	0.50		0.84	0.75		0.80	0.60		0.38	0.17		0.59	0.45	
	6	0.89	0.78	0.75	0.93	0.67	0.60	0.52	0.26	0.17	0.68	0.51	0.45	0.85	0.76		0.83	0.61		0.41	0.19		0.61	0.46	
	6-3/4	0.92	0.79	0.76	1.00	0.70	0.63	0.59	0.31	0.20	0.72	0.54	0.47	0.87	0.77		0.88	0.64		0.46	0.23		0.64	0.49	
	7-1/2	0.95	0.81	0.77		0.73	0.65	0.65	0.35	0.24	0.77	0.57	0.50	0.90	0.78	0.75	0.93	0.67	0.60	0.52	0.26	0.17	0.68	0.51	0.45
	8	0.96	0.82	0.78		0.76	0.67	0.70	0.39	0.26	0.80	0.59	0.51	0.91	0.79	0.76	0.97	0.68	0.61	0.55	0.29	0.19	0.70	0.53	0.46
	8-7/16	0.98	0.82	0.79		0.78	0.68	0.74	0.41	0.28	0.83	0.61	0.52	0.92	0.79	0.76	1.00	0.70	0.63	0.59	0.31	0.20	0.72	0.54	0.47
	9	1.00	0.84	0.79		0.80	0.70	0.79	0.45	0.31	0.86	0.63	0.54	0.94	0.80	0.77		0.72	0.64	0.63	0.34	0.23	0.75	0.56	0.49
	10		0.85	0.81		0.84	0.73	0.88	0.51	0.35	0.92	0.67	0.57	0.97	0.82	0.78		0.76	0.67	0.70	0.39	0.26	0.80	0.59	0.51
	11-1/4		0.88	0.82		0.90	0.78	1.00	0.59	0.41	1.00	0.72	0.61	1.00	0.84	0.79		0.80	0.70	0.79	0.45	0.31	0.86	0.63	0.54
	12		0.89	0.84		0.93	0.80		0.63	0.45		0.76	0.63		0.85	0.80		0.83	0.72	0.85	0.48	0.34	0.90	0.66	0.56
	13		0.91	0.85		0.98	0.83		0.69	0.49		0.80	0.66		0.86	0.81		0.86	0.75	0.92	0.53	0.37	0.95	0.69	0.58
	13-1/2		0.92	0.86		1.00	0.85		0.72	0.52		0.82	0.68		0.87	0.82		0.88	0.76	0.96	0.56	0.39	0.97	0.71	0.60
	14-1/16		0.93	0.86			0.87		0.76	0.54		0.84	0.70		0.88	0.82		0.90	0.78	1.00	0.59	0.41	1.00	0.72	0.61
	16		0.96	0.89			0.93		0.88	0.63		0.92	0.76		0.90	0.85		0.97	0.83		0.68	0.48		0.79	0.66
	16-7/8		0.98	0.90			0.96		0.93	0.67		0.95	0.78		0.92	0.86		1.00	0.85		0.72	0.52		0.82	0.68
	18		1.00	0.92			1.00		1.00	0.72		1.00	0.82		0.93	0.87			0.88		0.78	0.56		0.85	0.71
	20			0.95						0.82			0.88		0.96	0.89			0.93		0.88	0.63		0.92	0.76
	22			0.97						0.91			0.94		0.99	0.91			0.99		0.98	0.71		0.98	0.80
	22-1/2			0.98						0.93			0.95		1.00	0.92			1.00		1.00	0.72		1.00	0.82
	24			1.00						1.00			1.00			0.93						0.78			0.85
	26															0.96						0.85			0.90
	28															0.98						0.93			0.95
	30															1.00						1.00			1.00

Note:

Tables apply for listed embedment depths. Reduction factors for other embedment depths must be calculated using equations below.

Spacing
for $s_{cr} > s > s_{min}$
Tension and Shear
$s_{min} = 0.5\ h_{ef}$, $s_{cr} = 2.0\ h_{ef}$
$f_{AN} = 0.165\ (s/h_{ef}) + 0.67$

Edge Distance	
for $c_{cr} > c > c_{min}$	
Tension	
$c_{min} = 0.5\ h_{ef}$, $c_{cr} = 1.5\ h_{ef}$	
$f_{RN} = 0.40\ (c/h_{ef}) + 0.4$	
Shear, where $h_{ef} < 9.0 \times d$[1]	
$c_{min} = 0.5\ h_{ef}$, $c_{cr} = 2.5\ h_{ef}$	
⊥ toward edge	**II or away from edge**
$f_{RV1} = 0.415\ (c/h_{ef}) - 0.0375$	$f_{RV2} = 0.275\ (c/h_{ef}) + 0.312$
Shear, where $h_{ef} \geq 9.0 \times d$[1]	
$c_{min} = 0.5\ h_{ef}$, $c_{cr} = 2.0\ h_{ef}$	
⊥ toward edge	**II or away from edge**
$f_{RV1} = 0.554\ (c/h_{ef}) - 0.107$	$f_{RV2} = 0.366\ (c/h_{ef}) + 0.267$

1 d = nominal bolt diameter

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HIT-HY 150 MAX Adhesive Anchoring System 4.2.4

Anchor Spacing and Edge Distance Guidelines in Concrete for HIT-TZ and HIT-RTZ Threaded Rods

Load Adjustment Factors for 3/8" and 1/2" Diameter Anchors									
Anchor Diameter		3/8" diameter				1/2" diameter			
Adjustment Factor		Spacing Tension/Shear f_A	Edge Distance Tension f_{RN}	Edge Distance Shear, f_{RV1} (⊥ toward edge)	Edge Distance Shear, f_{RV2} (‖ to or away from edge)	Spacing Tension f_{AN}	Edge Distance Tension f_{RN}	Edge Distance Shear, f_{RV1} (⊥ toward edge)	Edge Distance Shear f_{RV2} (‖ to or away from edge)
Embedment Depth, in.		2-7/8	2-7/8	2-7/8	2-7/8	3-1/2	3-1/2	3-1/2	3-1/2
Spacing (s)/Edge Distance (c), in.	2	0.77	0.63	0.25	0.53				
	2-7/16	0.79	0.68	0.35	0.59	0.77	0.63	0.25	0.53
	3	0.81	0.74	0.46	0.67	0.79	0.68	0.35	0.59
	3-3/8	0.83	0.78	0.55	0.72	0.80	0.71	0.42	0.63
	4	0.86	0.84	0.68	0.80	0.83	0.77	0.53	0.70
	4-3/8	0.87	0.88	0.76	0.85	0.84	0.80	0.59	0.75
	5	0.90	0.95	0.90	0.94	0.86	0.85	0.71	0.82
	5-1/4	0.91	0.98	0.95	0.97	0.87	0.88	0.75	0.84
	5-7/16	0.92	1.00	1.00	1.00	0.88	0.89	0.79	0.87
	6	0.95				0.90	0.94	0.88	0.93
	6-11/16	0.98				0.92	1.00	1.00	1.00
	7	0.99				0.94			
	7-3/16	1.00				0.94			
	8-1/2					0.99			
	8-3/4					1.00			

Note:

Tables apply for listed embedment depths. Reduction factors for other embedment depths must be calculated using equations below.

Spacing
for $s_{cr} > s > s_{min}$
Tension and Shear
$s_{min} = 0.7\ h_{ef}$, $s_{cr} = 2.5\ h_{ef}$
$f_A = 0.128\ (s/h_{ef}) + 0.68$

Edge Distance	
for $c_{cr} > c > c_{min}$	
Tension	
$c_{min} = 0.7\ h_{ef}$, $c_{cr} = 1.9\ h_{ef}$	
$f_{RN} = 0.308\ (c/h_{ef}) + 0.414$	
Shear	
$c_{min} = 0.7\ h_{ef}$, $c_{cr} = 1.9\ h_{ef}$	
⊥ toward edge	**‖ or away from edge**
$f_{RV1} = 0.625\ (c/h_{ef}) - 0.1875$	$f_{RV2} = 0.392\ (c/h_{ef}) + 0.256$

4.2.4 HIT-HY 150 MAX Adhesive Anchoring System

Anchor Spacing and Edge Distance Guidelines in Concrete for HIT-TZ and HIT-RTZ Threaded Rods

Load Adjustment Factors for 5/8" and 3/4" Diameter Anchors									
Anchor Diameter		5/8" diameter				3/4" diameter			
Adjustment Factor		Spacing Tension/Shear f_A	Edge Distance Tension f_{RN}	Edge Distance Shear, f_{RV1} (⊥ toward edge)	Edge Distance Shear, f_{RV2} (II to or away from edge)	Spacing Tension f_{AN}	Edge Distance Tension f_{RN}	Edge Distance Shear, f_{RV1} (⊥ toward edge)	Edge Distance Shear, f_{RV2} (II to or away from edge)
Embedment Depth, in		4	4	4	4	5-1/4	5-1/4	5-1/4	5-1/4
Spacing (s)/Edge Distance (c), in.	2-13/16	0.77	0.63	0.25	0.53				
	3	0.78	0.65	0.28	0.55				
	3-11/16	0.80	0.70	0.39	0.62	0.77	0.63	0.25	0.53
	4-5/16	0.82	0.75	0.49	0.68	0.79	0.67	0.33	0.58
	4-1/2	0.82	0.76	0.52	0.70	0.79	0.68	0.35	0.59
	4-3/4	0.83	0.78	0.55	0.72	0.80	0.69	0.38	0.61
	5	0.84	0.80	0.60	0.75	0.80	0.71	0.42	0.63
	5-3/4	0.86	0.86	0.71	0.82	0.82	0.75	0.50	0.69
	6-3/4	0.90	0.93	0.87	0.92	0.84	0.81	0.62	0.76
	7-3/16	0.91	0.97	0.94	0.96	0.86	0.84	0.67	0.79
	7-5/8	0.92	1.00	1.00	1.00	0.87	0.86	0.72	0.82
	8	0.94				0.88	0.88	0.76	0.85
	8-7/16	0.95				0.89	0.91	0.82	0.89
	9	0.97				0.90	0.94	0.88	0.93
	10	1.00				0.92	1.00	1.00	1.00
	11-1/4					0.95			
	12					0.97			
	13-1/8					1.00			

Note:
Tables apply for listed embedment depths. Reduction factors for other embedment depths must be calculated using equations below.

Spacing
for $s_{cr}>s>s_{min}$
Tension and Shear
$s_{min} = 0.7\ h_{ef}$, $s_{cr} = 2.5\ h_{ef}$
$f_A = 0.128\ (s/h_{ef}) + 0.68$

Edge Distance	
for $c_{cr}>c>c_{min}$	
Tension	
$c_{min} = 0.7\ h_{ef}$, $c_{cr} = 1.9\ h_{ef}$	
$f_{RN} = 0.308\ (c/h_{ef}) + 0.414$	
Shear	
$c_{min} = 0.7\ h_{ef}$, $c_{cr} = 1.9\ h_{ef}$	
⊥ toward edge	**II or away from edge**
$f_{RV1} = 0.625\ (c/h_{ef}) - 0.1875$	$f_{RV2} = 0.392\ (c/h_{ef}) + 0.256$

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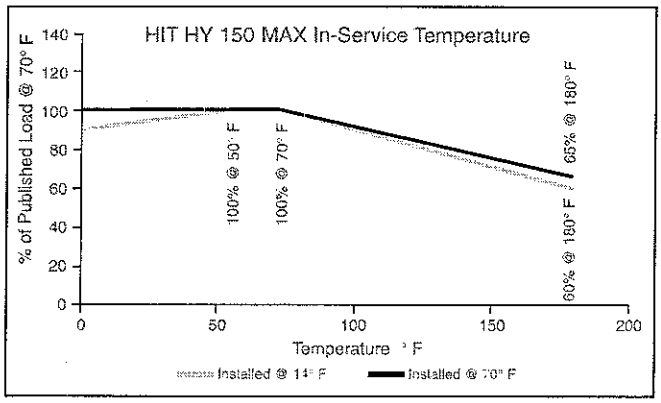
HIT-HY 150 MAX Adhesive Anchoring System 4.2.4

Resistance of HIT-HY 150 MAX to Chemicals

Chemical		Behavior
Sulphuric acid	conc	–
	30%	•
	10%	+
Hydrochloric acid	conc.	•
	10%	+
Nitric acid	conc	–
	10%	•
Phosphoric acid	conc.	+
	10%	+
Acetic acid	conc	•
	10%	+
Formic acid	conc.	–
	10%	•
Lactic acid	conc.	+
	10%	+
Citric acid	10%	+
Sodium Hydroxide	40%	•
(Caustic soda)	20%	+
	5%	+
Ammonia	conc	•
	5%	+
Soda solution	10%	+
Common salt solution	10%	+
Chlorinated lime solution	10%	+
Sodium hypochlorite	2%	+
Hydrogen peroxide	10%	+
Carbolic acid solution	10%	–
Ethanol		–
Sea water		+
Glycol		+
Acetone		–
Carbon tetrachloride		–
Toluene		+
Petrol/Gasoline		•
Machine oil		•
Diesel oil		•

Key: – non-resistant + resistant • limited resistance



Samples of the HIT-HY 150 MAX resin were immersed in the various chemical compounds for up to one year. At the time of the test period, the samples were analyzed. Any samples showing no visible damage and having less than a 25% reduction in bending (flexural) strength were classified as **"Resistant."** Samples that had slight damage, such as small cracks, chips, etc. or reduction in bending strength of 25% or more, were classified as **"Partially Resistant."** Samples that were heavily damaged or destroyed were classified as **"Not Resistant."**

Note: In actual use, the majority of the resin is encased in the base material, leaving very little surface area exposed. In some cases, this would allow the HIT-HY 150 MAX to be used where it would be exposed to the **"Partially Resistant"** chemical compounds.

Open Gel Time (Approximate)[1, 2]

Base Material Temperature		Approximate Gel Time
°F	°C	
14	-10	100 min
23	-5	40 min
32	0	20 min
50	10	8 min
68	20	6 min
86	30	3 min
104	40	2 min

Final Cure Time (Approximate)[1, 2]

Base Material Temperature		Approximate Cure Time
°F	°C	
14	-10	12 hrs
23	-5	4 hrs
32	0	2 hrs
50	10	1 hr
68	20	30 min
86	30	30 min
104	40	30 min

1 The temperature of the HIT-HY 150 MAX adhesive must be between 32°F (0°C) and 104°F (40°C) at the time of installation

2 Use of HIT-HY 150 MAX with HIT-TZ rods must be installed in base material temperatures ≥ 40°F (5°C).

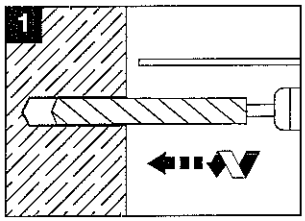
Note: Test procedure involves the concrete being held at the elevated temperature for 24 hours then removing it from the controlled environment and testing to failure.

Long term creep test in accordance with AC58 is available; please contact Hilti Technical Services.

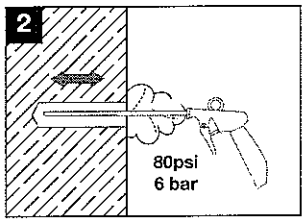
4.2.4 HIT-HY 150 MAX Adhesive Anchoring System

4.2.4.4 Installation Instructions

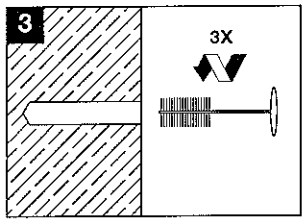
HAS Rod, Rebar and Insert Installation Instructions



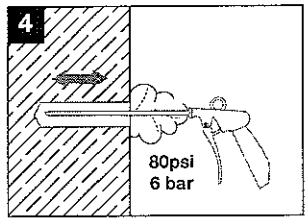
1 Drill anchor hole with a carbide bit.



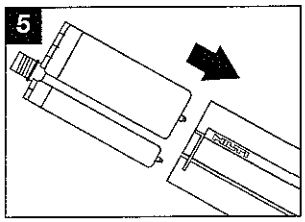
2 Insert air nozzle to bottom of hole and blow out all dust and debris from the hole usin compressed air.*



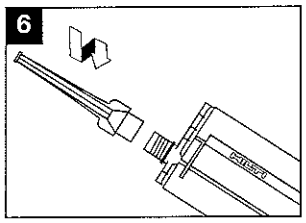
3 Clean hole with wire brush. Proper hole cleaning is essential



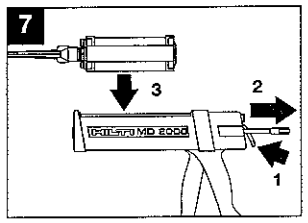
4 Insert air nozzle to bottom of hole and blow out all dust and debris from the hole using compressed air.



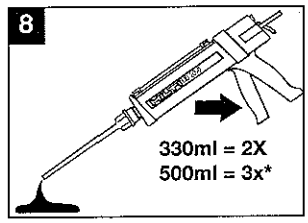
5 Put foil pack into foil pack holder. Remove cap covering threaded projection



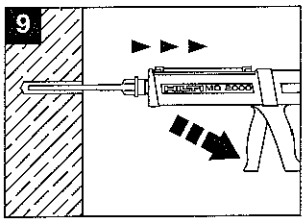
6. Screw on static mixer.



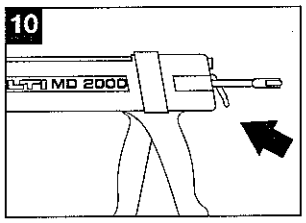
7 Put holder/ foil pack into appropriate dispenser.



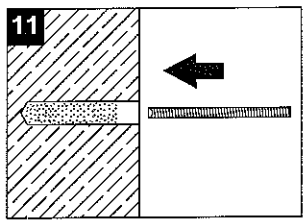
8. Discard first trigger pulls of adhesive from each foil pack. *Below 41°F (5°C) discard four trigger pulls



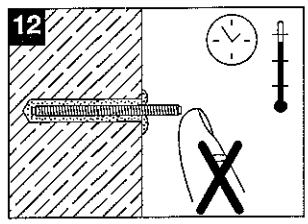
9 Inject adhesive into hole without forming air pockets starting at the bottom until 1/2 to 2/3 full. Use mixer filler tube extensions when needed to reach the hole bottom.



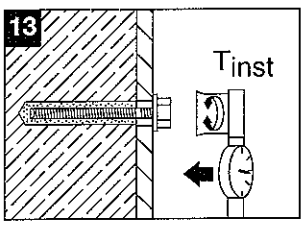
10. After injecting adhesive depressurize the dispenser by pressing the release button



11. Insert rod, insert or rebar Twist during installation. Fastener may be adjusted during specified gel time



12 Do not disturb anchor between specified gel time and cure time



13. Apply specified torque as required to secure items to be fastened. Do not exceed maximum torque specified

* For holes with standing water, holes must be flushed clean with water, brushed with a wire brush and again flushed clean with water or other means removing any debris or slurry in the hole. Standing water must be removed prior to performing the remainder of anchor installation

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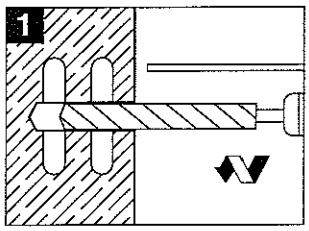
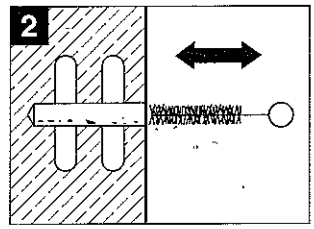
HIT-HY 150 MAX Adhesive Anchoring System 4.2.4

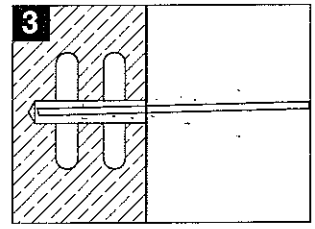
HIT-I Inserts and HIT-A Rods into Hollow Brick, Hollow Block or Tile



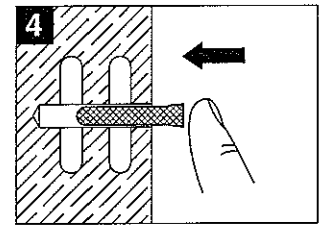
1. Select the proper bit. Set the depth gauge, drill the hole, rotation only. Hilti URM bits are recommended for drilling into masonry.



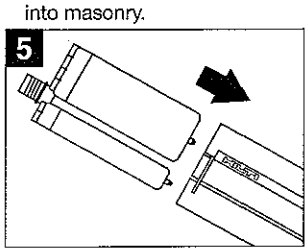
2. Proper hole cleaning is essential. Use a nylon brush to remove loose material. Do not use brushes with metal bristles.



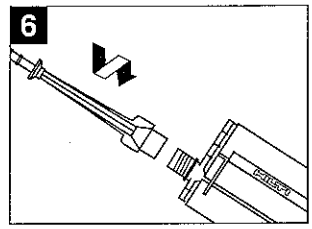
3. Use compressed air to blow out the hole from the bottom The Hilti air nozzle is designed for hole cleaning.



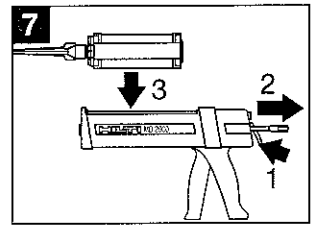
4. Insert specified HIT-S type screen tube into hole



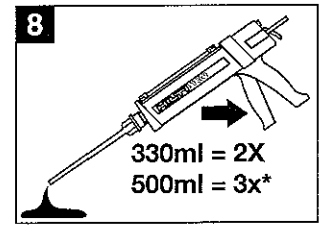
5 Insert refill pack into holder.



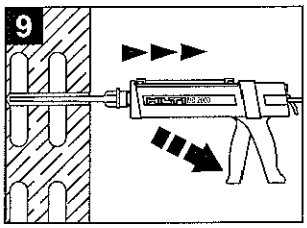
6 Screw on mixing nozzle with extension.



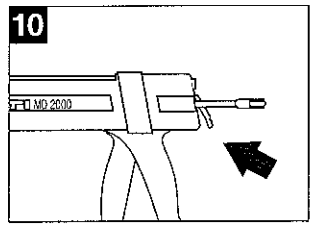
7. Put holder into dispenser.



8 Discard first two trigger pulls of adhesive from each foil pack. *Below 41°F (5°C) discard four trigger pulls.



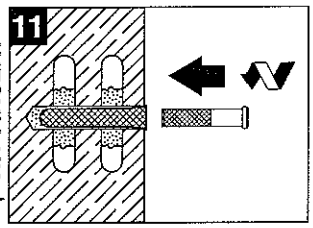
9. Fill HIT-S type screen tube completely from back to front edge of screen using the minimum number of trigger pulls listed in table.



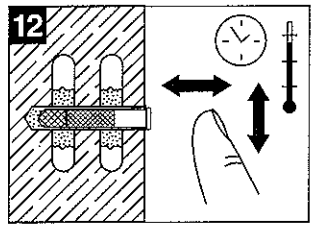
10 Unlock dispenser

The minimum number of trigger pulls to fill each screen is as follows:	
S12	1 pump
S16/2	4 pumps
S16	6 pumps
S22/2	4 pumps
S22	6 pumps

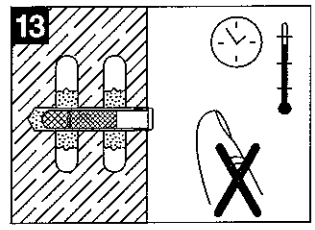
HIT-I INSERT



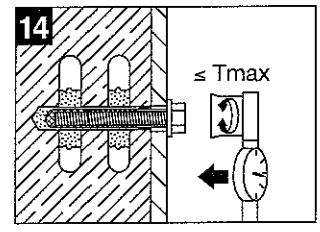
11 Insert HIT-I Insert, or HIT-A Rod into adhesive-filled screen, twisting slightly



12. Fastener may be adjusted during specified gel time



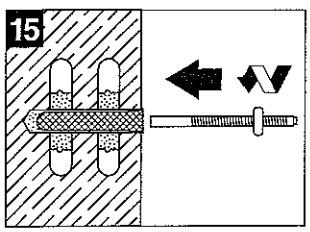
13 Do not disturb fastener between specified gel and cure time

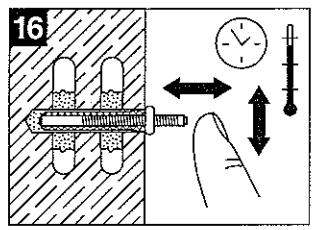


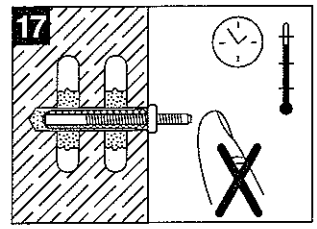
14. Apply torque to anchor. Do not exceed maximum recommended torque.

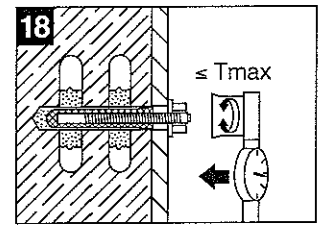
OR

HIT-A ROD









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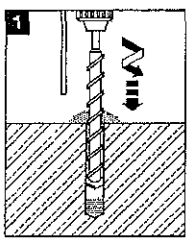
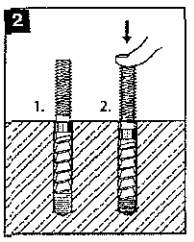
4.2.4 HIT-HY 150 MAX Adhesive Anchoring System

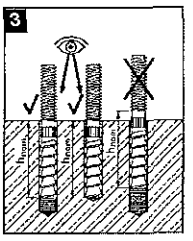
HIT-TZ and HIT-RTZ Installation Instructions

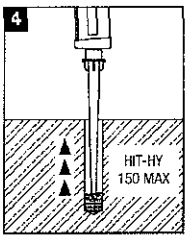


Drill hole using a roto-hammer or Hilti diamond coring machine

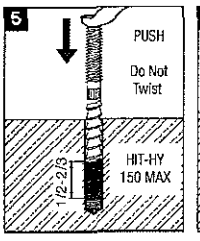


Push the HT-TZ in the hole to verify sufficient hole depth (only threads visible). For floor applications pushing the rod compacts the drill dust

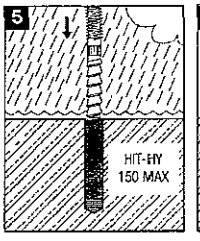


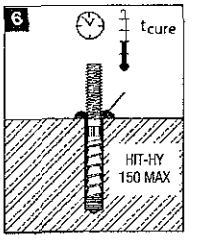


Inject adhesive starting from the bottom of the hole.



Fill the hole 1/2 to 2/3 full If the hole is full of water, it is suggested to start injecting from the bottom of the hole and fill entirely with adhesive





Do not adjust the HIT-TZ rod between the gel and cure times. Apply a load only after the appropriate cure time has elapsed

HIT-HY 150 MAX Volume Charts

Threaded Rod and HIT-TZ Rod Installation

Rod Diameter (in.)	Drill Bit[1] Diameter (in.)	Adhesive Volume Required per Inch of embedment (in^3)
1/4	5/16	0.055
3/8	7/16	0.095
1/2	9/16	0.133
5/8	3/4	0.261
3/4	7/8	0.326
7/8	1	0.391
1	1 1/8	0.478
1-1/4	1 3/8	0.626

Rebar Installation

Rod Diameter (in.)	Drill Bit[1] Diameter (in.)	Adhesive Volume Required per Inch of embedment (in^3)
#3 or 3/8	1/2	0.110
#4 or 1/2	5/8	0.146
#5 or 5/8	3/4	0.176
#6 or 3/4	7/8	0.218
#7 or 7/8	1	0.252
#8 or 1	1-1/8	0.299
#9 or 1 1/8	1-3/8	0.601
#10 or 1 1/4	1-1/2	0.659

Metric Rebar Installation (Canada Only)

Bar Diameter (in.)	Drill Bit[1] Diameter (in.)	Adhesive Volume Required per Inch embedment (in^3)
10M	5/8	0.186
15M	3/4	0.170
20M	1	0.388
25M	1-1/8	0.289
30M	1-3/8	0.481

1 Rebar diameter may vary Use smallest drill bit which will accommodate rebar

Example: Determine approximate fastenings for 5/8" rod embedded 10" deep.

10 x 0.261 = 2.61 in^3 of adhesive per anchor

HIT-HY 150 MAX 11.1 oz:
16 5 ÷ 2.61= 6 fastenings

HIT-HY 150 MAX 16.9 oz:
26.9 ÷ 2.61= 10 fastenings

HIT-HY 150 MAX Jumbo:
81 8 ÷ 2 61= 31 fastenings

Note: Estimated useable volume of:

HIT-HY 150 MAX 11 1 oz cartridge is
16 5 in^3 (270 ml)

HIT-HY 150 MAX 16.9 oz cartridge is
26 9 in^3 (440 ml)

HIT-HY 150 MAX Jumbo cartridges are
81 8 in^3

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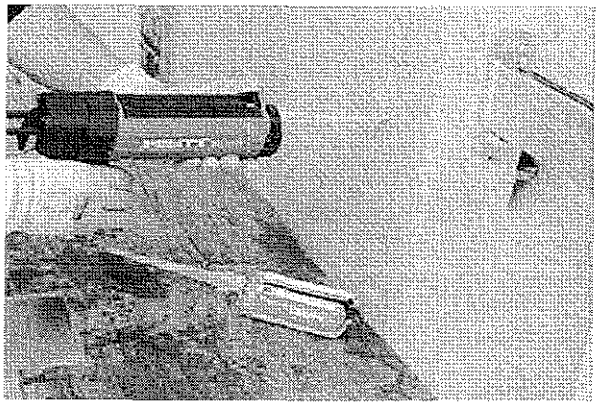
HIT-HY 150 MAX Adhesive Anchoring System 4.2.4



Technical data

Product:	Hybrid/urethane methacrylate
Gel time (68°F/20°C):	5 min*
Cure time (68°F/20°C):	30 min*
Base material temp:	14°F (-10°C) to 104°F (40°C)
Diameter range:	3/8" to 1 1/4"

* approximately

HIT-HY 150 MAX
Foil Pack

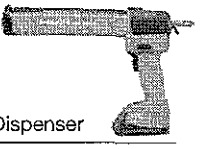
HIT Adhesives

Item No.	Description	Contents
283548	HIT-HY 150 MAX 11.1 fl oz (330 ml)	1 Foil Pack, 1 Mixer with Filler Tube
3412766	HIT-HY 150 MAX 11.1 fl oz (330 ml) MC	25 Foil Packs, 25 Mixers, 25 Filler Tubes
283549	*HIT-HY 150 MAX 16.9 fl oz (500 ml) MC*	*20 Foil Packs, 20 Mixers, 20 Filler Tubes*
283550	HIT-HY 150 MAX Jumbo 47.3 fl oz (1400 ml) MC	4 Foil Packs, 4 Mixers

HIT Dispensers

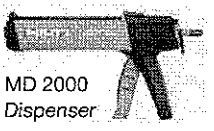
Battery Powered Dispenser

Item No.	Description
3245363	ED 3500 2.0 Ah Kit

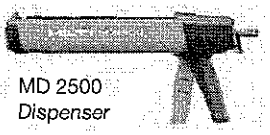


ED 3500
Battery Dispenser

Manual Dispensers

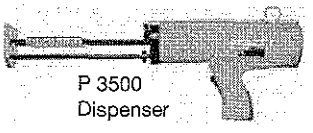


MD 2000
Dispenser

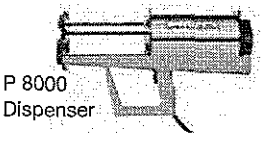


MD 2500
Dispenser

Item No.	Description
229154	MD 2000 Manual Dispenser + 1 foil pack holder for HIT HY foil packs
338853	MD 2500 Manual Dispenser + 1 foil pack holder for HIT HY foil packs
229170	Foil Pack Holder Replacement for MD 2000 or BD 2000 dispensers
339477	Foil Pack Holder for 16.9 fl oz (500 ml) (MD 2500, P 3500)



P 3500
Dispenser

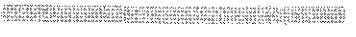


P 8000
Dispenser

Pneumatic Dispensers

Item No.	Description
354180	HIT P 3500 Pneumatic Dispenser + 1 foil pack holder for HIT HY foil packs
373959	HIT P 8000-D Pneumatic Dispenser (for Jumbo cartridges)
373960	Jumbo Foil Pack Holder Replacement for HIT P 8000 dispenser

HIT-RE-M



HIT Filler Tube

Mixers and Filler Tubes

Item No:	Description	Qty/Pkg	Notes
337111	HIT-RE Mixer	1	For use with any cartridge size

4.2.4 HIT-HY 150 MAX Adhesive Anchoring System

4.2.4.5 Ordering Information

HAS-E, HAS-R & HAS Super Rods, HIS Inserts and HIT-TZ & HIT-RTZ Rods

HAS Rod 5.8				HAS Super A193, B7 High Strength Rods			HAS-R 304 Stainless Steel			HAS-R Rods 316 Stainless Steel		
Item No. (Box)	Master Carton (MC)	Description	Qty Box/MC	Item No.	Description	Qty Box	Item No.	Description	Qty Box	Item No.	Description	Qty Box
385417	3432178	3/8x3	10/360									
385418	3432179	3/8x4-3/8	10/240									
385419	3432180	3/8x5-1/8	20/240	68657	3/8x5-1/8	10	385462	3/8x5-1/8	20	3024335	3/8x5-1/8	10
385420	3432181	3/8x8	10/160				385463	3/8x8	10			
385421	3432182	3/8x12	10/90									
385422	3432183	1/2x3-1/8	10/240									
385423	3432184	1/2x4-1/2	10/160									
385424	3432185	1/2x6-1/2	20/160	68658	1/2x6-1/2	10	385464	1/2x6-1/2	20	3024336	1/2x6-1/2	10
385425	3432239	1/2x8	10/120				385465	1/2x8	10			
385426	3432186	1/2x10	10/120				385466	1/2x10	10			
										3024337	1/2x11	10
385427	3432187	1/2x12	10/80									
385428	3432188	5/8x8	20/80	333783	5/8x7-5/8	10	385467	5/8x7-5/8	20	333781	5/8x7-5/8	10
							385468	5/8x10	10			
385429	3432189	5/8x9	10/60							3024338	5/8x9	10
385430	3432190	5/8x12	10/60							3024339	5/8x12	10
385431	3432191	5/8x17	10/40									
385432	3432052	3/4x10	10/40	68660	3/4x9-5/8	5	385469	3/4x9-5/8	10	3024340	3/4x9-5/8	5
385433	3432163	3/4x11	10/30									
385434	3432164	3/4x12	10/30				385470	3/4x12	10			
385435	3432165	3/4x14	10/30	3006083	3/4x14	5	385471	3/4x14	10			
							385472	3/4x16	10			
385436	3432166	3/4x17	10/20									
385437	3432167	3/4x19	10/20									
385438	3432168	3/4x21	10/20									
385439	3432169	3/4x25	10/20									
385440	3432170	7/8x10	10/20	68661	7/8x10(HDG)	5	385473	7/8x10	10			
				3006077	7/8x12(HDG)	5						
385441	3432171	7/8x13	10/20	45259	7/8x16(HDG)	5						
385442	3432172	1x12	4/16	68662	1x12	5	385474	1x12	4	3024341	1x12	4
385443	3432173	1x14	2/16	3006079	1x14	5						
385444	3432174	1x16	2/12	3006080	1x16	5						
385445	3432175	1x20	2/12	3006081	1x21	5						
385446	3432176	1-1/4x16	4/8	333779	1 1/4x16	4						
385447	3432177	1-1/4x22	4/8									
				3006082	1 1/4x23	4						

HIS Carbon Steel and HIS-R 316 Stainless Steel Internally Threaded Inserts

HIS Item No.	HIS-R Item No.	Description	Usable Thread Length (in.)	Qty Box
258020	258029	3/8x4-1/4	1	10
258021	258030	1/2x5	1-3/16	5
258022	258031	5/8x6-5/8	1-1/2	5
258023	258032	3/4x8-1/4	2	5

HIT-TZ and HIT-RTZ Rods

Threaded Rod Diameter (in.)	Drill Bit Diameter (in.)	Maximum Depth of Embedment (in.)	Fastening Thickness (in.)	Overall Length (in.)	Qty Box	Item No. HIT-TZ ISO 5.8 Carbon Steel	Item No. HIT-RTZ 316 Stainless Steel	Description
3/8	7/16	2-7/8	1	4-1/2	40	337484	337498	HIT-TZ 3/8x2-7/8/1
1/2	9/16	3-1/2	1-1/2	5-11/16	24	337485	337499	HIT-TZ 1/2x3-1/2/1-1/2
5/8	11/16	4	2-1/4	7-1/16	16	337486	337500	HIT-TZ 5/8x4/2-1/4
3/4	13/16	5-1/4	2-1/4	8-9/16	8	337487	337501	HIT-TZ 3/4x5-1/4/2-1/4

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HIT-HY 150 MAX Adhesive Anchoring System 4.2.4

HIT-A and HIT-I Inserts and Screen Tubes

Anchor System	Base Material	HIT Rod-A/Insert-1 Item No. (10 pcs/pkg)	HIT-S Screen Tube Item No. (10 pcs/pkg)	Approximate[1] Recommended Hilti Bit
HIT-A Standard and HIT-A Short Anchor Rods	Brick with Holes	HIT-A Rod 1/4 x 2-1/2 78739	HIT Combi-S12/A 49765 2" long	TE-CX 1/2 - 6 205352
		HIT-A Rod 5/16 x 4 88977	HIT-S-16 68613 3-3/8" long	TE-C+ 5/8 - 8 28043
		HIT-A Rod 3/8 x 4-3/8 88978	HIT-S-16 68613 3-3/8" long	TE-C+ 5/8 - 8 28043
		HIT-A Rod 1/2 x 4-1/2 88979	HIT-S-16 68613 3-3/8" long	TE-C+ 5/8 - 8 28043
	Hollow Block Lightweight or Normal Weight	HIT-A Rod 1/4 x 2-1/2 78739	HIT Combi-S12/A 49765 2" long	TE-CX 1/2 - 6 205352
		HIT-A Rod 5/16 x 2-1/2 88392	HIT-S-16/2 77810 2" long	TE-C+ 5/8 - 8 28043
		HIT-A Rod 3/8 x 3 88393	HIT-S-16/2 77810 2" long	TE-C+ 5/8 - 8 28043
		HIT-A Rod 1/2 x 3-1/8 88394	HIT-S-16/2 77810 2" long	TE-C+ 5/8 - 8 28043
	Clay Tile	HIT-A Rod 1/4 x 2-1/2 78739	HIT Combi-S12/A 49765 2" long	TE-CX 1/2 - 6 205352
		HIT-A Rod 5/16 x 2-1/2 88392	HIT-S-16/2 77810 2" long	TE-C+ 5/8 - 8 28043
		HIT-A Rod 3/8 x 3 88393	HIT-S-16/2 77810 2" long	TE-C+ 5/8 - 8 28043
		HIT-A Rod 1/2 x 3-1/8 88394	HIT-S-16/2 77810 2" long	TE-C+ 5/8 - 8 28043
HIT-I Standard and HIT-I Short Internally Threaded Inserts	Brick with Holes	Screen Tube with Insert Combi-S12/I (for #14 screw) 49766 2"long		TE-CX 1/2 - 6 28043
		HIT-I Insert 5/16 x 3-3/16 88996	HIT-S-16 68613 3-3/8" long	TE-C+ 5/8 - 8 28043
		HIT-I Insert 3/8 x 3-3/16 88997	HIT-S-22 68615 3-3/8" long	TE-C-S 27/32-12 28623
		HIT-I Insert 1/2 x 3-3/16 88998	HIT-S-22 68615 3-3/8" long	TE-C-S 27/32-12 28623
	Hollow Block Lightweight or Normal Weight	Screen Tube with Insert Combi-S12/I (for #14 screw) 49766 2"long		TE-CX 1/2 - 6 205352
		HIT-I Insert 5/16 x 2 88397	HIT-S-16/2 77810 2" long	TE-C+ 5/8 - 8 28043
		HIT-I Insert 3/8 x 2 88398	HIT-S-22/2 77811 2" long	TE-C-S 27/32-12 28623
		HIT-I Insert 1/2 x 2 88399	HIT-S-22/2 77811 2" long	TE-C-S 27/32-12 28623
	Clay Tile	Screen Tube with Insert Combi-S12/I (for #14 screw) 49766 2"long		TE-CX 1/2 - 6 205352
		HIT-I Insert 5/16 x 2 88397	HIT-S-16/2 77810 2" long	TE-C+ 5/8 - 8 28043
		HIT-I Insert 3/8 x 2 88398	HIT-S-22/2 77811 2" long	TE-C-S 27/32-12 28623
		HIT-I Insert 1/2 x 2 88399	HIT-S-22/2 77811 2" long	TE-C-S 27/32-12 28623

BGMU Submittal Package, Part 1 of 2, 05/03/2010, Page 212 of 635

In The United Sates

PAYMENT TERMS: Net 30 days from date of invoice. Customer agrees to pay all costs incurred by Hilti in collecting any delinquent amounts including attorney's fees.

FREIGHT: All sales are F.O.B. Destination with transportation allowed via Hilti designated mode. Delivery dates are estimates only. Additional charges for expedited shipments, special handling requirements, and orders below certain dollar amounts shall be the responsibility of Customer. Fuel surcharges may apply depending on market conditions

CREDIT: All orders sold on credit are subject to Credit Department approval.

RETURN POLICY: Products must be in saleable condition to qualify for return. Saleable condition is defined as unused items in original undamaged packaging and unbroken quantities and in as-new condition. All returns are subject to Hilti inspection and acceptance, and a $125 restocking charge if returned more than 90 days after invoice date. Proof of purchase is required for all returned materials. Special orders products and discontinued items are not eligible for return credit. Dated materials are only returnable in case quantity and within 30 days after invoice date

WARRANTY: Hilti warrants that for a period of 12 months from the date it sells a product it will, at its sole option and discretion, refund the purchase price, repair, or replace such product if it contains a defect in material or workmanship. Absence of Hilti's receipt of notification of any such defect within this 12-month period shall constitute a waiver of all claims with regard to such product.

THE FOREGOING WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, INCLUDING BUT NOT LIMITED TO THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. Hilti shall in no event be liable for, and Customer hereby agrees to indemnify Hilti against all claims related to special, direct, indirect, incidental, consequential, or any other damages arising out of or related to the sale use or inability to use the product.

ACCEPTANCE OF ORDER: Acceptance is limited to the express terms contained herein, and terms are subject to change by Hilti without notice. Additional or different terms proposed by Customer are deemed material and are objected to and rejected, but such rejection shall not operate as a rejection of the offer unless it contains variances in the terms of the description, quantity, price or delivery schedule of the goods. Orders are not deemed 'accepted' by Hilti unless and until it ships the associated items

DOMESTIC ORIGIN: Any non-domestic Hilti product will be so identified on shipping documents and invoices for customers who properly identify themselves as a federal government entity. All other customers may obtain such information by written request to Hilti, Inc., Contract Compliance, P.O. Box 21148, Tulsa, Oklahoma 74121. Hilti's Quality Department personnel are the only individuals authorized to warrant the country of origin of Hilti products.

BUSINESS SIZE: Hilti is a large business

PRICES: Prices are those stated on the order, and unless otherwise noted are based on purchasing all items on the order — pricing for individual products may vary for purchases of different quantities or item combinations. Hilti does not maintain most favored customer records, makes no representation with respect to same, and rejects any price warranty terms proposed by Customer. Hilti's published net price list is subject to change without notice.

CONSENT TO JURISDICTION: All transactions made pursuant hereto shall be deemed to have been made and entered into in Tulsa, Oklahoma. Any and all disputes arising directly or indirectly from such transactions shall be resolved in the courts of the County of Tulsa, State of Oklahoma, to the exclusion of any other court, and any resulting judgment may be enforced by any court having jurisdiction of such an action. All transactions shall be governed by and construed in accordance with the laws of the State of Oklahoma

INDEMNIFICATION: Customer hereby agrees to indemnify Hilti for any costs including attorney's fees incurred by Hilti as a result, in whole or in part, of any violation by Customer of any Federal, State or Local statute or regulation, or of any nationally accepted standard. It shall be Customer's sole responsibility to comply with all applicable laws and regulations regarding the handling,use, transportation or disposal of products upon taking possession of same

AUTHORIZATION: HILTI LEGAL DEPARTMENT PERSONNEL ARE THE ONLY INDIVIDUALS AUTHORIZED TO MODIFY THESE TERMS AND CONDITIONS, WARRANT PRODUCT SUITABILITY FOR SPECIFIC APPLICATIONS, OR EXECUTE CUSTOMER DOCUMENTS, AND ANY SUCH ACTION IS NULL AND VOID UNLESS IN WRITTEN FORM SIGNED BY SUCH INDIVIDUAL.

In Canada

PAYMENT TERMS: Net 30 days from date of invoice Customer agrees to pay all costs incurred by Hilti in collecting delinquent amounts, if any including reasonable attorney's fees.

FREIGHT: Sales are F.O.B. Destination Point with transportation allowed via Hilti designated mode. Additional charges may apply for expedited delivery special handling requirements, and order under certain limits. A fuel surcharge may apply depending on market conditions.

CREDIT: All orders sold on credit are subject to Credit Department approval

RETURN POLICY: Product may be returned prepaid (unless otherwise authorized) to Hilti provided:

i) it is returned by the original purchaser

ii) it is not dated product returned more than 30 days after the original delivery date

iii) it is not discontinued clearance or special order product

iv) it is unused, in original packaging and in unbroken quantities

Hilti will inspect product and if the above requirements are satisfied, will credit to customer the original purchase price. A 15% restocking fee may apply.

WARRANTY: Other than the manufacturer's published warranty, no warranties or conditions express or implied, written or oral statutory or otherwise are implied. Any and all conditions and warranties implied by law or by the Sale of Goods Act or any similar statutes of any Province are hereby expressly waived

TITLE TO PRODUCT: Title to product remains with Hilti until the total purchase price of product is paid.

PRICES: Customer agrees to pay Hilti prices set out on invoice. Customer agrees to pay taxes as indicated on invoice unless Hilti receives acceptable exemption certificates.

INDEMNIFICATION: Customer agrees to use product at own risk and to indemnify Hilti against all liabilities, including legal fees, to third parties arising out of the use or possession thereof. Hilti shall in no event be liable for special, incidental or consequential damages.

CHANGES: Hilti sales personnel are not authorized to modify these Terms and Conditions or modify Customer's credit terms. Terms are subject to change by Hilti with reasonable notice to Customer

CASH SALES: Payment in full is due prior to goods being released

QUOTATIONS: All terms and conditions apply once customer agrees to purchase product Quotations on special promotion products are only valid until end of promotion period

BCMU Submittal Package Part 1 of 2 05/03/2010 Page 213 of 695

F. Discharge Cooling Screw

- Performance Specification: BSD-7410 Cooling Screw
- TFL Drawing: TFL 5412 Discharge Cooling Screw
- 3” Martin Superpack Seal
- 3” Dodge Bearing, Type E Flange 02311-F4B-E-300R
- Gearmotor, Discharge Cooling Screw, Nord SK 6382 AZ SH– 90L/4
    - Nord SK 6382AZSH Drawing
    - Cooling Screw SK 6382 AZ SH Gearmotor Ordering Guide
    - SK 6382 Ratings & Combinations
    - SK 6382 Motor Performance & Ordering Data
    - SK 6382 Drive Shaft Detail
    - SK 6382 Dimensions
    - SK 6382 Oil Fill Quantities

1-877-BIO-SLDS
P 707-747-5949
F 707-747-5951

TFL5412 PERFORMANCE SPECIFICATION

BSD-7410 BIOSCRU COOLER

Capacity:

Conveyance Rate:	2,500 lb/hr
Cooling Load:	132,000 Btu/hr

Power:

NORD Gear Motor / VFD Driven:	480V / 3PH / 2.8FLA
Model No:	SK6382 – 90L/4 – 2HP – 393.19:1 RATIO

Water Flow:

Flow Rate:	30 GPM @78F
Inlet Connection Size/Type:	1 ¼" FNPT
Outlet Connection Size/Type:	1 ¼" FNPT

Material of Construction:

Screw Rotor:	Carbon Steel
Housing:	Carbon Steel
Support Structures:	Carbon Steel

Paint Specification:

NORD Gearmotor	MFG Standard
All Exterior Surfaces:	Dimetcote9H/PSX892HS
Support Structures:	Dimetcote9H/PSX892HS

Sub-components:

Drive End Bearing:	3" DODGE Type E Flange 023111-F4B-E-300R
Drive End Seal:	3" Martin Superpack Seal
Tail End Bushing Assembly.	3 7/16" Therma-Flite

Manufacture:

Designed and Manufactured by Therma-Flite, Inc.

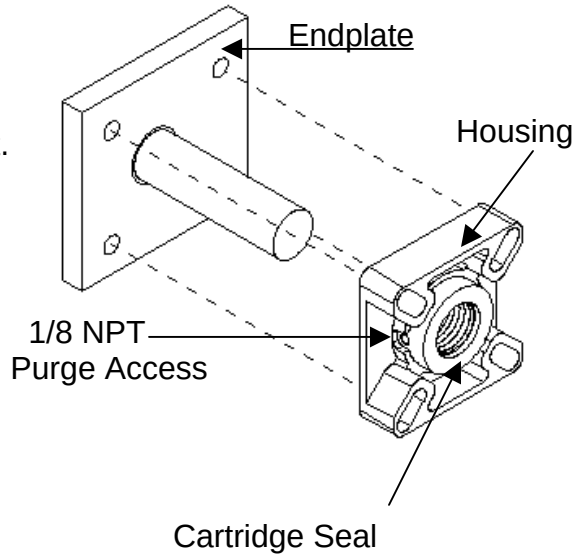
TFL Drawing: TFL 5412 Discharge Cooling Screw

Martin Superpack Seal, 3”

- Martin Super Pack Seal Installation Instructions
- MartinCatalog, Super Pack Seal MSP7 Sizing Sheet

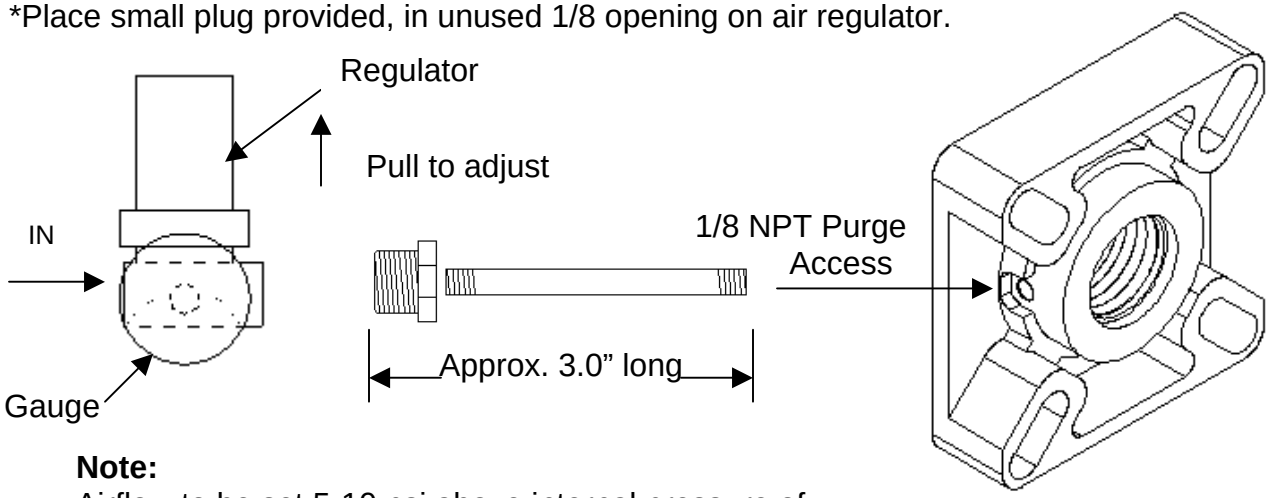
Martin Super Pac Installation Instructions

- Carefully slip the housing onto the shaft.
  ***** Use ONLY mild soapy water for lubrication.
- Align housing **flush** to Endplate.
  Housing must be **perpendicular** - **normal** to the shaft.
  *Alignment of housing to shaft cannot exceed 2°.
- Check for equal spacing around the shaft and the ID of the seal.
- Tighten mounting hardware to manufacturers recommended torque settings.
- If purge required for application, purge seal before operating .
  *Operating temperature range: - 30°F to + 450°F



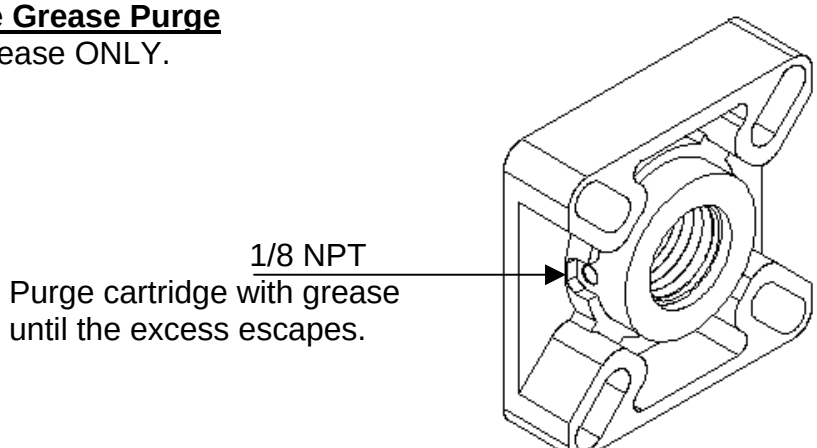
Purge options available:
Purge option: 1 Air Purge using an Air Regulator.
Purge option: 2 Silicone Grease Purge.

Option 1: Using an Air Purge with regulator
Port size: 1/4 * Use bushing provided to mate 1/8 male fitting of cartridge.
Gauge ports: 1/8 (2 Ports available for orientation convenience)
*Place small plug provided, in unused 1/8 opening on air regulator.

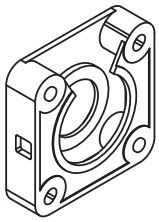
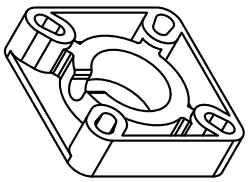
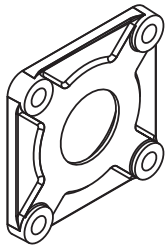
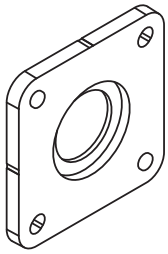
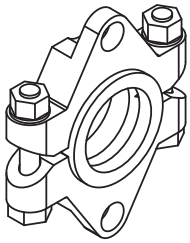
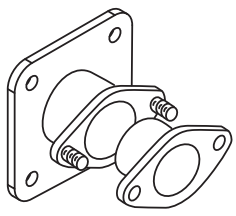
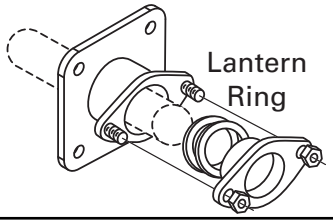


Note:
Airflow to be set 5-10 psi above internal pressure of conveyor. Max air pressure of seal is 50 psi.

Option 2: Silicone Grease Purge
*Use silicone grease ONLY.

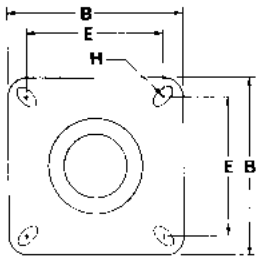


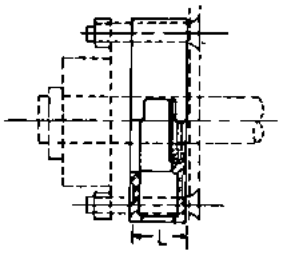
Shaft Seals

WASTE PACK SEAL		Waste pack seals can be furnished with waste packing or in combination with lip seal. This type seal is normally installed between the trough end and bearing, but may be used separately on pedestal type trough ends. An opening is provided at top for repacking without removing seal from trough end. Can be used with flanged ball, roller or other standard 4-bolt bearings.
Martin SUPER PACK SEAL		Martin Super Pack Seal combines the heavy duty waste pack housing with the superior sealing characteristics of a Super Pack Seal. Seal may also be air or grease purged for difficult sealing applications.
PRODUCT DROP OUT SEAL		This flange type dust seal is designed for insertion between trough end and flanged ball bearing. The cast iron housing is open on all four sides for exit of material that might work past seal or lubricant from bearing.
PLATE SEAL		Plate seals are the most common and economical seal. It is normally furnished with a lip seal. This type seal is normally installed between the trough end and bearing, but may be used separately on pedestal type trough ends. Can be used with flanged ball, roller or other standard 4-bolt bearings.
SPLIT GLAND SEAL		Split gland compression type seals provide for easy replacement and adjustment of packing pressure on the shaft without removal of the conveyor. These seals can be installed inside or outside the end plates.
COMPRESSION TYPE PACKING GLAND SEAL		Flanged packing gland seals consist of an external housing and an internal gland which is forced into the housing to compress the packing. This is the most positive type shaft seal and may be used where minor pressure requirements are desired.
AIR PURGED SEAL		Air purge shaft seals are arranged for attaching to standard or special trough ends. A constant air pressure is maintained to prevent material from escaping from the trough along the shaft. The air purge seal is desirable for sealing highly abrasive materials. May be purged with grease or water.

Shaft Seals

Super Pack Seal



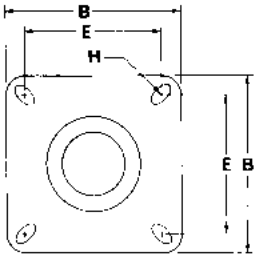


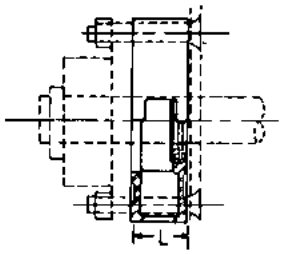
With Super Pack Seal

A Shaft	Part Number	B	L	E		H Bolts		Weight
				(–B)	(–R)	(–B)	(–R)	
1½	MSP3	5⅜	1¾	4	4⅛	½	½	6
2	MSP4	6½	1¾	5⅛	4⅜	⅝	½	8
2 7/16	MSP5	7⅜	1¾	5⅝	5⅜	⅝	⅝	10
3	MSP6	7¾	1¼	6	6	¾	¾	13
3 3/16	MSP7	9¼	2¼	6¾	7	¾	¾	16

Martin Super Pack Seal combines the heavy duty waste pack housing with the superior sealing characteristics of a Super Pack Seal. Seal may also be air or grease purged for difficult sealing applications.

Waste Pack Seal



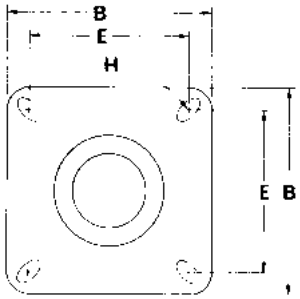


With Lip Seal

A Shaft	Part Number	B	L	E		H Bolts		Weight
				(–B)	(–R)	(–B)	(–R)	
1½	CSW3	5⅜	1¾	4	4⅛	½	½	6
2	CSW4	6½	1¾	5⅛	4⅜	⅝	½	8
2 7/16	CSW5	7⅜	1¾	5⅝	5⅜	⅝	⅝	10
3	CSW6	7¾	1¾	6	6	¾	¾	13
3 3/16	CSW7	9¼	2¼	6¾	7	¾	¾	16

Waste pack seals are furnished with waste packing in combination with lip seal. This type seal is normally installed between the trough end and bearing, but may be used separtely on pedestal type trough ends. An opening is provided at top for repacking without removing seal from trough end.

Plate Seal



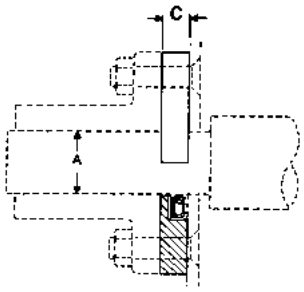


Plate seals are the most common and economical seal. They are furnished with a lip seal. This type seal is normally installed between the trough end and bearing, but may be used separately on pedestal type trough ends. Slotted mounting holes allow use with both ball and roller flanged bearings.

A Shaft Diameter	Part Number	B	C	E		H Bolts		Weight
				(–B)	(–R)	(–B)	(–R)	
1½	CSP3	5⅜	½	4	4⅛	½	½	2
2	CSP4	6½	½	5⅛	4⅜	⅝	½	3
2 7/16	CSP5	7⅜	½	5⅝	5⅜	⅝	⅝	4
3	CSP6	7¾	½	6	6	¾	¾	5
3 3/16	CSP7	9¼	¾	6¾	7	¾	¾	8

CONVEYORS

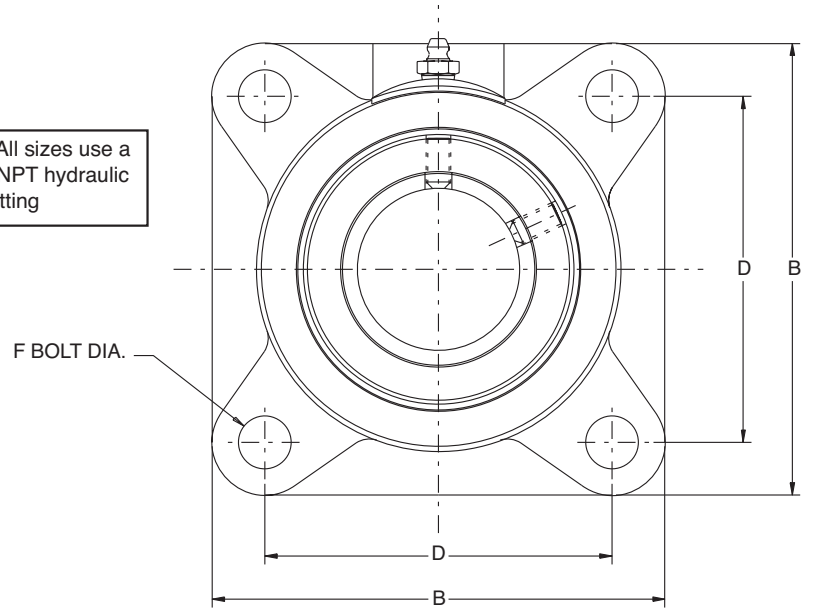
3” Dodge Type E Flange Bearing, 02311-F4B-E-300R

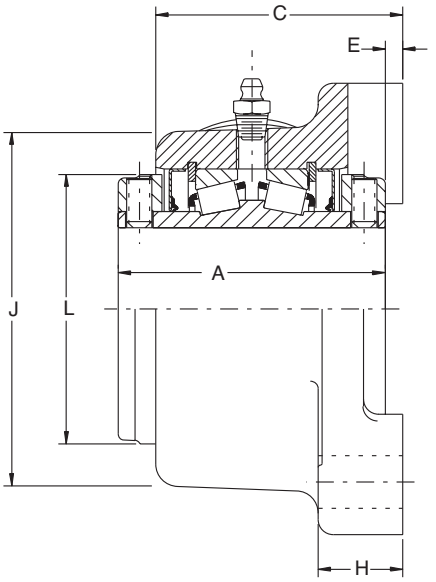
- Dodge Type E Flange Bearing Selection/Dimension Catalog Sheets

SELECTION/DIMENSIONS

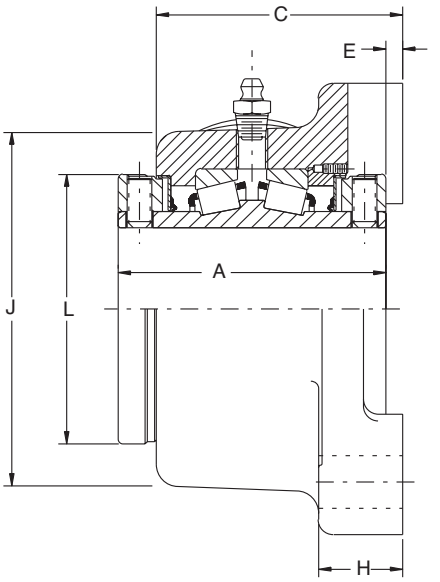
Type E Flange Bearing - Inch
4-BOLT BASE

NOTE: All sizes use a 1/8 - 27 NPT hydraulic grease fitting





1-3/16" THRU 3" CONSTRUCTION



3-3/16" THRU 4-1/2" CONSTRUCTION

FEATURES/BENEFITS PAGE B6-2	NOMENCLATURE PAGE B6-4	SELECTION PAGE B6-5	SELECTION/DIMENSIONS PAGE B6-8

Type E Flange Bearing - Inch
4-BOLT BASE

GRAY IRON			
SHAFT SIZE INCHES #	PART NUMBER	PART NAME	WEIGHT LBS (APPROX)
1-3/16	**023093**	F4B-E-103R	4
1-1/4	**023094**	F4B-E-104R	4
1-3/8	**023095**	F4B-E-106R	7
1-7/16	**023096**	F4B-E-107R	7
1-1/2	**023097**	F4B-E-108R	11
1-5/8	**023098**	F4B-E-110R	11
1-11/16	**023099**	F4B-E-111R	11
1-3/4	**023100**	F4B-E-112R	12
1-7/8	**023101**	F4B-E-114R	12
1-15/16	**023102**	F4B-E-115R	12
2	**023103**	F4B-E-200R	12
2-3/16	**023104**	F4B-E-203R	15
2-1/4	**023105**	F4B-E-204R	21
2-7/16	**023106**	F4B-E-207R	20
2-1/2	**023107**	F4B-E-208R	19
2-11/16	**023108**	F4B-E-211R	28
2-3/4	**023109**	F4B-E-212R	28
2-15/16	**023110**	F4B-E-215R	27
3	**023111**	F4B-E-300R	26
3-3/16	**023112**	F4B-E-303R	52
3-1/4	**023113**	F4B-E-304R	51
3-7/16	**023114**	F4B-E-307R	50
3-1/2	**023115**	F4B-E-308R	50
3-15/16	**023116**	F4B-E-315R	75
4	**023117**	F4B-E-400R	75
4-7/16	**023118**	F4B-E-407R	90
4-1/2	**023119**	F4B-E-408R	90

Consult DODGE For Sizes Not Listed.

SHAFT SIZE INCHES	A	B	C	D	E	F BOLT	H	J	L
1-3/16 1-1/4	2-3/4	3-3/4	2-11/32	2-7/8	1/16	3/8	1	2-15/16	2-1/4
1-3/8 1-7/16	3	4-5/8	2-19/32	3-1/2	1/16	1/2	1-1/16	3-1/2	2-3/4
1-1/2 1-5/8 1-11/16	3-3/8	5-3/8	2-31/32	4-1/8	1/8	1/2	1-3/16	4-3/16	3-3/16
1-3/4 1-7/8 1-15/16 2	3-1/2	5-5/8	3-3/32	4-3/8	1/8	1/2	1-3/16	4-7/16	3-7/16
2-3/16	3-3/4	6-1/4	3-9/32	4-7/8	1/8	5/8	1-3/8	4-7/8	3-3/4
2-1/4 2-7/16 2-1/2	4	6-7/8	3-9/16	5-3/8	3/16	5/8	1-1/2	5-5/16	4-1/16
2-11/16 2-3/4 2-15/16 3	4-1/2	7-3/4	3-15/16	6	3/16	3/4	1-5/8	6	4-23/32
3-3/16 3-1/4 3-7/16 3-1/2	5	9-1/4	4-1/2	7	1/4	3/4	1-7/8	7-1/4	5-1/2
3-15/16 4	6-1/4	10-1/4	5-5/8	7-3/4	1/4	7/8	2-1/8	8-1/4	6
4-7/16 4-1/2	6-3/4	10-7/8	5-15/16	8-3/4	11/32	7/8	2-7/16	8-3/4	6-29/64

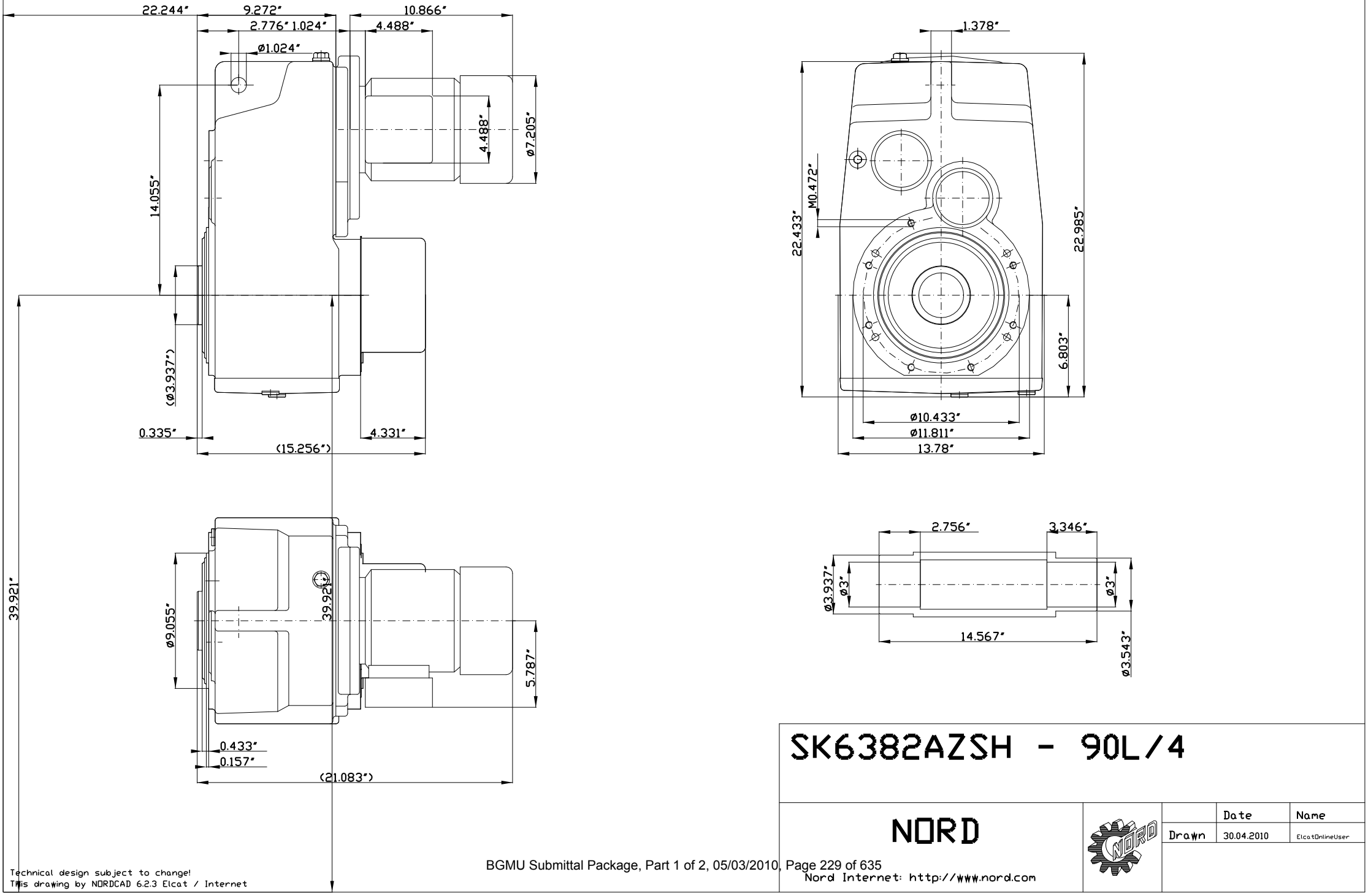
NOTE: All sizes use a 1/8-27 NPT hydraulic grease fitting

FEATURES/BENEFITS PAGE B6-2	NOMENCLATURE PAGE B6-4	SELECTION PAGE B6-5	SELECTION/DIMENSIONS PAGE B6-8

Gearmotor, Discharge Cooling Screw, Nord SK 6382AZ SH – 90L/4

- Nord SK 6382AZSH Drawing
- Discharge Cooling Screw Gearmotor Ordering Guide
- SK 6382 Ratings & Combinations
- SK 6382 Motor Performance & Ordering Data
- SK 6382 Drive Shaft Detail
- SK 6382 Dimensions
- SK 6382 Oil Fill Quantities

Nord SK 6382AZSH Drawing



SK6382AZSH - 90L/4

NORD

	Date	Name
Drawn	30.04.2010	ElcatOnlineUser

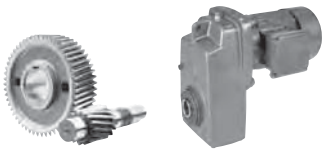
Technical design subject to change!
This drawing by NORDCAD 6.2.3 Elcat / Internet

Nord Internet: http://www.nord.com

Discharge Cooling Screw Gearmotor Ordering Guide

NOTE: TO INCLUDE APPROPRIATLEY PLACED AUTOVENT BREATHER (DR)
TFL 5412 COOLING SCREW

Clincher™ Ordering Guide



	Gear Unit	Shaft/Mounting	Reducer Options		Motor/Input	Motor Options
SK	❶ 6382	❷ AZ	❸ SH	-	❹ 90 L/4	NONE
					see page 690	see page 690

❶ **Gear Unit**

0182NB	1382NB	1282/02	6382/22
0282NB	2382	2282/02	6382/32
1282	3382	3282/12	7382/22
2282	4382	4282/12	7382/32
3282	5382	5282/12	8382/22
4282	6382		8382/32
5282	7382		9382/42
6282	8382		9382/52
7282	9382		10382/52
8282	10382		11382/52
9282	11382		
10282	12382		
11282			

❷ **Shaft/Mounting**

VZ - Solid Shaft/B14 Flange	**VX -** Solid Shaft/Foot	**AZ** - Hollow Shaft/B14 Flange
VF - Solid Shaft/B5 Flange	**LX -** Double Solid Shaft/Foot	**AF** - Hollow Shaft/B5 Flange
SCP - Screw Conveyor Package		**AX** - Hollow Shaft/Foot

❸ **Reducer Options**

☐ **B -** Fixing Element Kit	☐ **VL -** Heavy Duty Output Bearings	☐ **VI -** Fluoro-rubber Seals
☐ **G -** Rubber Buffers	☐ **VL2 -** Spread Bearing Design	☐ **OSG -** Oil Sight Glass
☐ **VG -** Heavy Duty Rubber Buffers	☐ **VL3 -** Oil Safe Spread Bearing Design	☐ **OA -** Oil Expansion Chamber
☐ **H -** Hollow Shaft Cover	☐ **VL4-** Drywell Drop Bearing Design	☐ **OC -** Oil Cooler
☐ **H66 -** IP66 Hollow Shaft Cover	☐ **LX-** Double Solid Shaft	☐ **WC -** Water Cooling Cover
☒ **SH -** Shrink Disc & Cover	☐ **SM5 -** Stainless Steel Output Shaft	☐ **OT -** Oil Reservoir Tank
☐ **VSH -** Heavy Duty Shrink Disc & Cover	☐ **SWA -** Special Hollow Shaft	☐ **MDP -** Magnetic Drain Plug
☐ **PR -** Flange Pilot Removal	☐ **SWV -** Special Solid Shaft	☐ **ADP -** Additional Drain Plug
☐ **LL -** Long Term Storage	☐ Cross Drilled Shaft	

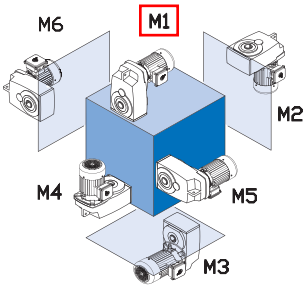
❹

Input Shaft	NEMA Adapter	IEC Adapter	Integral Motors		Integral Energy Efficent Motors		Scoop	Motor Platform	Servo Adapter (Keyed)
W	N56C	IEC 63	63S/4 - 0.16hp	160L/4 - 20hp	80LH/4 - 1hp	200LH/4 - 40hp	S56	MKN056	SEP 100
	N140TC	IEC 71	63L/4 - 0.25hp	180MX/4 - 25hp	90SH/4 - 1.5hp	225SH/4 - 50hp	S140T	MKN140	SEP 130
	N180TC	IEC 80	71S/4 - 0.33hp	180LX/4 - 30hp	90LH/4 - 2hp	225MH/4 - 60hp	S180T	MKN180	SEP 165
	N210TC	IEC 90	71L/4 - 0.50hp	200L/4 - 40hp	100LH/4 - 3hp	250MH/4 - 75hp	S210T	MKN210	SEP 215
	N250TC	IEC 100	80S/4 - 0.75hp	225S/4 - 50hp	112MH/4 - 5hp	280SH/4 - 100hp	S250T	MKN250	SEP 300
	N280TC	IEC 112	80L/4 - 1hp	225M/4 - 60hp	132SH/4 - 7.5hp	280MH/4 - 125hp	S280T	MKN280	**Servo Adapter (Clamp)**
	N320TC	IEC 132	90S/4 - 1.5hp	250M/4 - 75hp	132MH/4 - 10hp	315SH/4 - 150hp	S320T	MKN320	
	N360TC	IEC 160	90L/4 - 2hp	280S/4 - 100hp	160MH/4 - 15hp	315MH/4 - 175hp	S360T	MKN360	SEK 100
	N400TC	IEC 180	100L/4 - 3hp	280M/4 - 125hp	160LH/4 - 20hp	315MAH/4 - 200hp	S400T	MKN400	SEK 130
		IEC 200	100LA/4 - 5hp	315S/4 - 150hp	180MH/4 - 25hp	315LH/4 - 250hp			SEK 165
		IEC 225	112M/4 - 5.4hp	315M/4 - 175hp	180LH/4 - 30hp				SEK 215
		IEC 250	132S/4 - 7.5hp	315MA/4 - 200hp					SEK 300
		IEC 280	132M/4 - 10hp	315L/4 - 250hp					
		IEC 315	160M/4 - 15hp	Other Speeds Available		Other Speeds Available			

Product Specifications

Ratio
393.19 :1
see pages 244 - 288
— OR —
Output Speed
rpm
see pages 244 - 288

Mounting Position
- ☒ M1
- ○ M2
- ○ M3
- ○ M4
- ○ M5
- ○ M6
- ○ Special _____



Paint
- ☒ Standard Stainless Steel Paint
- ○ NSD+ (gray)
- ○ NSD+W (white)
- ○ NSD-X3 (gray)
- ○ NSD-X3W (white)
- ○ Casting Primed
- ○ Special _____

Lubricant
- ☒ Standard
- ○ Synthetic
- ○ Food Grade
- ○ Other _____

Hollow Shaft Diameter (If required)
see pages 388 - 393

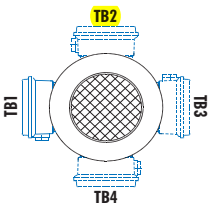
B5 Flange Diameter (If required)

SCP Drive Shaft Diameter (If required)
NONE
see page 29

Gearmotor Only Details

Voltage & Frequency
- ☒ 230/460V-60Hz (460V only ≥ 40 hp)
- ○ 575V-60Hz
- ○ 208V-60Hz
- ○ 400V-50Hz
- ○ 115/230V-60Hz, 1 ph.
- ○ Other _____

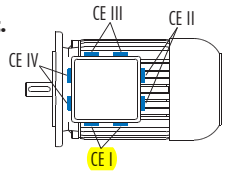
Terminal Box Pos.
- ○ TB1
- ☒ TB2
- ○ TB3
- ○ TB4



Mtg. Pos. M1 Shown

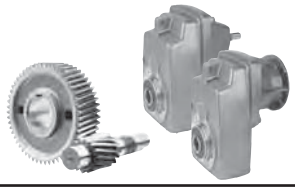
Conduit Entry Loc.
- ☒ CE I *
- ○ CE II
- ○ CE III *
- ○ CE IV

* Brakemotor



Mtg. Pos. M1 Shown

SK 6382, SK 6382/22, 6382/32 NEMA-C + W Ratings & Combinations



Model Type	Gear Ratio i_{tot}	Output Speed n_2 1750 rpm [rpm]	Output Torque* $T_{2\,max}$ [lb-in]	Maximum input power◈ Solid input shafts type "W" Input Speed 1750 rpm [hp]	1150 rpm [hp]	875 rpm [hp]	580 rpm [hp]	NEMA C-Face* Available Combinations 56C	140TC	180TC	210TC	250TC	280TC	320TC	360TC
SK 6382	24.42	72	41507	30.00	19.80	15.00	9.90	X	X	X	X	X	X		
	28.72	61	40710	30.00	19.80	15.00	9.90	X	X	X	X	X	X		
	30.91	57	40268	30.00	19.80	15.00	9.90	X	X	X	X	X	X		
	36.34	48	40268	30.00	19.80	15.00	9.90	X	X	X	X	X	X		
	42.46	41	40268	26.20	17.29	13.10	8.64	X	X	X	X	X	X*		
	51.07	34	44958	24.25	16.01	12.13	8.00	X	X	X	X	X	X*		
	59.66	29	48675	22.40	14.78	11.20	7.39	X	X	X	X	X	X*		
	73.50	24	49295	18.77	12.39	9.39	6.19	X	X	X	X	X*			
	75.18	23	53100	19.38	12.79	9.69	6.39	X	X	X	X	X*	X*		
	92.63	19	53100	16.01	10.57	8.00	5.28	X	X	X	X	X*			
	114.79	15	52038	12.39	8.17	6.19	4.09	X	X	X	X	X*			
	126.87	14	40533	9.00	5.94	4.50	2.97	X	X	X	X*				
	159.88	11	51065	8.91	5.88	4.46	2.94	X	X	X	X*				
	171.34	10	49295	7.82	5.16	3.91	2.58			X	X*				
	212.33	8.2	41330	5.38	3.55	2.69	1.77			X	X*				
	225.79	7.8	35577	4.40	2.91	2.20	1.45	X	X	X*					
	251.76	7.0	39648	4.40	2.91	2.20	1.45	X	X	X*					
	267.59	6.5	52038	5.37	3.54	2.68	1.77			X	X*				
	317.28	5.5	49914	4.36	2.87	2.18	1.44	X	X	X*					
	393.19	4.5	52038	3.72	2.45	1.86	1.23	X	X	X*					
	445.09	3.9	36905	2.28	1.51	1.14	0.75	X	X						
	551.58	3.2	45755	2.32	1.53	1.16	0.77	X	X						
SK 6382/22	298.46	5.9	47790	4.47	2.95	2.24	1.48	X	X	X*					
	347.33	5.0	47790	3.79	2.50	1.90	1.25	X	X	X*					
	435.29	4.0	47790	3.03	2.00	1.52	1.00	X	X	X*					
	569.11	3.1	47790	2.35	1.55	1.18	0.78	X	X	X*					
	637.53	2.7	47790	2.05	1.35	1.02	0.68	X	X	X*					
	818.71	2.1	47790	1.59	1.05	0.80	0.53	X	X*	X*					
	1104.39	1.6	47790	1.21	0.80	0.61	0.40	X	X*	X*					
	1259.27	1.4	47790	1.06	0.70	0.53	0.35	X	X*	X*					
	1859.20	0.94	47790	0.77	0.51	0.38	0.25	X*	X*						
	2203.53	0.79	47790	0.65	0.43	0.33	0.22	X*	X*						
	2738.39	0.64	42303	0.48	0.32	0.24	0.16	X*	X*						
	3450.76	0.51	47790	0.44	0.29	0.22	0.15	X*	X*						
	4164.86	0.42	42303	0.34	0.22	0.17	0.11	X*	X*						
SK 6382/32	159.23	11	42303	7.38	4.87	3.69	2.44	X	X	X*	X*				
	191.51	9.1	42303	6.11	4.03	3.05	2.02	X	X	X*	X*				
	223.73	7.8	42303	5.24	3.46	2.62	1.73	X	X	X*	X*				

* Caution - The motor power may exceed the gear unit's mechanical torque capacity
◈ The mechanical power limit of the solid input shaft type "W" may limit the reducer rating.
All ratings are mechanical. See page 14 for thermal considerations.

lb	W	56C	140TC	180TC	210TC	250TC	280TC
SK 6382	423	403	412	428	459	481	481
SK 6382/22	443	439	448	456	–	–	–
SK 6382/32	467	463	472	481	500	–	–

Motor Order Form

	Frame	Size	Poles	Motor Options	Brake Size	Brake Options
SK	90	L	4	NONE	NONE	NONE

Frame	Size	Poles
63	S	4
71	SH	2
80	M	6
90	MH	4-2
100	MX	8-2
112	L	8-4
132	LA	12-2
160	LH	Other
180	LX	
200		
225		
250		
280		
315		

Paint

- ❍ Unpainted Aluminum Alloy
- ⊗ Standard Stainless Steel Paint
- ❍ NSD+ (gray)
- ❍ NSD+W (white)
- ❍ NSD-X3 (gray)
- ❍ NSD-X3W (white)
- ❍ Special _____

Electrical Motor Options

- ❐ **H** - Energy Efficient Motor
- ❐ **TW** - Thermostat
- ❐ **TF** - Thermistor
- ❐ **SH** - Space Heater (select voltage)
  - ❍ 110 Volt ❍ 230 Volt ❍ 460 Volt
- ❐ **ISO H** - Class H insulation
- ❐ **WU -** High Resistance Rotor
- ❐ **4-2** - 2-Speed, 4/2 Pole, 1800/3600rpm
- ❐ **8-2** - 2-Speed, 8/2 Pole, 900/3600rpm
- ❐ **ECR** - Single Phase Motor

Environmental Options

- ❐ **NSD+** - Nord Severe Duty Paint
- ❐ **NSDx3** - Nord Extreme Duty Paint
- ❐ **RD** - Canopy Drip Cover
- ❐ **RDD** - Double Fan Cover
- ❐ **KB** - Condensation Drain Holes (plugged)
- ❐ **KBO** - Condensation Drain Holes (open)
- ❐ **IP66** - IP66 Enclosure Protection
- ❐ **KKV** - Terminal Box Sealed with Resin
- ❐ **AICM** - Additional Insulation
- ❐ **EP** - Epoxy Dipped Windings

Frequency Inverter Related Options

- ❐ **F** - Blower Fan (200-575V 1 & 3 Phase)
- ❐ **FC** - Blower Cooling Fan (115V, 1 Phase)
- ❐ **IG__** - Incremental Encoder
- ❐ **IG__P** - Incremental Encoder with Plug
- ❐ **AG** - Absolute Encoder

Additional Motor Options

- ❐ **OL -** Totally Enclosed Non-Ventilated (TENV)
- ❐ **OL/H** - (TENV) Without Fan Cover
- ❐ **WE -** Second Shaft Extension (Fan Side)
- ❐ **HR -** Hand Wheel
- ❐ **Z -** High Inertia Cast Iron Fan
- ❐ **RLS -** Motor Backstop (rotation viewing fan)
  - ❍ Clockwise ❍ Counter-Clockwise
- ❐ **EKK -** Small Terminal Box (not UL approved)
- ❐ **MS -** Quick Power Plug Connector

Brake Size
BRE 5
BRE 10
BRE 20
BRE 40
BRE 60
BRE 100
BRE 150
BRE 250
BRE 400
BRE 800
BRE 1200

Brake Options

- ❐ **HL** - Hand Release Lever
- ❐ **FHL** - Locking Hand Release Lever
- ❐ **HLH** - Hand Release Lever with Hole
- ❐ **RG** - Corrosion Protected Brake
- ❐ **SR** - Dust and Corrosion Protected Brake
- ❐ **ADJ_____Nm** - Adjust Brake Torque
- ❐ **BIP66** - IP66 Brake Enclosure
- ❐ **MIK** - Micro-switch
- ❐ **BSH** - Brake Heating/Bifilar Coil
- ❐ **NRB1** - Quiet Brake Release
- ❐ **NRB2** - Quiet Brake Motor Operation
- ❐ **FBR** - Brass Foil
- ❐ **DBR -** Double Brake
- ❐ **G...P -** High Performance Rectifier
- ❐ **G...V** - Sealed Rectifier
- ❐ **IR** - Current Sensing Relay

Rectifier Selection

Rectifier Wiring

- ❍ Across the line (from motor terminal box)
- ❍ Separate power source (frequency inverter, soft starter)

Brake Supply Voltage

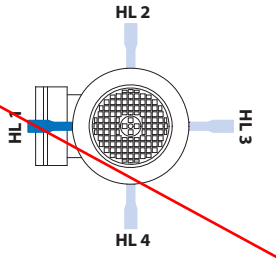
- ❍ 24 VDC
- ❍ 115 VAC
- ❍ 200 VAC
- ❍ 230 VAC
- ❍ 400 VAC
- ❍ 460 VAC
- ❍ 500 VAC
- ❍ 575 VAC
- ❍ Other _____

Braking Method

- ❍ Method 10
- ❍ Method 15
- ❍ Method 20
- ❍ Method 25
- ❍ Method 30
- ❍ Method 35
- ❍ Method 40
- ❍ Method 45
- ❍ Method 50
- ❍ Method 55

Hand Release Position

- ❍ HL1
- ❍ HL2
- ❍ HL3
- ❍ HL4



Mounting

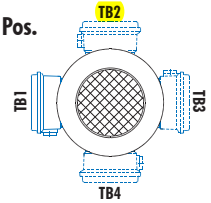
- ⊗ Integral to gearbox
- ❍ NEMA C-Face
- ❍ NEMA foot mount
- ❍ IEC B5 Mount
- ❍ IEC B14 Mount
- ❍ IEC foot mount

Voltage & Frequency

- ⊗ 230/460V-60Hz (460V only ≥ 40hp)
- ❍ 575V-60Hz
- ❍ 208V-60Hz
- ❍ 400V-50Hz
- ❍ 115/230V, 60Hz-1-ph.
- ❍ Other

Terminal Box Pos.

- ❍ TB1
- ⊗ TB2
- ❍ TB3
- ❍ TB4

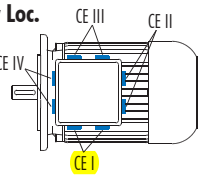


Mtg. Pos. M1 Shown

Conduit Entry Loc.

- ⊗ CE I *
- ❍ CE II
- ❍ CE III *
- ❍ CE IV

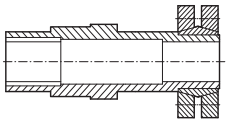
* Brakemotor



Mtg. Pos. M1 Shown

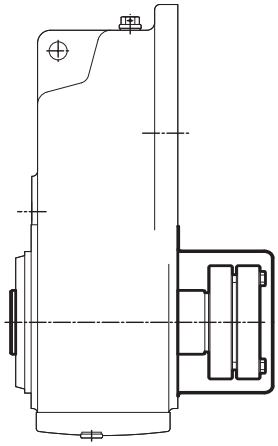
MOTORS

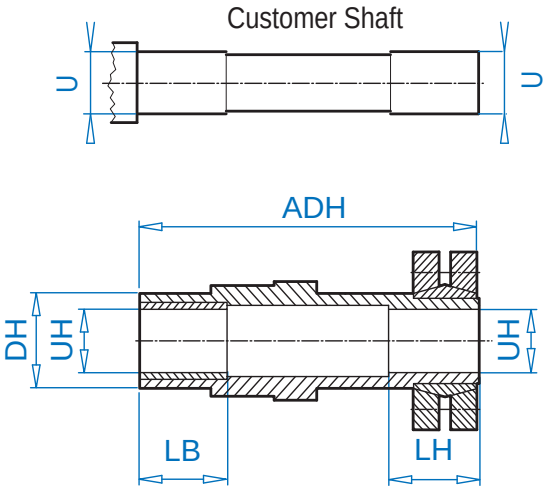
SK 6382 Drive Shaft Detail



Shrink Disc Shaft Dimensions

Shrink Disc Shaft Dimensions (AZSH)

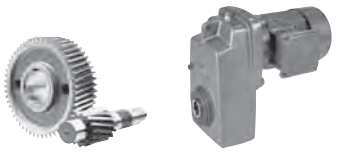




TYPE	HOLLOW SHAFT UH	HOLLOW SHAFT TOLERANCE	ADH	LB	LH	DH	CUSTOMER SHAFT U	CUSTOMER SHAFT TOLERANCE
SK 0282NB AZSH	1.1875	+0.0009 / -0.0000	6.30	1.18	1.57	1.57	1.1875	+0.0000 / -0.0006
	30mm	+0.021 / -0.000mm	160mm	30mm	40mm	40mm	30mm	+0.000 / -0.013mm
SK 1382NB AZSH	1.500	+0.0009 / -0.0000	8.66	1.57	1.77	1.97	1.500	+0.0000 / -0.0006
	35mm	+0.025 / -0.000mm	220mm	40mm	45mm	50mm	35mm	+0.000 / -0.016mm
SK 1282 AZSH	1.250	+0.0009 / -0.0000	6.38	1.18	1.57	1.77	1.250	+0.0000 / -0.0006
	30mm	+0.021 / -0.000mm	162mm	31mm	40mm	45mm	30mm	+0.000 / -0.013mm
SK 2282 AZSH	1.500	+0.0009 / -0.0000	7.68	1.57	1.77	1.97	1.500	+0.0000 / -0.0006
SK 2382 AZSH	35mm	+0.025 / -0.000mm	195mm	41.5mm	45mm	50mm	35mm	+0.000 / -0.016mm
SK 3282 AZSH	1.625	+0.0009 / -0.0000	8.86	1.61	2.17	2.17	1.625	+0.0000 / -0.0006
SK 3382 AZSH	40mm	+0.025 / -0.000mm	225mm	41mm	55mm	55mm	40mm	+0.000 / -0.016mm
SK 4282 AZSH	2.000	+0.0011 / -0.0000	10.28	2.01	2.17	2.76	2.000	+0.0000 / -0.0007
SK 4382 AZSH	50mm	+0.025 / -0.000mm	261mm	51mm	55mm	70mm	50mm	+0.000 / -0.016mm
SK 5282 AZSH	2.500	+0.0011 / -0.0000	11.61	2.17	2.76	3.35	2.500	+0.0000 / -0.0007
SK 5382 AZSH	60mm	+0.030 / -0.000mm	295mm	61mm	70mm	85mm	60mm	+0.000 / -0.019mm
SK 6282 AZSH	3.000	+0.0011 / -0.0000	14.57	2.56	3.35	3.94	3.000	+0.0000 / -0.0007
SK 6382 AZSH	70mm	+0.030 / -0.000mm	370mm	71mm	85mm	100mm	70mm	+0.000 / -0.019mm
SK 7282 AZSH	3.1875	+0.0013 / -0.0000	15.55	2.17	3.54	4.33	3.1875	+0.0000 / -0.0008
SK 7382 AZSH	80mm	+0.030 / -0.000mm	395mm	81mm	90mm	110mm	80mm	+0.000 / -0.019mm
SK 8282 AZSH	4.000	+0.0013 / -0.0000	17.95	2.76	3.74	5.12	4.000	+0.0000 / -0.0008
SK 8382 AZSH	100mm	+0.035 / -0.000mm	456mm	71mm	95mm	130mm	100mm	+0.000 / -0.022mm
SK 9282 AZSH	4.750	+0.0015 / -0.0000	21.06	3.23	4.33	6.30	4.750	+0.0000 / -0.0009
SK 9382 AZSH	125mm	+0.040 / -0.000mm	535mm	82mm	110mm	160mm	125mm	+0.000 / -0.022mm
SK 10282 AZSH	6.250	+0.0015 / -0.0000	25.98	4.72	5.12	8.66	6.250	+0.0000 / -0.0009
SK 10382 AZSH	160mm	+0.040 / -0.000mm	660mm	122mm	130mm	220mm	160mm	+0.000 / -0.025mm
SK 11282 AZSH	7.000	+0.0015 / -0.0000	26.57	4.00	4.33	9.45	7.000	+0.0000 / -0.0009
SK 11382 AZSH	180mm	+0.040 / -0.000mm	675mm	101.5mm	110mm	240mm	180mm	+0.000 / -0.025mm
SK 12382 AZSH	7.000	+0.0015 / -0.0000	33.27	4.00	10.59	9.45	7.000	+0.0000 / -0.0009
	180mm	+0.040 / -0.000mm	845mm	101.5mm	269mm	240mm	180mm	+0.000 / -0.025mm

SK 6382 Dimensions

SK 6382 + Motor



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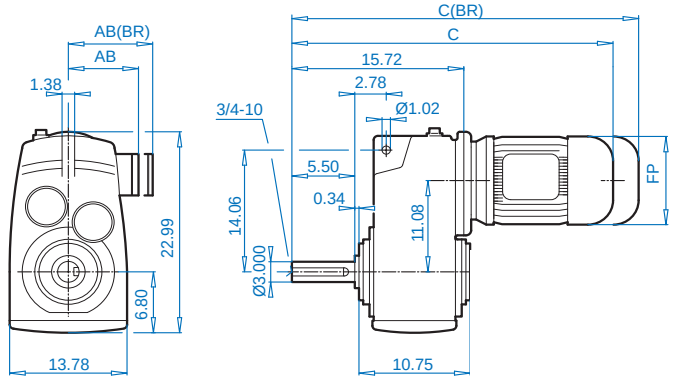

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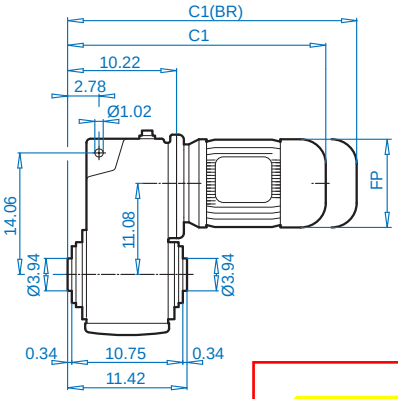

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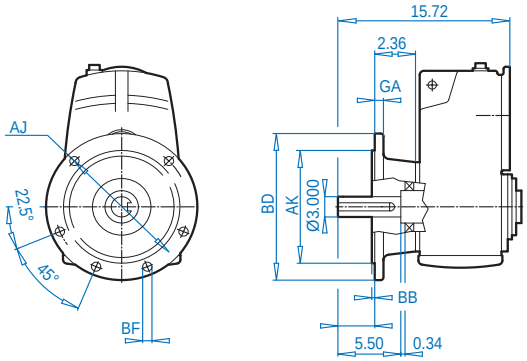

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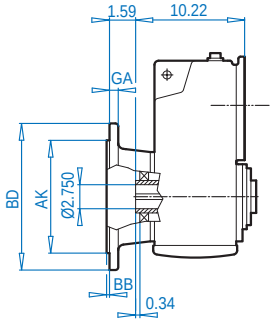

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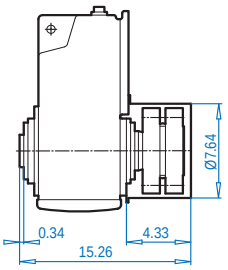

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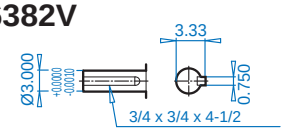

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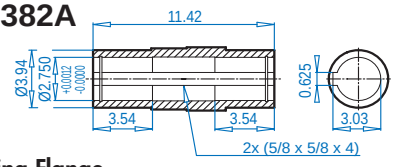
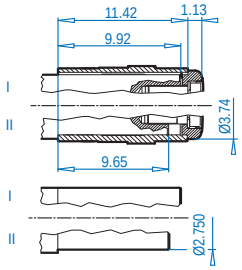


SK 6382AB ⇨📖 394



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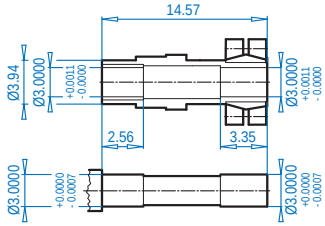


Mounting Flange

BD (mm)	AJ	AK	BB	BF	GA
15.75 (400)	13.78	11.81 +0.0000 -0.0013	0.20	0.71	0.79
17.72 (450)	15.75	13.78 +0.0000 -0.0014	0.20	0.71	0.87

Motor dimensions

Standard eff.	90S/L	100L		132S/M	160M/L		180MX/LX		For Other Connection Possibilities please see ⇨📖 376 & 378
Energy eff.	90SH/LH	100LH	112MH	132SH/MH	160MH	160LH		180MH/LH	
AB	5.79	6.65	7.05	8.03	8.90	8.90	8.90	10.20	
AB (BR)	5.83	6.26	6.69	7.72	8.90	8.90	8.90	10.20	
C1	21.15	22.33	23.23	26.62	29.10	30.67	30.67	34.77	
C1 (BR)	24.10	25.91	26.89	30.83	35.67	37.41	37.41	38.90	
C	26.65	27.83	28.73	32.12	34.60	36.17	36.17	40.27	
C (BR)	29.60	31.41	32.39	36.33	41.17	42.91	42.91	44.40	
FP	6.92	7.63	8.58	10.16	12.60	12.60	12.60	14.09	

(BR) denotes Brakemotor

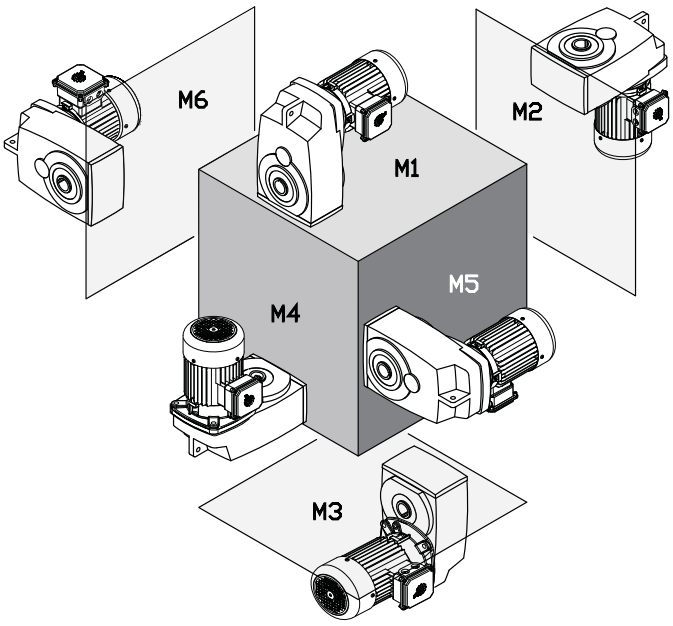
DIMENSIONS
Dimensions in Inches
ALTERNATE SHAFTS SEE PAGES 388 - 393

SK 6382 Oil Fill Quantities

CLINCHER™ OIL FILL QUANTITIES

CLINCHER™ lubrication

Unless otherwise noted below, the following NORD Gear reducers are shipped from the factory with a pre-determined oil fill level in accordance to the specified reducer size and mounting position. For additional information, please refer to the "Oil Plug & Vent Locations" documentation for your gear unit.



HARMFUL SITUATION

Actual oil volume can vary slightly depending upon the gear case size, mounting and ratio. Prior to commissioning the reducer, check the oil-fill level using the reducer's oil level plug and drain or add addition oil as needed.

For mounting orientations other than shown please consult NORD Gear. Reducer modifications may be required.

Type	M1		M2		M3		M4		M5		M6	
	Quarts	Liters	Quarts	Liters	Quarts	Liters	Quarts	Liters	Quarts	Liters	Quarts	Liters
SK 0182NB	0.420	0.400	0.580	0.550	0.630	0.600	0.580	0.550	0.370	0.350	0.370	0.350
SK 0282NB	0.740	0.700	1.06	1.000	0.850	0.800	1.16	1.10	0.950	0.900	0.950	0.900
SK 1282	0.950	0.900	1.37	1.30	0.950	0.900	1.27	1.20	1.000	0.950	1.000	0.950
SK 1382NB	1.37	1.30	2.43	2.30	1.48	1.40	2.22	2.10	2.11	2.00	2.01	1.90
SK 2282	1.74	1.65	2.54	2.40	2.01	1.90	2.11	2.00	1.90	1.80	1.90	1.80
SK 2382	1.80	1.70	2.75	2.60	2.01	1.90	3.28	3.10	1.59	1.50	1.59	1.50
SK 3282	3.33	3.15	4.33	4.10	3.44	3.25	4.33	4.10	3.33	3.15	3.33	3.15
SK 3382	4.33	4.10	5.18	4.90	3.49	3.30	5.92	5.60	3.49	3.30	3.49	3.30
SK 4282	4.97	4.70	6.45	6.10	5.02	4.75	5.71	5.40	4.97	4.70	4.97	4.70
SK 4382	6.24	5.90	7.19	6.80	5.18	4.90	8.77	8.30	5.18	4.90	5.18	4.90
SK 5282	7.93	7.50	9.30	8.80	7.93	7.50	9.30	8.80	7.61	7.20	7.61	7.20
SK 5382	13.21	12.50	12.68	12.00	7.08	6.70	14.80	14.00	8.77	8.30	8.77	8.30
SK 6282	17.97	17.00	14.80	14.00	12.68	12.00	18.50	17.50	10.57	10.00	14.80	14.00
SK 6382	17.44	16.50	13.74	13.00	10.15	9.60	19.03	18.00	14.80	14.00	13.21	12.50
SK 7282	26.42	25.00	22.20	21.00	21.14	20.00	28.54	27.00	16.91	16.00	22.20	21.00
SK 7382	23.25	22.00	21.14	20.00	16.91	16.00	26.42	25.00	24.31	23.00	20.08	19.00
SK 8282	39.11	37.00	34.88	33.00	31.71	30.00	43.34	41.00	32.77	31.00	32.77	31.00
SK 8382	35.94	34.00	33.82	32.00	26.42	25.00	40.17	38.00	37.00	35.00	31.71	30.00
SK 9282	78.22	74.00	73.99	70.00	58.14	55.00	76.10	72.00	63.42	60.00	62.36	59.00
SK 9382	77.16	73.00	73.99	70.00	47.56	45.00	78.22	74.00	68.70	65.00	63.42	60.00
SK 10282*	95.13	90.00	95.13	90.00	42.28	40.00	95.13	90.00	63.42	60.00	86.67	82.00
SK 10382*	89.84	85.00	105.67	100.00	77.16	73.00	105.70	100.00	84.56	80.00	84.56	80.00
SK 11282*	174.40	165.00	169.12	160.00	153.26	145.00	206.12	195.00	105.70	100.00	147.98	140.00
SK 11382*	169.12	160.00	163.84	155.00	147.98	140.00	221.97	210.00	163.84	155.00	142.70	135.00
SK 12382*	169.12	160.00	163.84	155.00	147.98	140.00	221.97	210.00	163.84	155.00	142.70	135.00

*** For shipping purposes the larger Clincher™ gear units are supplied without oil.**

G. Thermal Fluid Heater

- Therma-Flite IC 10,000 Thermal Fluid Piping Responsibilities
- Fulton Drawing No.: T91DR-0565, FT-1200-C, Heater, Skid Mounted w/ Exothermics Tubular Heat Exchanger
- Fulton Product Data Submittal, Model FT-1200-C
- Fulton Installation, Operation, and Maintenance Manual
- Paratherm NF Heat Transfer Oil
- Fulton FT 1200-C Thermal Heating Unit Spare Parts List
- Fulton FT 1200 C Air Cooled Pump Spare Parts List
- Fulton FT 1200 C Pump Performance Data
- Fulton FT 1200 C Blower Performance Data
- Fulton FT 1200C Electrical Schematic Drawing T53DR-1834 Sheet 1 of 2
- Fulton FT 1200C Electrical Schematic Drawing T53DR-1834 Sheet 2 of 2
- Fulton Drawing No.: 7-54-120006, Fulton FT 1200 C Gas Train
- Fulton FT 1200 C BGMU Room Layout

Therma-Flite IC 10,000 Thermal Fluid Piping Responsibilities

Therma-Flite
The Screw Heat Exchanger Company

P.O. Box 847
849 Jackson St.
Benicia, CA 94510
P (707) 747-5949
F (707) 747-5951
www.therma-flite.com

IC10000 Recommendations and Responsibilities for Thermal Fluid Piping

Reference: Typical Fulton Thermal Piping Schematic

System Piping Responsibilities:

Case 1: Thermal Fluid Heater is located adjacent to the Dryer Module and is pre-piped from the factory upon shipment.

Therma-Flite shall provide a standard FT-1400-C Fulton Thermal Corp. Hot Oil Heating System with all interconnecting piping and instrumentation to and from the Dryer Module.

Case 2: Thermal Fluid Heater is located away from the Dryer Module and is not pre-piped from the factory upon shipment.

Therma-Flite shall provide a standard FT-1400-C Fulton Thermal Corp. Hot Oil Heating System and instrumentation for the function of the system. Supply and Return piping to and from the Dryer module shall be the responsibility of the Contractor.

Not Provided by Therma-Flite

1. Catch Tank (15) for drain of pressure relief valve, cold seal expansion tank and vent. (Catch Tank must be located in a safe area)
2. Vent Piping (11) from the Cold Seal Expansion Tank to the Catch Tank.
3. Manual Low Level Test Line (21) to the Catch Tank.
4. Manual High Level Test Line (22) to the Catch Tank.
5. Buffer Drain (23) from the Cold Seal Expansion Tank to the Catch Tank.
6. Pressure Relief line to the Catch Tank.

Recommended Volume of the Catch Tank

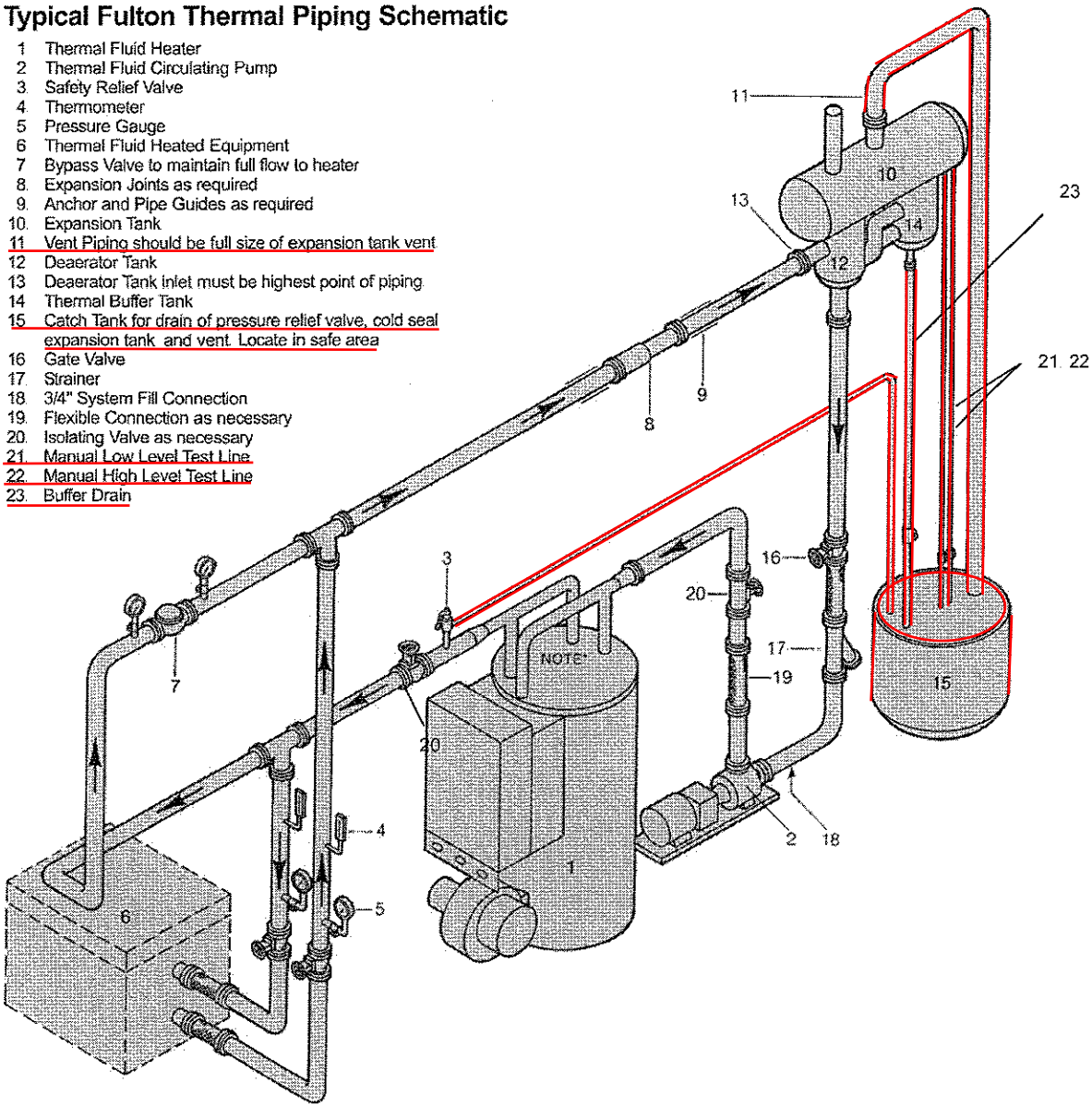
Case 1: Minimum of 200 gal. capacity.

Case 2: Minimum of 200 gal. capacity plus the additional volume added by the piping between the Thermal Fluid Heater and the Dryer Module.

d) Typical Fulton Thermal Piping Schematic

Typical Fulton Thermal Piping Schematic

1. Thermal Fluid Heater
2. Thermal Fluid Circulating Pump
3. Safety Relief Valve
4. Thermometer
5. Pressure Gauge
6. Thermal Fluid Heated Equipment
7. Bypass Valve to maintain full flow to heater
8. Expansion Joints as required
9. Anchor and Pipe Guides as required
10. Expansion Tank
11. Vent Piping should be full size of expansion tank vent
12. Deaerator Tank
13. Deaerator Tank inlet must be highest point of piping
14. Thermal Buffer Tank
15. Catch Tank for drain of pressure relief valve, cold seal expansion tank and vent. Locate in safe area
16. Gate Valve
17. Strainer
18. 3/4" System Fill Connection
19. Flexible Connection as necessary
20. Isolating Valve as necessary
21. Manual Low Level Test Line
22. Manual High Level Test Line
23. Buffer Drain



Note

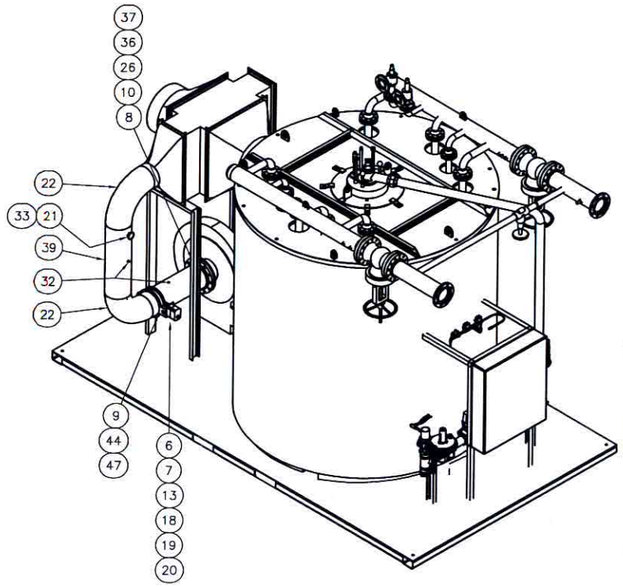
The catch tank should be appropriately sized based on the system volume and configuration.

Under normal operating conditions, the catch tank should be empty.

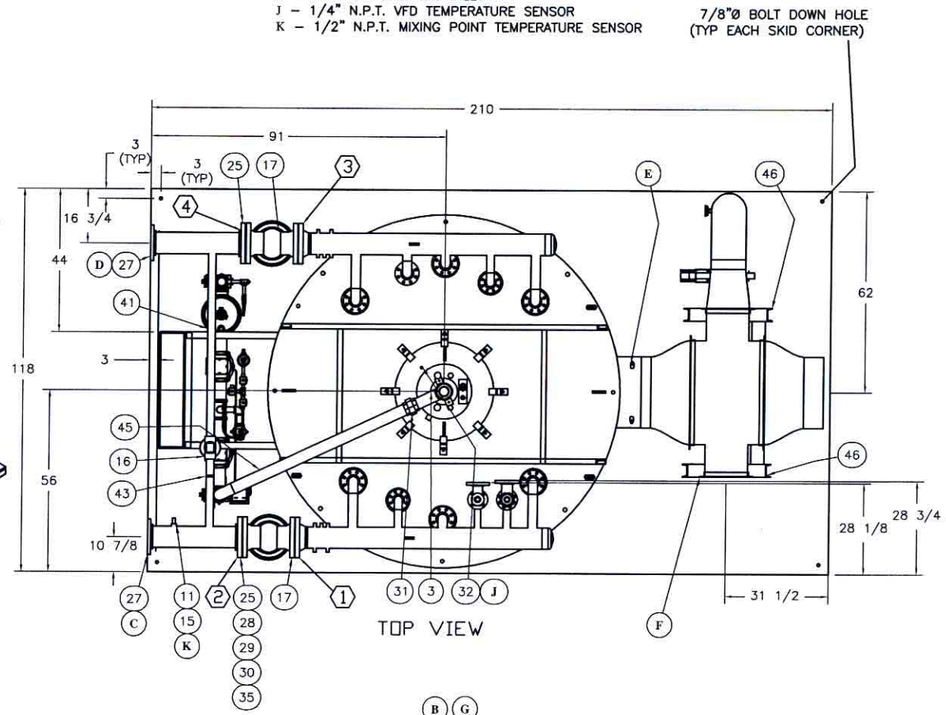
Fluid that is expelled into the tank should not be reintroduced into the system.

Fulton Drawing No.: T91DR-0565, FT-1200-C Heater w/ Exothermics Tubular Heat Exchanger

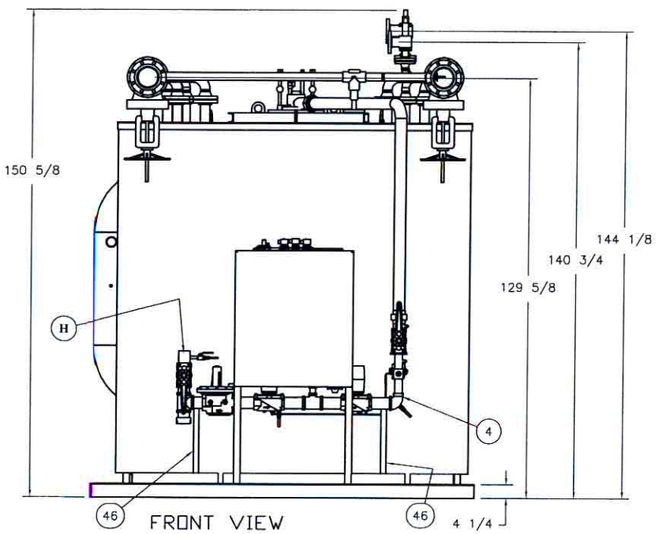
THE FOLLOWING ARE MAJOR CUSTOMER CONNECTIONS:
- A – 22"Ø FLUE CONNECTION
  26"Ø RECOMMENDED VERTICAL STACK DIAMETER
- B – 2 1/2" 150# FLANGED SAFETY RELIEF VALVE OUTLET
- C – 6" 150# THERMAL FLUID OUTLET
- D – 6" 150# THERMAL FLUID INLET
- E – 1/2" STACK LIMIT SWITCH
- F – 13 1/8" x 33 1/4" FLANGED AIR INLET CONNECTION
- G – 3" 150# FLANGED SAFETY RELIEF VALVE OUTLET
- H – 3" N.P.T. NAT. GAS INLET
- J – 1/4" N.P.T. VFD TEMPERATURE SENSOR
- K – 1/2" N.P.T. MIXING POINT TEMPERATURE SENSOR



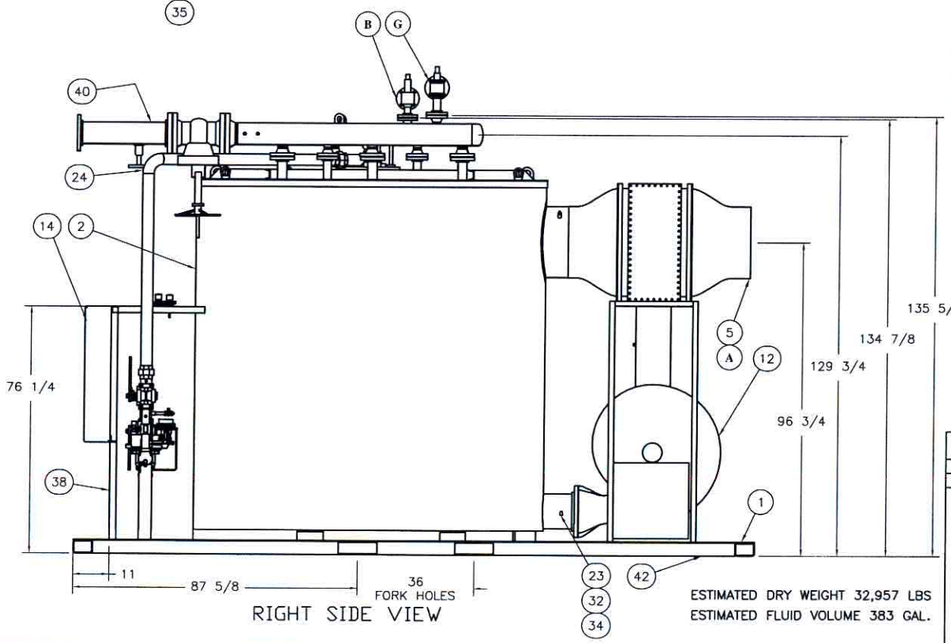
ISO VIEW



TOP VIEW



FRONT VIEW



RIGHT SIDE VIEW

ESTIMATED DRY WEIGHT 32,957 LBS
ESTIMATED FLUID VOLUME 383 GAL.

Parts List

ITEM	PART NUMBER	DESCRIPTION	QTY	U.O.M.
1		1/4" HR PLATE	173	S.F.
2	9-FT-1200-C	FT-1200-C HEATER	1	EA.
3	7-30-004027	DUEL FUEL BURNER FOR FT1000,1200, AND 1400-C HEATER	1	EA.
4	7-54-120006	7-54-NFPA GAS TRAIN	1	EA.
5	PO#	EXOTHERMIC TUBULAR HEAT EXCHANGER (TBS-01U)	1	EA.
6	PO#	1/2" COLLAR (MCMASTER 6435K14)	2	EA.
7	PO#	1/2" BEARING (MCMASTER 6384K361)	2	EA.
8	PO#	10" 150# GASKET	4	EA.
9	PO#	10" BUTTERFLY VALVE	1	EA.
10	PO#	7/8" x 3" BOLT	24	EA.
11	PO#	3/4" S.W. COUPLING	1	EA.
12	PO#	NY BLOWER (23TO2610)	1	EA.
13	PO#	14MM TO 1/2" SHAFT COUPLING	1	EA.
14	(SEE ELECTRICAL)	PANEL BOX 42" H x 36" W x 8" D	1	EA.
15	2-30-000556	THERMOWELL 3/4" SW. x 1/2" N.P.T. FOR 4" PIPING AND UP	1	EA.
16	2-30-000903	2" S.W. GLOBE VALVE	1	EA.
17	2-30-000844	6" 300# GATE VALVE	2	EA.
18	2-40-000433	SIEMENS AIR SERVO MOTOR	1	EA.
19	5-10-003067	SERVO MOTOR BRACKET	1	EA.
20	2-22-000095	6-32- X 1/2" SS MACHINE SCREW	3	EA.
21	2-30-001003	200-1000F THERMOMETER 1/2" NPT	1	EA.
22	2-35-000725	10" WELD ELBOW	2	EA.
23	2-35-000269	1/4" N.P.T. ELBOW	1	EA.
24	2-35-000422	3" SCH. 40 WELD ELBOW	1	EA.
25	2-35-000555	6" 300# R.F. S.O. FLANGE SA-105	2	EA.
26	2-35-000676	10" 150# R.F. S.O. FLANGE	2	EA.
27	2-35-000553	6" 150# R.F. S.O. FLANGE	2	EA.
28	2-12-000421	6" 300# GASKET	4	EA.
29	2-35-000343	3/4" x 4 1/2" BOLT	48	EA.
30	2-22-000068	3/4" LOCK WASHER	48	EA.
31	2-35-000066	3" N.P.T. UNION	1	EA.
32	2-35-000210	1/4" N.P.T. SCH-40 COUPLING	4	EA.
33	2-35-000460	1/2" FS COUPLING N.P.T.	1	EA.
34	2-35-000371	1/4" x 2" N.P.T. NIPPLE SCH 80	1	EA.
35	2-35-000346	3/4" HEX NUT	48	EA.
36	2-22-000129	7/8" LOCK WASHER	24	EA.
37	2-22-000128	7/8" HEX NUT	24	EA.
38	1-10-000109	2" x 2" x 1/4" ANGLE STEEL	23	FT.
39	1-10-000008	10" PIPE	7	FT.
40	2-10-000147	6" PIPE	4	FT.
41	2-10-000112	2" PIPE	7	FT.
42	2-10-000216	4" x 6" TUBE STEEL	53	FT.
43	CUSTOM MANUFACTURED	4 HOLES @ 3/8" ORIFICE	1	EA.
44	CUSTOM MANUFACTURED	10" BUTTERFLY FLANGES	2	EA.
45	2-10-000114	3" PIPE	12	FT.
46	2-10-000100	4" x5.4# CHANNEL	40	FT.
47	2-12-000120	1/4" HOLLOW GASKET	2	EA.

NOTES:
1. PORTIONS OF THE PIPING AND COMPONENTS WILL BE DISASSEMBLED FOR SHIPPING.
2. THE SUPPORT STRUCTURE MAY BE CROSS BRACED OR OTHERWISE ENHANCED BEYOND WHAT IS SHOWN, AS REQUIRED.
3. FORK HOLES ARE LOCATED ON RIGHT SIDE OF SKIDS. HEATER SKID CONSTRUCTION FOR FT-0600-C THRU FT-1200-C, PLACE ONE RUNNER ON HEATER CENTERLINE & ONE ON OUTSIDE EDGE OF EACH FORK HOLE. PLACE ALL OTHER RUNNERS MAX. 24" ON CENTER
4. ADDITIONAL FIELD SUPPORTS MAY BE REQUIRED.
5. PLEASE REFER TO THE O&M MANUAL FOR ADDITIONAL INFORMATION REGARDING CLEARANCES AND INSTALLATION INSTRUCTIONS.

(X) — DENOTES FLANGE CONNECTION NUMBER- USE NUMBERS STAMPED ON MATCHING FLANGES TO AID REASSEMBLY.

REV.	DESCRIPTION	CHECKED	MECH. ENG.	ELEC. ENG.	APPROVAL
-	INITIAL RELEASE	4/20/10	4/20/10	4/20/10	4/20/10

REVISIONS

The item shown in this drawing may be covered by one or more patents of The Fulton Companies.

This design and drawing are proprietary and are the exclusive property of The Fulton Companies. The corporation does not permit their use except with prior written consent.

DRAWN BY: T. CORSON — DATE: 15 APR 2010
SCALE: 3 / 64 — SHEET NO. 1 / 1
UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCE ON
FRACTIONS ± 1/4
TWO PLACE DECIMALS ± .01
THREE PLACE DECIMALS ± .005
ANGLES ± 2 DEG.
SURFACE FINISH 250 MICROINCHES

Fulton Thermal Corp.
972 Centerville Road
Pulaski, New York, USA 13142

FULTON

FT-1200-C THERMAL FLUID HEATER
SKID MOUNTED WITH
EXOTHERMICS TUBULAR HEAT EXCHANGER

SHEET SIZE D — DWG NO. T91DR-0565 — REV -

Fulton Product Data Submittal, Model FT-1200-C

Industrial/Commercial Division
Fulton Thermal Corporation

Product Data Submittal
Model FT-1200-C

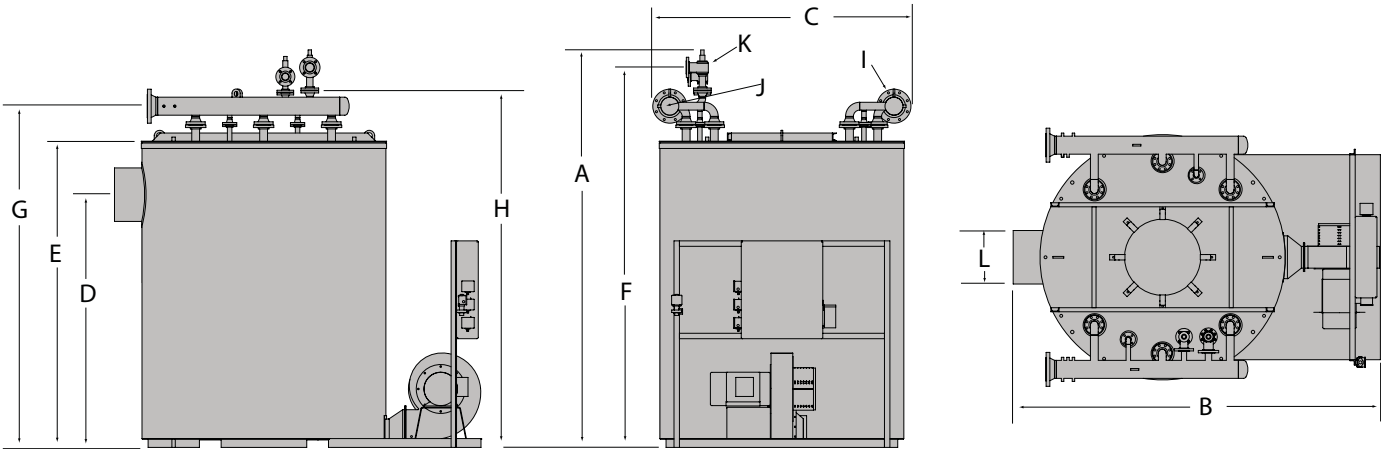
Fulton Coil Design
Thermal Fluid Heater

Dimensions and Specifications

A. Heater Height	IN	146.4
	MM	3718
B. Heater Depth	IN	152.9
	MM	3882
C. Heater Width	IN	108.4
	MM	2753
D. Height to Center of Flue	IN	92.4
	MM	2348
E. Height to Top of Vessel	IN	111.4
	MM	2831
F. Height to Safety Valve Outlet	IN	136.5
	MM	3467
	IN	139.9
	MM	3553
G. Height to Heater Inlet/Outlet	IN	125.4
	MM	3186
H. Height to Safety Relief Valve Inlet	IN	130.6
	MM	3316
	IN	131.4
	MM	3337
I. Heater Inlet	IN	6
	MM	152
J. Heater Outlet	IN	6
	MM	152
K. Safety Relief Valve Outlet	IN	2.5
	MM	64
	IN	3
	MM	76
L. Flue Diameter	IN	22
	MM	559

Heat Output	1000 BTU/Hr.	12000
	1000 KCAL/Hr.	3000
Fuel Input	No. 2 Oil GPH	104.5
	Liter/Hr	395.5
	Natural Gas FT^3/Hr	14998
	Natural Gas M^3/Hr	424.6
Gas Pressure Required	IN W.C.	120
Recommended Circulation Rate	GPM	730
	M^3/Hr.	167
Pressure Drop Across Heater at Recommended Circulation Rate	PSID	27
	Bars	1.9
Burner Motor	HP	20
	KW	15
Circulating Pump Motor	HP	50
	KW	37.3
Heater Fluid Content	Gallons	383
	Liters	1448
Heater Dry Weight	LB	21700
	KG	9850
Customer Thermal Fluid Connection	IN	6
	MM	152.4

Specifications and Dimensions are approximate and for reference only.
We reserve the right to change specifications and/or dimensions.
Operating specifications may change based on field conditions.

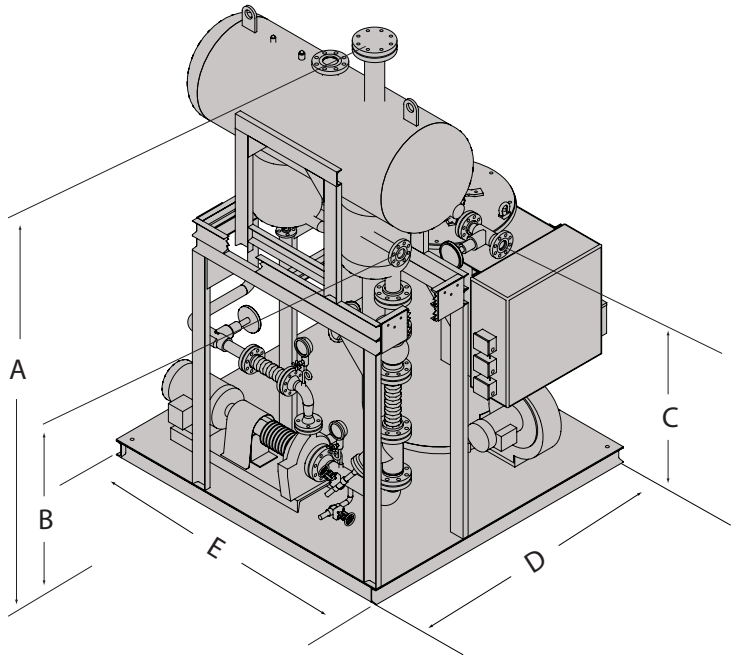


Specifications

Completely Skid Mounted Units
(Heater, Pump and Tank)

Completely skid mounted units come equipped with:
A. Pipework between Deaerator Tank outlet and Pump Suction including:
   1. Valve
   2. Flexible Connector
   3. Y-Type Strainer
B. Pipework between Pump discharge and Heater inlet including:
   1. Flexible Connector
   2. Valve

Note: unit will be disassembled for shipping

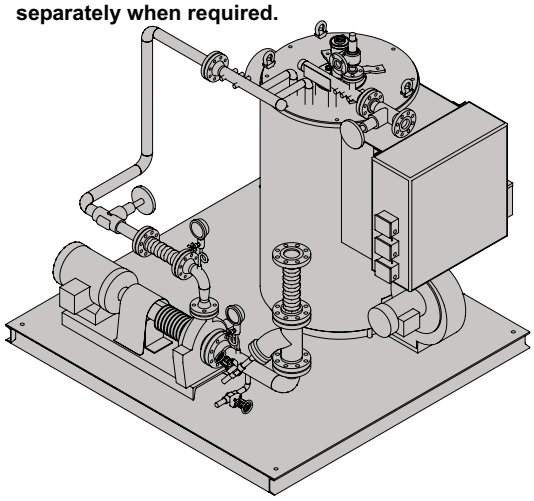


Drawings are for reference only. Details vary with model.
Specifications subject to change without notice.

Skid Mounted Units
(Heater and Pump)

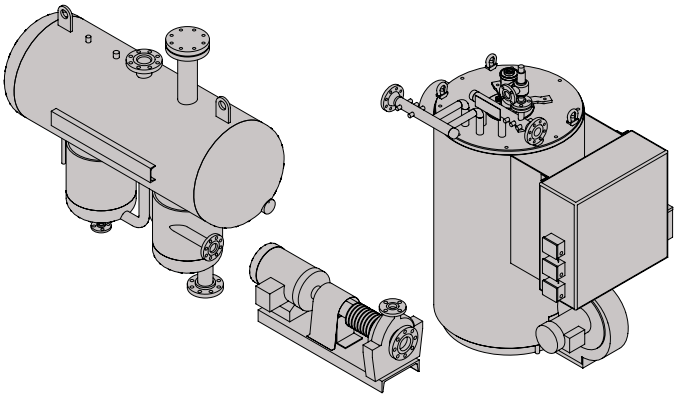
Skidded units ordered without the Combination Tank come equipped with:
A. Pipework on the suction side of pump
   1. Y-Type Strainer
   2. Flexible Connector
   3. Valve
B. Pipework between Pump discharge and Heater inlet including:
   1. Flexible Connector
   2. Valve

Expansion tank is supplied separately when required.



Non-Skid Mounted Units
(Heater, Pump, and Tank Without Skid Mounting)

No piping components are supplied as standard. However, they are available as options - consult factory.



Dimensions
Model FT-1200-C

Heater Model	Tank Model	Highest Elevation A	Tank Inlet B	Heater Outlet C	Width D	Depth E
FT-1200-C	FT-1000-L	188.5in. 4788mm	126.5in. 3213mm	129.75in. 3296mm	150in. 3810mm	148in. 3759mm
FT-1200-C	FT-1500-L	188.5in. 4788mm	126.5in. 3213mm	129.75in. 3296mm	150in. 3810mm	148in. 3759mm
FT-1200-C	FT-2000-L	202.5in. 5143mm	130in. 3181mm	129.75in. 3296mm	158in. 4013mm	148in. 3759mm
FT-1200-C	FT-3000-L	207.5in. 5270mm	135in. 3429mm	129.75in. 3296mm	158in. 4013mm	148in. 3759mm
FT-1200-C	FT-5000-L	225.5in. 5728mm	135in. 3429mm	129.75in. 3296mm	175in. 4445mm	148in. 3759mm

Fulton®

Fulton Thermal Corporation.
972 Centerville Road
Pulaski, New York USA 13142
Call 315-298·5121
Fax 315-298·6390

1200C PDS
09/08
Printed in USA

Fulton Vertical Coil Design Thermal Fluid Heaters

(Models FT-C & FT-S)

Installation, Operation and Maintenance Manual

Serial # _____

Model # _____

Fulton Order # _____

Sold To _____

Job Name _____

Date _____

Fulton Thermal Corp.
972 Centerville Road
Pulaski, NY 13142
Telephone: (315) 298-5121
Facsimile: (315) 298-6390
www.fulton.com

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Section 1

Section 1 – Safety Warnings & Precautions

Prior to shipment, the following tests are made to assure the customer the highest standards of manufacturing:

a) Material inspections
b) Manufacturing process inspections
c) ASME welding inspection
d) ASME hydrostatic test inspection
e) Electrical components inspection
f) Operating test
g) Final engineering inspection
h) Crating inspection

Rigging your heater into position should be handled by a competent rigger experienced in handling heavy equipment.

The customer should examine the heater for any damage, especially the refractories. **It is the responsibility of the installer to ensure all parts supplied with the heater are fitted in a correct and safe manner.**

Warning

Operating the heater beyond its design limits can damage the heater, it can also be dangerous. Do not operate the heater outside its limits. Do not try to upgrade the heater performance by unapproved modifications. Unapproved modifications can cause injury and damage. Contact your Fulton dealer before modifying the heater.

Warning

A defective heater can injure you or others. Do not operate a heater which is defective or has missing parts. Make sure that all maintenance procedures are completed before using the heater. Do not attempt repairs or any other maintenance work you do not understand. Obtain a Service Manual from Fulton or call a Fulton Service Engineer.

Warning

Thermal Fluid Heaters have high temperature surfaces, that if touched may cause serious burns. Only competent and qualified personnel should work on or in the locality of a thermal fluid heater and ancillary equipment. Always ensure the working area and floor are clear of potential hazards, work slowly and methodically.

WARNING: If the information in this manual is not followed exactly, a fire or explosion may result causing property damage, personal injury or loss of life.

- Do not store or use gasoline or other flammable vapors and liquids in the vicinity of this or any other appliances.

- **WHAT TO DO IF YOU SMELL GAS**

  - Do not try to light any appliance.
  - Do not touch any electrical switch; do not use any phone in your building.
  - Immediately call your gas supplier from a neighbor's phone. Follow the gas supplier's instructions.
  - If you cannot reach your gas supplier, call the fire department.

- Installation and service must be performed by a qualified installer, service agency or the gas supplier.

For Your Safety

The following **WARNINGS**, **CAUTIONS** and **NOTES** appear in various chapters of this manual. They are repeated on these safety summary pages as an example and for emphasis.

- **WARNINGS** must be observed to prevent serious injury or death to personnel.
- **CAUTIONS** must be observed to prevent damage or destruction of equipment or loss of operating effectiveness.
- **NOTES** must be observed for essential and effective operating procedures, conditions, and as a statement to be highlighted.

It is the responsibility and duty of all personnel involved in the operating and maintenance of this equipment to fully understand the **WARNINGS, CAUTIONS** and **NOTES** by which hazards are to be eliminated or reduced. Personnel must become familiar with all aspects of safety and equipment prior to operation or maintenance of the equipment.

Note

The installation of a barometric stack regulator is recommended at all installations.

Note

If the tank is located outdoors nitrogen is required.

Note

Non-code tanks cannot be pressurized over 15 psig.

Warning

High temperature thermal fluid, steam and combustible vapors may be vented through the vent connection on the combination dearetor/thermal buffer/expansion tank.

Warning

Once the system has been filled, any modification to the tank or connected piping requires purging of the work area to prevent ignition of potentially flammable vapors. Consult factory prior to beginning work. Consult MSDS for your thermal fluid for flammability limits.

Note

If the circulating pump motor is not supplied by Fulton Thermal Corporation, the motor starter will not be supplied.

Note

Low emissions burners for all models require 10 psi gas pressure.

Note

With the exception of the duct run previously described, horizontal sections of ducting must be avoided and should not exceed four feet total.

Note

The system pump is not to be used to fill the system.

Caution

For reasons of safety, the hot exhaust gas duct and chimney must be insulated or shielded within the locality of the heater.

Caution

During operation, any leaks are usually detected by a small amount of vapor. Leaks should be attended to as soon as possible because under certain circumstances, such as saturated insulation, thermal fluid can ignite when exposed to air and heat.

Note

Fulton Thermal Corporation cannot be held responsible in the case of accident or damage resulting from the use of inadequate fluid.

Note

Unless specially filtered, compressed air will introduce moisture into the system. Dry air or Nitrogen is recommended.

Note

Some plastics can be dissolved by thermal fluid.

Note

Do not use system circulating pump for system filling.

Note

A pump that has been used for water or a different thermal fluid should not be used prior to extensive cleaning. Thermal fluid can be damaged by contact with moisture or other fluids.

Warning

Pressurizing a drum to force fluid into the system is not recommended. The drum can easily explode, creating a hazard to personnel and equipment.

Note

Tanks are non-code as a standard. Non-code tanks cannot be pressurized over 15psig. Tanks built to ASME code Section VIII Div 1 are available upon request.

Note

Do not run the pump before filling it with fluid.

Caution

1. **Use extreme caution opening plug when system temperature is elevated.**
2. **Wear eye and hand protection.**
3. **Back the plug out slowly to the last two or three threads. Allow any pressure under plug to bleed slowly to prevent a spray of hot oil.**

Warning

During a system boil out, it is imperative that all system legs or paths are open to flow to ensure no water is trapped in the system.

Warning

Never open a cool or unheated user leg of a system when the rest of the system is above 250°F.

Note

Do not open drain or vent valves during operation.

Note

If excessive amounts of thermal fluid is vented from the system, additional thermal fluid may be required in the system.

Note

Flash steam may be generated at any point up to the operating temperature. Watch for gauge fluctuations.

Note

Start-up technician should verify that all valves are opened prior to establishing flow and heat-up.

Note

If fluid or piping is added to the system the boil out procedure must be followed as water has to be introduced into the system.

Note

If the burner loses flame while driving to a point then:

- **Turn the main ON/OFF switch to OFF. Reset the loss of flame fault. Press Escape on the AZL once. Press Enter on the AZL to reset the control. The red light on the panel box door should go out.**
- **Adjust the air and gas servos for that point while the burner is off. Follow steps 28-29.**
- **Turn the main ON/OFF switch to ON.**

Note

As soon as a servo position is altered, the servo will move to that position. Only change servo settings by a maximum of 0.5° at a time before verifying combustion.

Caution

The heater emissions may not be correct after changing the servo motor. Verify the emissions throughout the range of modulation. If emissions are off, the servo motor can be adjusted by following the procedure in the Commissioning the Heater section of this manual.

Note

Use extreme caution to avoid contact with the cleaning solution.

Note

Refer to local regulations for disposal of caustic solution.

Note

All of the above maintenance procedures should be completed by trained personnel. Appropriate training and instructions are available from the Fulton Service Department at (315) 298-7148 or your local Fulton Thermal Representative.

Note

Since unit lights at low fire, it may be necessary to increase high gas pressure setting or jumper contacts to allow unit to modulate to where modulation gas valve back pressure is lessened.

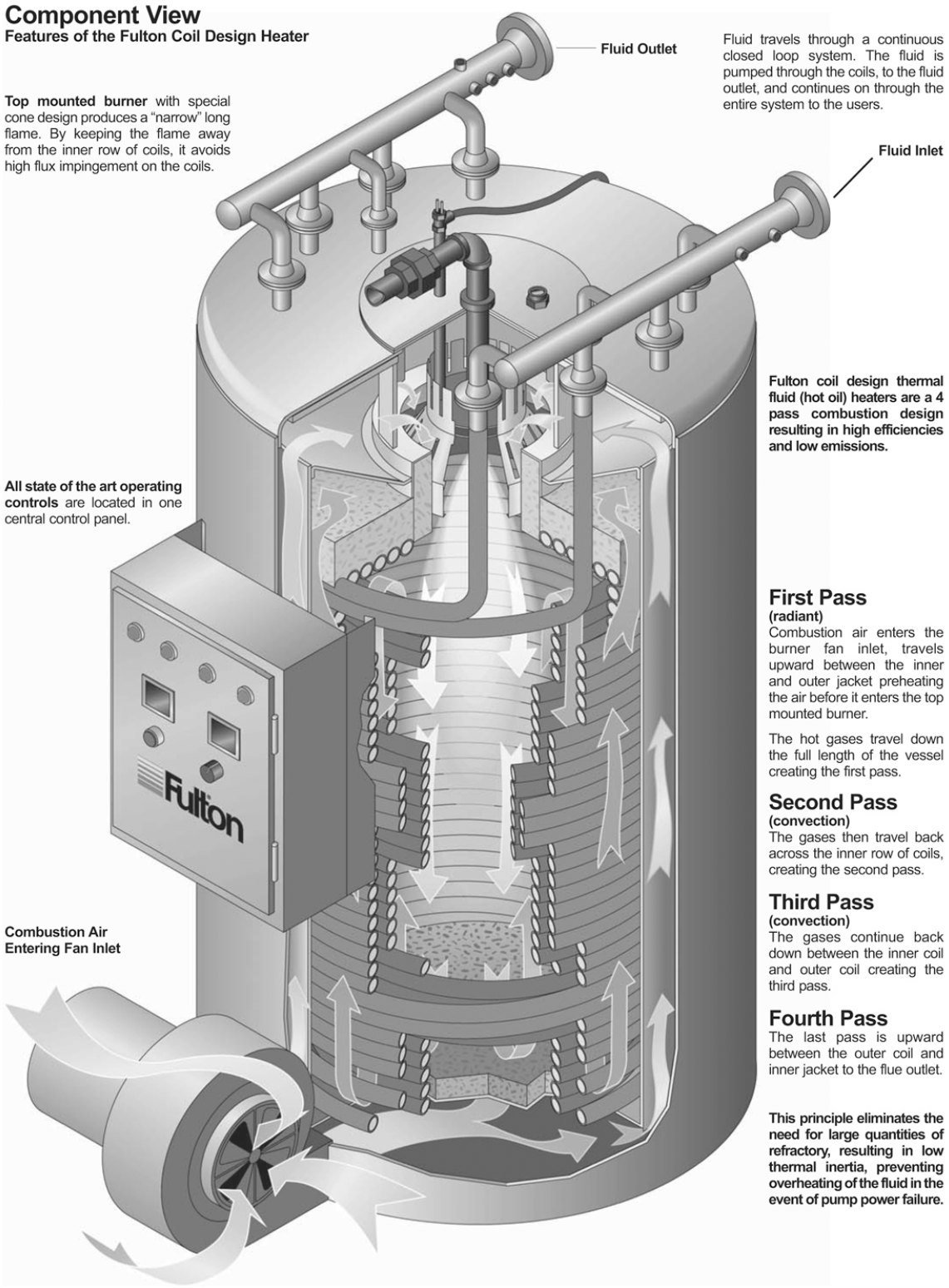
Note

Room temperature not to exceed 100^{o} F.

Section 2

Section 2 – Installation

1. Component View



2. Placement

a) Proper placement of your Fulton Thermal Fluid Heater is essential. Attention paid to the following points will save a great deal of difficulty in the future. Correct placement is the first step to trouble-free installation, operation and maintenance.

b) All Fulton Vertical Coil Design Heaters are shipped vertically and all units are crated for forklift transport. Once uncrated, all units with the exception of freestanding models FT-0080C, FT-0120C, FT-0160C and FT-0240C can be transported with a forklift.

c) These four models can only be lifted for unloading and moving by means of lifting lugs at the top of the heaters. If means of lifting are not available, rollers should be placed beneath the frame of the heater, and it should be guided to the position of where it is to be installed. Under no circumstances should weight be allowed to bear on the jacket, control panel or fan housing of any Fulton Thermal Fluid Heater.

d) All stand alone heaters can be moved via a crane utilizing the lifting lugs on top of the heater. The FT-0320C and larger stand alone heaters can also be moved using a fork lift. All skidded units can be moved with forklifts.

3. Location

a) Authorities with jurisdiction over any national or local codes which might be applicable to thermal fluid applications should be consulted before installations are made.

b) The heater should be located as close as possible to the place where the heat will be used in order to keep pipe work costs to a minimum.

c) A level, hard, non-combustible surface is required for a suitable base for mounting the unit. It is suggested that a four inch curb be installed completely around the unit. In the event of a large spill, this will help contain the fluid.

d) Approximations for the floor loading of each heater are given in the floor loadings table. Check building specifications for permissible floor loading.

e) The heater should be placed in a suitable heater house or well ventilated separate room through which personnel do not normally pass. This is not essential, but the layout should eliminate traffic in potentially hazardous areas. For instance, the service engineer or the operator should not have to pass exposed, hot pipe work to make adjustments to the heater controls.

f) Ventilation must be sufficient to maintain a building temperature of 100°F. or less and the panel box temperature must not exceed 125°F. Natural ventilation should be provided by means of grills at floor and ceiling level.

g) To burn fuel properly, the burner must have an adequate supply of air. The bottom vent should be sized to allow a minimum of 0.4 square inch of opening for every 1,000 BTU/hr. input of fuel (10 cm^2/1000 kcal/hr). The upper vent should be at least one third this size. See table for minimum make up air required and the recommended area of opening for each heater.

h) If positive forced ventilation is adopted, you must ensure that there will be no appreciable pressure variation in the heater room.

Note

The installation of a barometric stack regulator is recommended at all installations.

i) Artificial ventilation by extraction of air is not recommended. This method of ventilation can create a negative pressure in the building which will seriously affect combustion and proper operation of the stack. Please note that exhaust fans or similar equipment can create a down draft in the chimney or starve the burner's air supply. Either case may result in poor combustion or nuisance failures. A properly designed make-up air system in the heater room will preclude these possibilities and is required to maintain proper combustion.

j) In addition, an exhaust fan may draw products of combustion into the work environment creating a possible hazard to personnel.

k) It is essential that only fresh air be allowed to enter the combustion air system. Foreign substances, such as combustible volatiles and lint in the combustion system can create hazardous conditions.

Note

When calculating ventilation requirements, heat losses from the Fulton equipment (and other equipment) should be considered.

4. Approximate Floor Loadings

a) Free standing figures take the weight of the heater alone into consideration. Floor loadings for skid mounted units vary with configuration.

Model	Heater Only
FT-0080C	500 lbs/ft2
FT-0120C	400 lbs/ft2
FT-0160C	450 lbs/ft2
FT-0240C	450 lbs/ft2
FT-0320C	450 lbs/ft2
FT-0400C	450 lbs/ft2
FT-0600C	550 lbs/ft2
FT-0800C	500 lbs/ft2
FT-1000C	500 lbs/ft2
FT-1200C	400 lbs/ft2
FT-1400C	450 lbs/ft2
FT-0400S	675 lbs/ft2
FT-0600S	675 lbs/ft2
FT-0800S	525 lbs/ft2

5. Minimum Make-Up Air Required and Recommended Area of Opening for Vents

Model	Minimum Make-Up Air (SCFM)	Opening Area (in^2) Lower Vent	Opening Area (in^2) Upper Vent
FT-0080C	200	400	135
FT-0120C	300	600	205
FT-0160C	400	800	270
FT-0240C	600	1200	400
FT-0320C	800	1600	535
FT-0400C	1000	2000	670
FT-0600C	1500	3000	1000
FT-0800C	2000	4000	1335
FT-1000C	2500	5000	1670
FT-1200C	3000	6000	2000
FT-1400C	3500	7000	2335
FT-0400S	1000	2000	670
FT-0600S	1500	3000	1000
FT-0800S	2500	4000	1335

6. Access

a) Access around the heater should be provided to facilitate maintenance. Appropriate clearances for all sides follow.

b) Place heater with clearances to unprotected combustible materials, including plaster or combustible supports, not less than the following:

1. Heater Front 36” (1m)
2. Heater Sides 18” (.5m)
3. Heater Rear 18” (.5m)
4. Flue Pipe 18” (.5m)
5. Heater Top 60” (1.52m)*
6. *For burner removal. Burners may weigh up to 550 lbs. depending on the type and configuration. Customer to provide adequate means of burner removal.

c) All heaters will also require a minimum clearance of 5’ overhead for personnel access and burner removal. In cases where the available height is insufficient, a roof or ceiling trap might be considered.

d) Pipes should not be run within ten inches of any control cabinets or combustible material.

e) For UL listed units, see the specification plate on the Fulton Thermal Fluid Heater for these clearances. Verify that these clearances are acceptable with the local ordinances. Fulton Vertical Coil design units need only sufficient headroom for burner maintenance. However, in the event of major overhaul involving coil removal clearance as detailed in the **Minimum Clearance for Coil Removal** chart will be necessary. If this space is not available, the Fulton coil design unit may be removed to another area for coil removal.

f) Provision must be made for suitable access to the top of the heater. Larger models of the vertical coil design unit (FT-0320C and above) require an access ladder/gantry to be provided by the customer to allow clear access to the top of the heater for maintenance purposes. Fulton Thermal Corporation will advise on the suitability of the access provided and will be glad to give any assistance that may be required in this respect. Access provision should avoid possible contact with hot pipework, flues etc.

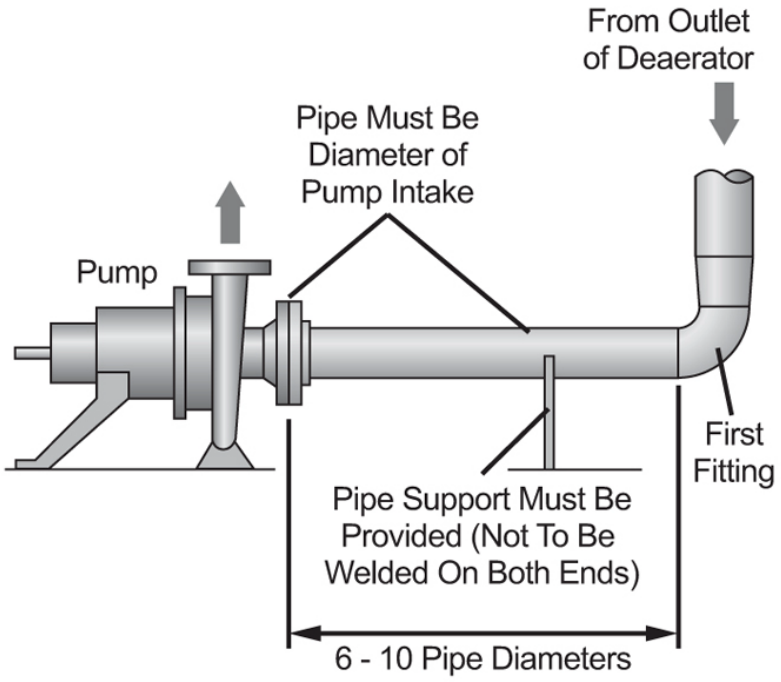
g) Failure to provide suitable and safe access at the time of commissioning may cause delays, as our Service Engineers are instructed not to commence commissioning if hazardous conditions exist.

Minimum Clearance for Coil Removal

Model	Inches	Meters
FT-0080C	60	1.6
FT-0120C	66	1.7
FT-0160C	66	1.7
FT-0240C	73	1.9
FT-0320C	80	2.0
FT-0400C	94	2.4
FT-0600C	124	3.2
FT-0800C	126	3.2
FT-1000C	126	3.2
FT-1200C	126	3.2
FT-1400C	140	3.6
FT-0400S	124	3.2
FT-0600S	124	3.2
FT-0800S	126	3.2

7. Circulating Pump

a) Installing the pump in accordance with the manufacturer's specifications and these instructions will prolong the life of the pump and contribute significantly to the successful operation of your Fulton heater system. The pump manufacturer's installation and operation instructions can be found in Section 5 of this manual.



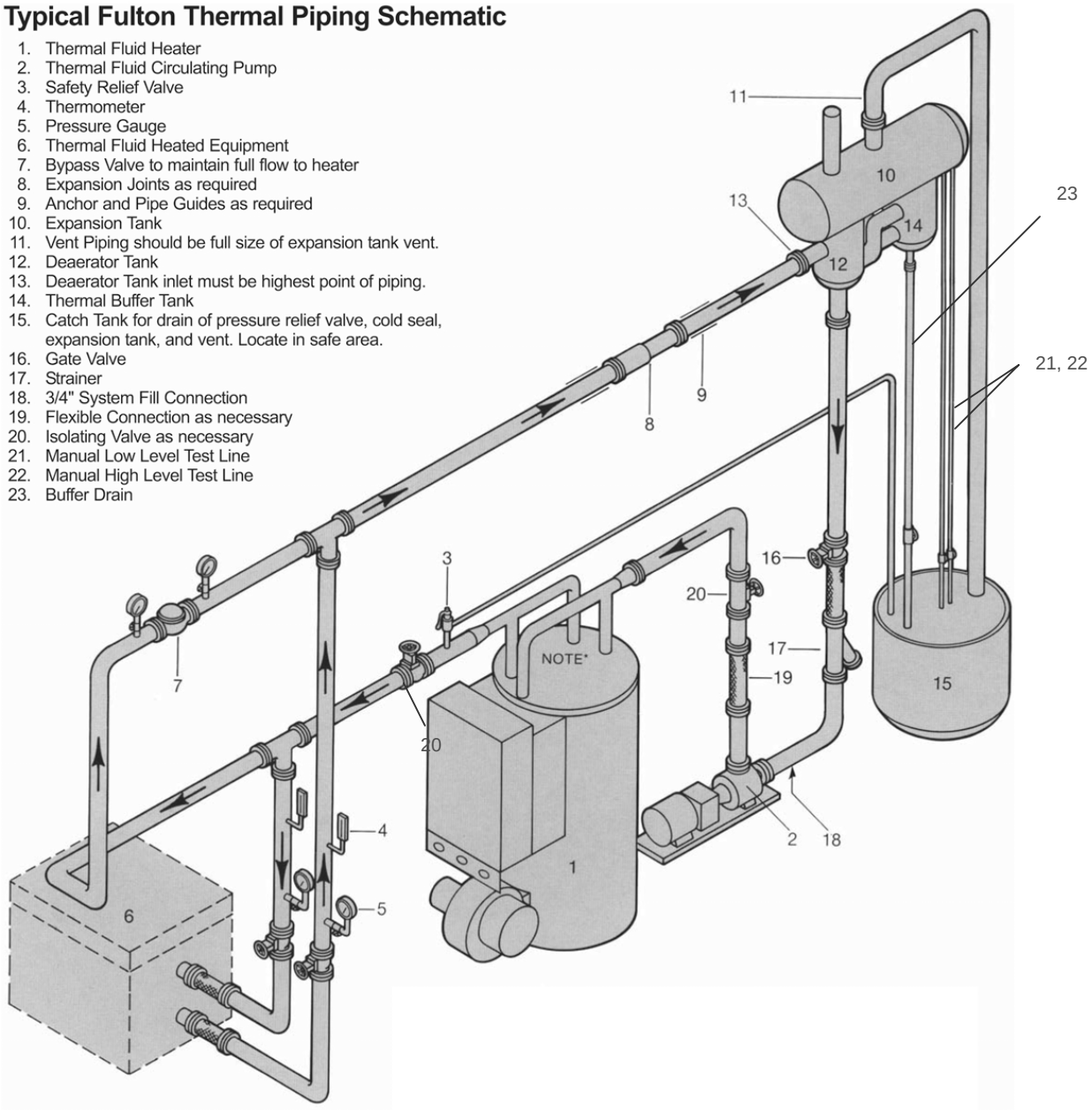
b) Location

1. The pump should be located adjacent to the heater. Its base must be firm, level (preferably concrete), and free from vibration.

c) Connections & Piping

1. The pump should be routed as per the manufacturer's requirements. It should be equipped with flexible connections at the suction and discharge sides. The primary function of these connections are to prevent stresses due to pipe expansion from being placed on the pump and to isolate pump vibrations from the pipe work and the heater. They also allow for expansion and deflection of the pipe work. These connections should be rated for high temperature since they are considered part of the piping system.
2. The suction pipe work must be directly connected to the deaerator section via a vertical run with as few elbows as possible, and should contain the strainer and an isolating valve. The discharge pipe work must be connected directly to the heater inlet, and should contain an isolating valve. See that pipe work connections match up accurately with pump flanges. Refer to the pump manufacturer's recommendations for the specific pump inlet piping requirements. Typically these requirements are that:
    a. It be a straight run of pipe.
    b. The straight run from the pump inlet to the first fitting, valve, or flex connector be a minimum of 6-10 pipe diameters in length.
    c. The pipe used should be the same size as the inlet of the pump.
3. The piping in the immediate vicinity of the pump must not be supported by the pump. The pump is not designed to bear the weight of the piping, and weight on any part of the pump will throw it out of alignment.

d) Typical Fulton Thermal Piping Schematic



Note

The catch tank should be appropriately sized based on the system volume and configuration.

Under normal operating conditions, the catch tank should be empty.

Fluid that is expelled into the tank should not be reintroduced into the system.

e) Alignment

1. Proper alignment directly affects bearing, coupling, and seal life expectancy. The pump is properly aligned before it leaves the factory. Because the system expands in operation, pump must be realigned when the system is at operating temperature.
2. The coupling alignment of the pump and driver must be carefully checked for angular and axial alignment. Check pump manufacturers instructions for these specifications. The use of a dial indicator to check the axial and angular alignment is recommended.

f) Lubrication

1. An air cooled pump does not have an oiler. This type of pump has a sleeve bearing which is, like the seals, lubricated by thermal fluid. An air cooled pump has a grease nipple located at the drive end of the pump near the coupling connection. This comes pre-greased, and should be greased at intervals as recommended by the manufacturer.
2. An oiler is shipped with each water cooled pump and it should be filled with a lubricating oil recommended by the manufacturer. The suggested lubricant is usually SAE-30 non-detergent oil. Thermal fluid is not sufficient lubrication for bearings.

g) Seals

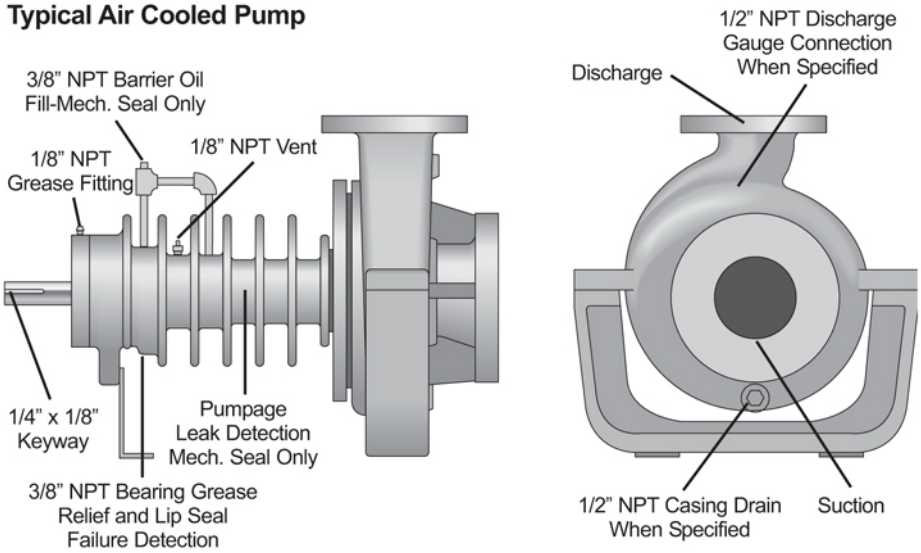
1. All seals on air cooled pumps are lubricated by thermal fluid, therefore the pump must never be run dry, i.e., without thermal fluid in it.
2. Filling a pump equipped with either a Grafoil packed or mechanical seal with thermal fluid will ensure lubrication. However, in order to be certain that all seals on an air cooled pump are coated with thermal fluid, the pump must be bled.
3. Grafoil packings require a run-in procedure. Typically, pumps with these seals are shipped with four or five rings installed and several rings loose. These extra rings must be on hand for the initial run-in procedure. See manufacturer's instruction manual for this procedure.

h) Air Cooling

1. Allow for free air flow around the entire pump casing at all times.
2. Max. room temperature should be 100°F.

3. In no case should any part of the drive side of the pump be insulated.
4. Max. operating temperature for air cooled pumps varies by manufacturer. Consult instruction manual to verify.

Typical Air Cooled Pump

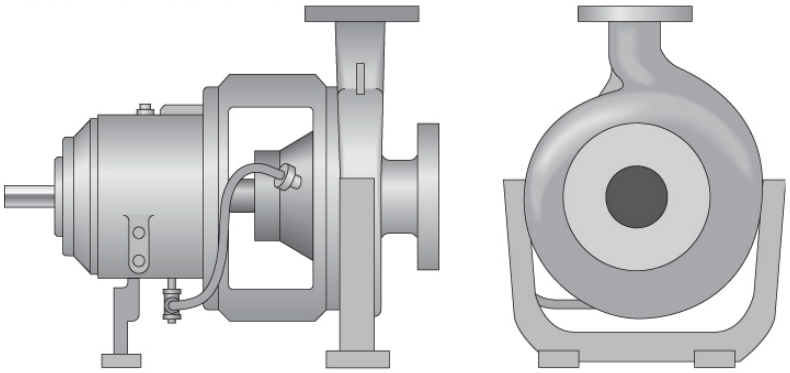


i) Water Cooling

1. A throttling needle valve should be installed on the inlet side of the water cooling passages and adjusted so that the outlet water is between 120°F. and 160°F. Typically this means a flow rate of 2-5 GPM at 40°F inlet temperature. Consult pump manufacturer's specifications for dimensions of water cooling connection.
2. The throttling valve on a water cooled pump is designed to automatically give the proper flow rate for a 40 PSIG or greater supply.
3. If a minimum of 40 PSIG is not available, consult Fulton Thermal Corporation about resizing the orifice. If the temperature of the cooling water is greater than 55°F to begin with, a correspondingly greater flow rate is required.
4. For automatic operation of water cooling, wire a solenoid valve on the inlet to open whenever the pump motor starter is energized.

5. The outlet flow from the pump must not be restricted in any manner. Therefore, valves are not to be installed on the outlet. Check local codes regarding disposal of hot water.

Typical Water Cooled Pump



8. Combination Expansion/Deaerator/Thermal Buffer Tank

a) Fulton Thermal's efficient design combines the operation of the expansion, deaerator, and thermal buffer tanks. Installation is considerably simplified by virtue of this arrangement.

b) Expansion Section

1. The expansion section is vital to the thermal fluid system. From ambient to operating temperature, the thermal fluid in the system will typically expand in the range of 30%, and a vessel capable of handling this expansion is mandatory. The customer should confirm the expansion rate of the chosen fluid and system volume.

c) Deaerator Section

1. At start up the primary purpose of the deaerator section is to remove all volatiles from the system to avoid pump cavitation. The deaerator section also allows oxygen to be vented from the system on a continuous basis during operation to avoid oxidation of the thermal fluid, and removes other volatile particles generated by the fluid itself during system operation. This section of the tank must be insulated.

d) Thermal Buffer Section

1. A system of interconnecting pipe work in the thermal buffer tank section prevents the movement of any oil that has not cooled sufficiently into the expansion section. This avoids contact of very high thermal fluid temperature with oxygen contained in the

atmosphere, which causes fluid breakdown. DO NOT insulate this section.

e) *Sizing The Tank For The System*

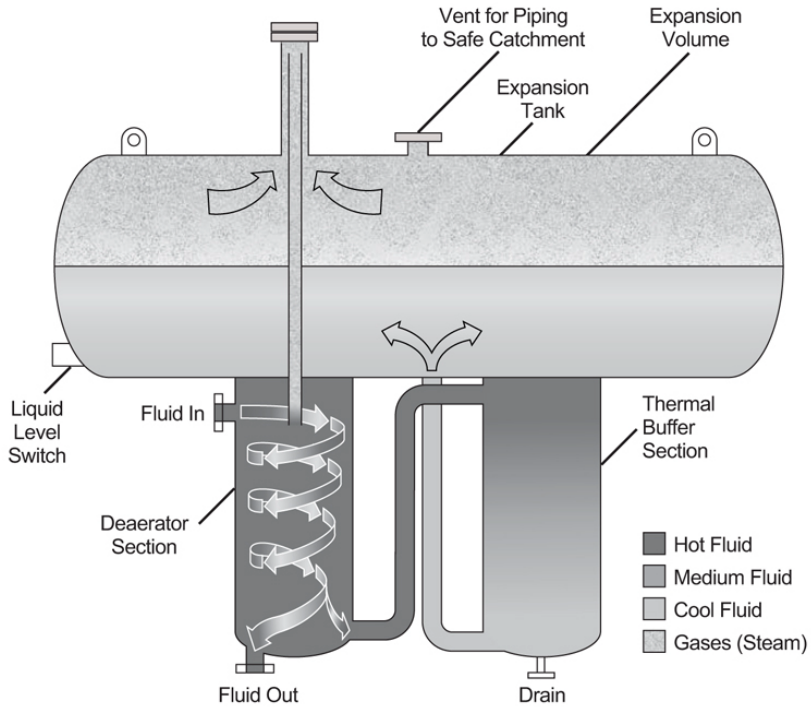
1. Expansion tank capacity is the total volume of the tank. It is necessary to have some air space available at the top of the tank to avoid spillage or overflow. At initial fill (for system volume calculations) the deaerator and cold seal sections must be filled completely and the expansion section must be filled to a level of 4 inches to "make" the liquid level switch.
2. The volume between the initial fill level and the safe "full" level is the amount available for expansion. That volume is used to decide which tank is suitable for the system expansion.

f) *Sizing Example*

1. A system contains 175 gallons, including the heater, but not the tank. You select the FT-200-L, so you add 25 gallons to 175. You must look up the expansion rate for the thermal fluid. (Assume it is 25%). 200 gal. x 1.25 = 250 gallons. 250-200 = 50 gallon expansion. The FT-200-L has only 46 gallons available for expansion, so the correct selection is the FT-500-L.

g) Location

1. The tank must be installed in accordance with Fulton Thermal Corporation's specifications.
2. Unless the system is pressurized, the inlet to the deaerator section must be higher than or equal to the highest point in the system to prevent pockets of air from collecting in system piping.
3. The head required at the circulation pump suction inlet must also be taken into account to avoid the possibility of pump cavitation. In systems operating close to maximum fluid temperature, the tank must be elevated enough, possibly well above the highest point in the system to prevent pump cavitation by increasing the static head. An inert pressurizing blanket may be considered as an alternative. See **Pressurized Systems.**
4. Supports for tank mounting should be provided by the client/contractor. These should be suited for supporting the tank by the side rails. The eyelets fitted to the tank are for lifting only.



Model	Capacity (Gallons)	Initial Fill (Gallons)	Available for Expansion (Gallons)	Max System Volume
FT-200-L	52	25	46	184
FT-500-L	132	40	121	525
FT-1000-L	264	80	232	1000
FT-1500-L	397	90	380	1400
FT-2000-L	528	145	444	1700
FT-3000-L	793	215	717	2600
FT-5000-L	1310	300	1168	4600

9. Pressurized Systems

a) Nitrogen pressurization may be used to advantage where the total system content is very large or in a system operating near or above the vapor pressure of the fluid employed or if the inlet of the DA tank is not the highest point in the piping system.

b) In conjunction with this system, an automatic venting device must be fitted to the system expansion tank. Consult Fulton Thermal Corporation for further details.

c) The location for the liquid level switch is a 2-1/2” NPT connection on the same end of the tank as the inlet. The liquid level switch is supplied and shipped with the unit, and must be installed by the customer and then wired to the control panel.

Note

If the tank is located outdoors nitrogen is required.

10. Connections

a) The vent connection must be made in a manner that will prevent penetration of water or foreign bodies into the tank. This connection must always terminate in a safe, well ventilated area and has to be free of obstruction, open to atmosphere, and arranged in such a manner that, in the event of discharge from the system, thermal fluid could drain into a catch tank without danger to personnel or property.

Note

Non-code tanks cannot be pressurized over 15 psig.

Warning

High temperature thermal fluid, steam and combustible vapors may be vented through this connection.

b) The vent run should be the same size as the tank outlet. It should run pitch down from the outlet of the tank to the catch tank.

c) If nitrogen is used on the system, the vent can be reduced and should be piped with a positive closing valve at the catch tank.

d) The connection between the tank outlet and the horizontal pump inlet run should be as close to a vertical drop as possible. It should not contain an excessive number of bends of length of pipe. These faults could encourage pump cavitation.

e) As noted, the inlet to the deaerator must be higher than or equal to the highest point in the system or a pressurized system must be used.

f) The liquid level switch, supplied and shipped with the unit, must be installed and wired to the control panel by the customer.

g) The high and low level test connections are 1/2" NPT, and are located on the end of the tank opposite the inlet. The low level is on the center line of the expansion tank, the high level is next to it, slightly off center. The high level rises up from the bottom of the tank and ends four inches below the top; the low level rises two inches from the bottom of the tank.

h) Both the high and low level connections should be piped to a safe catchment. Valves should be installed in these lines at the catch tank.

i) Installation of the valves should be accomplished in such a manner that any flow will be visible when the valves are open.

j) Flow from the high level test connection indicates a tank that is too full; no flow from the low level test connection indicates too little fluid.

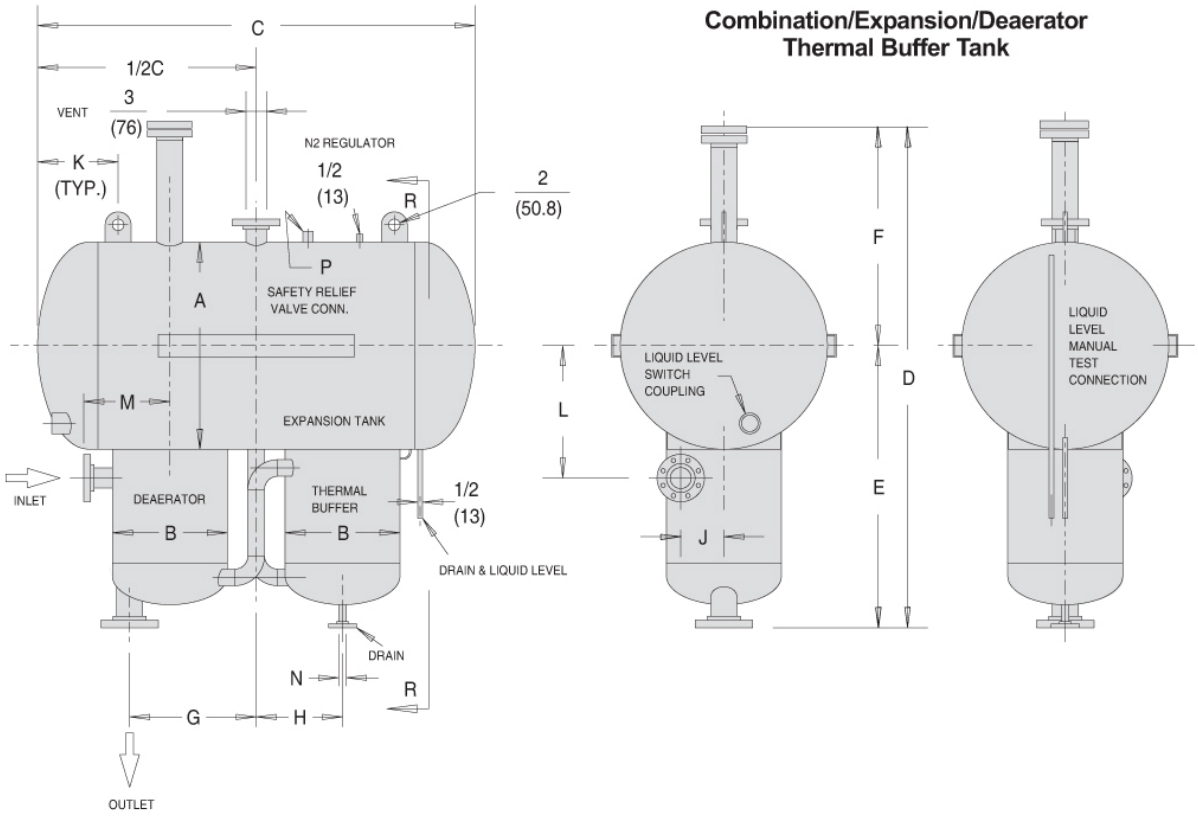
k) There is a 300 pound, raised face, flanged drain on the bottom of the thermal buffer section, for the purpose of draining the tank when necessary. This should be piped with a valve in the line, to a safe catchment. The valve specifications outlined above apply to this valve as well.

l) An inspection opening is located at the highest point on the tank. Access to this port is recommended but not required.

m) Refer to the maintenance schedule for recommendations on draining the buffer tank. For positioning of all connections on tank, see the diagram labeled Combination/Expansion/Deaerator Thermal Buffer Tank.

Warning

Once the system has been filled, any modification to the tank or connected piping requires purging of the work area to prevent ignition of potentially flammable vapors. Consult factory prior to beginning work. Consult MSDS for your thermal fluid for flammability limits.



MODEL	A	B	C	D	E	F	G (Ref)	H	J (Ref)	K	L	M	N	P	CAP.	Dry Wt.	Max Full Wt.
FT-0200-L	20 (510)	12¾ (325)	54 (1370)	60⅝ (1540)	34 (865)	26⅝ (676)	16⁷⁄₁₆ (424)	12 (305)	4½ (115)	4¼ (108)	15 (380)	12¹⁵⁄₁₆ (329)	¾ (20)	¾ (20)	52 (200)	636 (289)	1314 (596)
FT-0500-L	26 (660)	16 (405)	74 (1880)	66⅝ (1692)	37 (940)	29⅝ (752)	19¾ (502)	14 (355)	6 (150)	11½ (290)	18 (460)	14⁹⁄₁₆ (379)	¾ (20)	¾ (20)	132 (500)	970 (440)	2450 (1111)
FT-1000-L	36 (915)	20 (510)	76 (1930)	87⅝ (2226)	49 (1245)	38⅝ (981)	22¼ (565)	15 (380)	7¹⁄₁₆ (202)	14 (355)	24 (610)	14⁹⁄₁₆ (379)	1 (25)	1 (25)	264 (1000)	1350 (612)	4380 (1987)
FT-1500-L	36 (915)	20 (510)	106 (2690)	87 (2210)	49 (1245)	38⅝ (981)	24¾ (629)	17½ (445)	8 (203)	14 (355)	24 (610)	14⁹⁄₁₆ (379)	1 (25)	1¼ (32)	397 (1500)	1710 (776)	5875 (2667)
FT-2000-L	42 (1070)	22 (560)	106 (2690)	107⅝ (2734)	62½ (1590)	45⅛ (1146)	31³⁄₁₆ (792)	24 (610)	8½ (216)	15½ (394)	28 (710)	14⁹⁄₁₆ (379)	1 (25)	1½ (38)	528 (2000)	2550 (1134)	8230 (3733)
FT-3000-L	42 (1070)	26 (660)	140 (3556)	115⅛ (2924)	70 (1778)	45⅛ (1146)	33³⁄6 (843)	24 (610)	9¹⁵⁄₁₆ (252)	15½ (394)	28 (710)	18¹⁵⁄₁₆ (481	1 (25)	1½ (38)	793 (3000)	3200 (1451)	11,610 (5265)
FT-5000-L	60 (1524)	26 (660)	130⅜ (3312)	132⅛ (3356)	77½ (1969)	54⅝ (1387)	32⅜ (818)	24 (610)	9⅜ (238)	20⅝ (524)	37 (940)	18¹⁵⁄₁₆ (481)	1 (25)	1½ (38)	1321 (5000)	5300 (1637)	17,370 (7895)

Inlet and outlet dimensions vary with installation. All dimension are approximate. Specifications subject to change without notice.
Dimensions given in inches and (MM)
Capacities given in gallons and (LITERS)
Weights given in pounds and (KG)

n) Electrical Connections

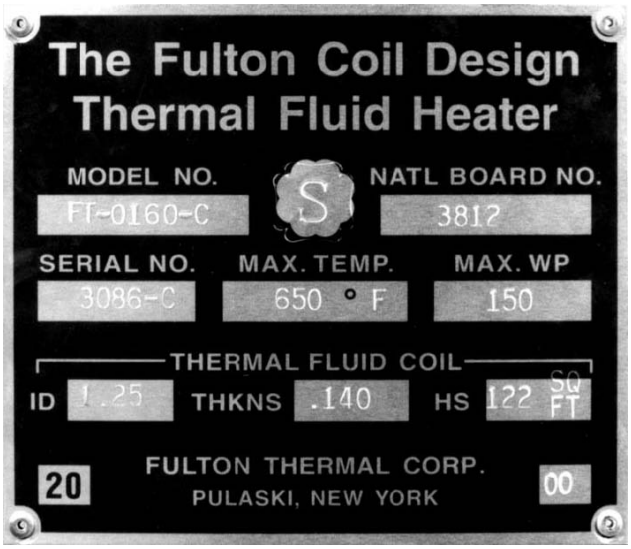
1. A wall-mounted, fused disconnect sized for the unit must be provided and fitted by the client/contractor, if a disconnect is not supplied on the panel.
2. Fuses must be sized according to motor name plates and local electrical codes.
3. Heaters and single skid systems are generally shipped completely prewired. The liquid level switch on the expansion tank, when supplied, will be shipped in the parts box and must be installed in the field. Multiple skid systems may require wiring between the skids.
4. If the unit is not skid-mounted at the factory, the client/contractor is required to wire the circulating pump starter.

Note

If the circulating pump motor is not supplied by Fulton Thermal Corporation, the motor starter will not be supplied.

o) Voltage & Frequency

1. Normal supply will be 460 volts, 3 phase, 60 Hz, AC unless otherwise specified.
2. Make sure the information on the electrical drawing corresponds to your voltage and frequency. Check the supply voltage and make sure that there is no over-or under-voltage exceeding 10% of the nominal value.



p) Fuel Connections

Gas Connections

1. The burner assembly and gas controls terminate at a manual stop valve to which the gas supply should be connected. Piping should be sized for a gas flow consistent with the required BTU/Hr input. Large pressure drops must be avoided.
2. Fulton Thermal Corporation recommends that the supply piping between the pressure regulator and the inlet to the heater be kept to a minimum.
3. The minimum required gas pressure at the stop valve varies with the model of heater. The requirements for natural gas-fired coil design models are as follows:
    a. Models FT-0080-C to FT-0400-C and FT-0400-S: 14" w.c.
    b. Models FT-0600-C to FT-0800-C and FT-0600-S to FT-0800-S: 40" w.c.
    c. Models FT-1000-C to FT-1400-C: 120" w.c.

Note

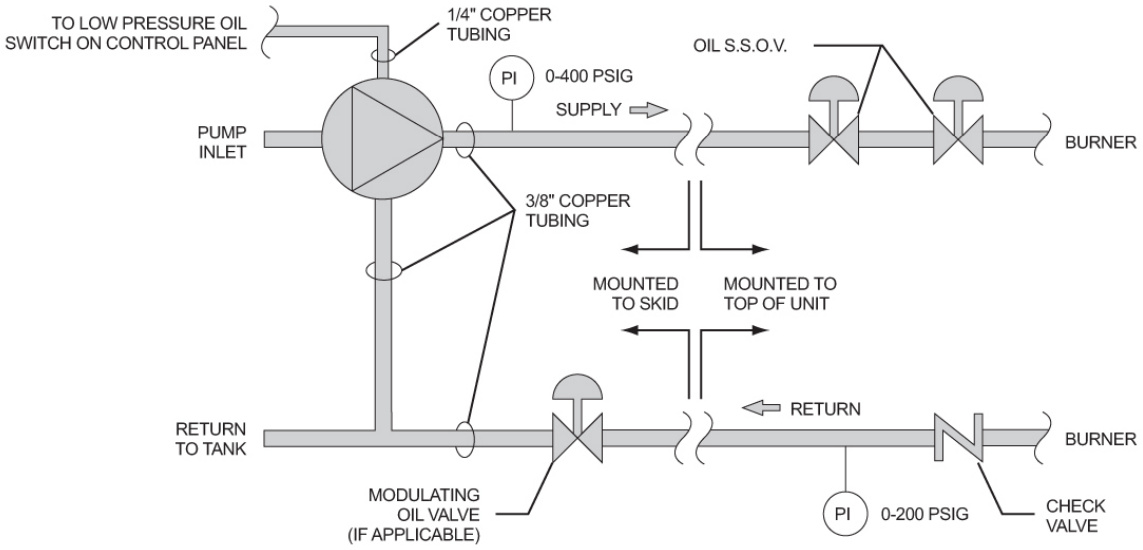
Low emissions burners for all models require 10 psi.

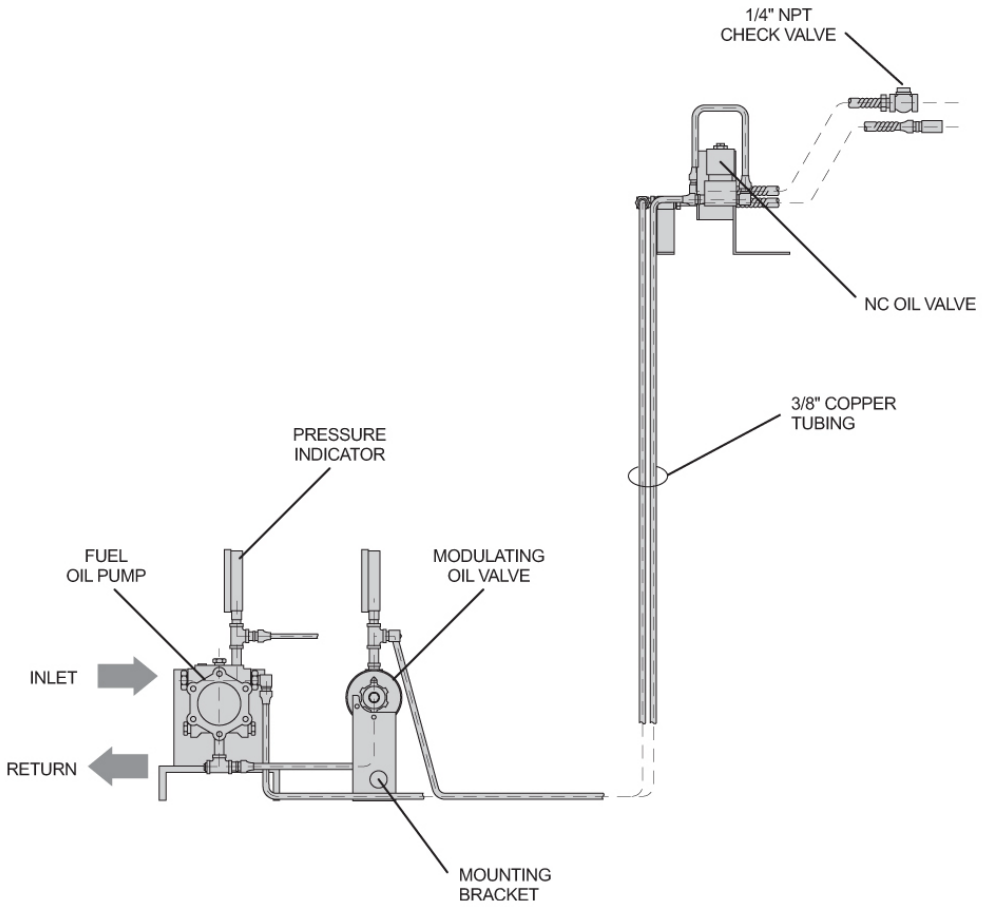
4. Even when the unit is shut down, the gas supply pressure must never exceed these values.
5. When operating, the supply pressure should not drop below these limits:
    a. Not less than 11 " w.c. where 14" w.c is required.
    b. Not less than 30" w.c. where 40" w.c. is required.
    c. Not less than 100" w.c. where 120" w.c. is required.
6. The supply pressure must be regulated by a non-stacking, tight, shut-off regulator.
7. Diaphragms, gas valves, pressure regulators, and pressure switches on all gas-fired units have vent connections which must be vented per local code.
8. On gas fired units with NFPA 85 valve trains, there is a vent valve which must be piped to atmosphere.

Oil Connections

9. Fuel pipes should be of approved materials and of a diameter suitable for the quantity of oil being delivered to the burner and the static head available. The fuel connection should be made in accordance with the details on the enclosed fuel pump cut sheet in Section 5. Fuel oil piping should be done in accordance with local/national requirements. In addition, if a two pipe system is employed, a check valve should be fitted into the return pipe. See fuel pump cut sheet.
10. The maximum pressure allowed at the fuel oil pump inlet is limited to 3 psig by the National Fire Protection Association (NFPA). If for some reason the pressure of the fuel supply will exceed this maximum, fitting a regulator to the fuel line must be considered, e.g. when there is a tank situated with an oil level eight feet or more above the pump.
11. On units fitted with NFPA 85 controls, ignition is obtained by means of a gas pilot. A natural gas or LP supply is required for these units. The required gas supply pressure is 7" w.c. If a guaranteed supply of natural gas is not available, then a supply of bottled gas at 11"w.c, is required. For details contact a local liquid propane dealer.

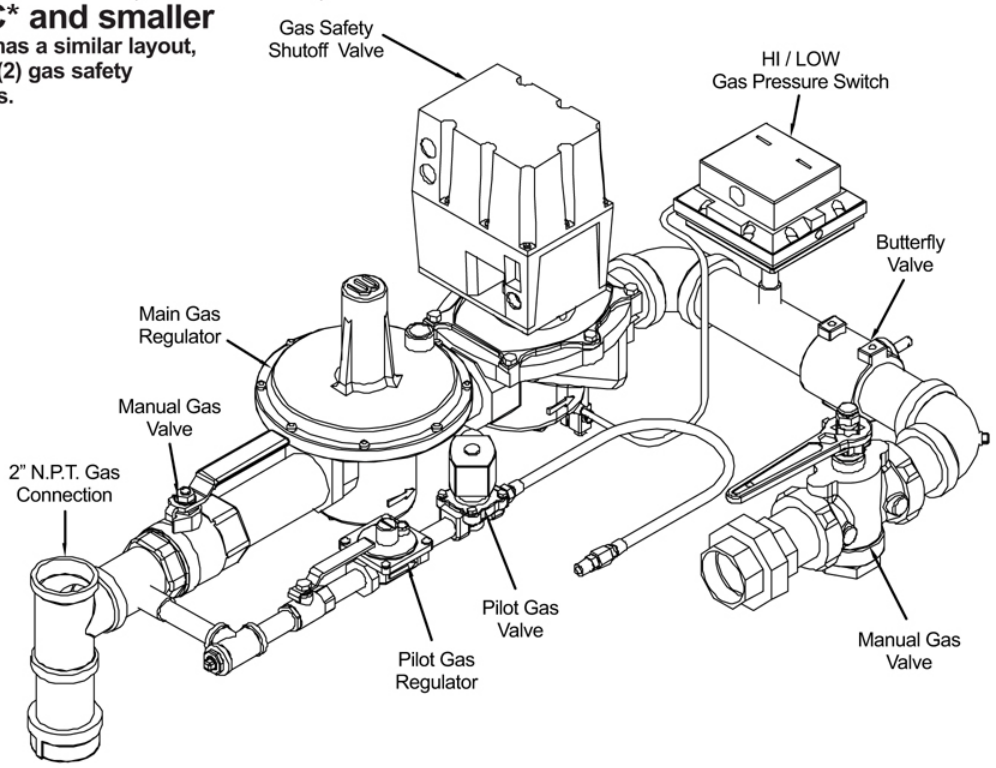
Typical No. 2 Oil Fired Fuel Train Illustration



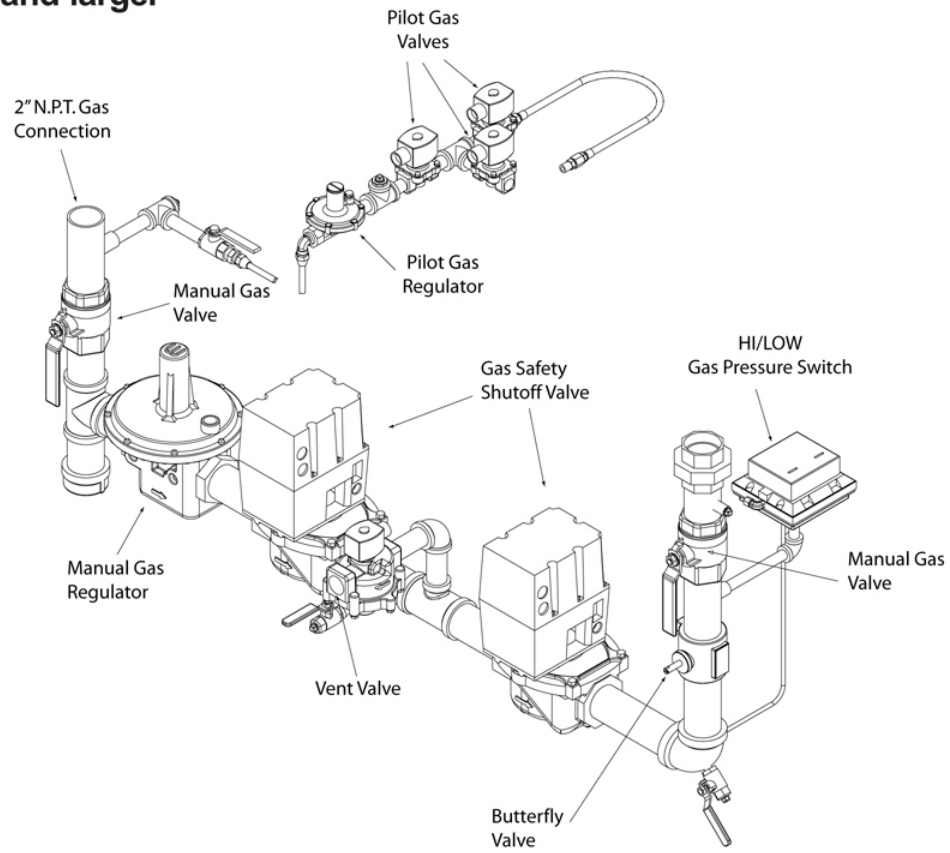


Typical Gas Fired, Modulated, CSD-1 Fuel Train Illustration FT-0320C* and smaller

The FT-400C has a similar layout, but uses two (2) gas safety shut off valves.



Typical Gas Fired Modulated, NFPA 85 Fuel Train Illustration FT-0600C and larger



q) Stack & Flue Connections

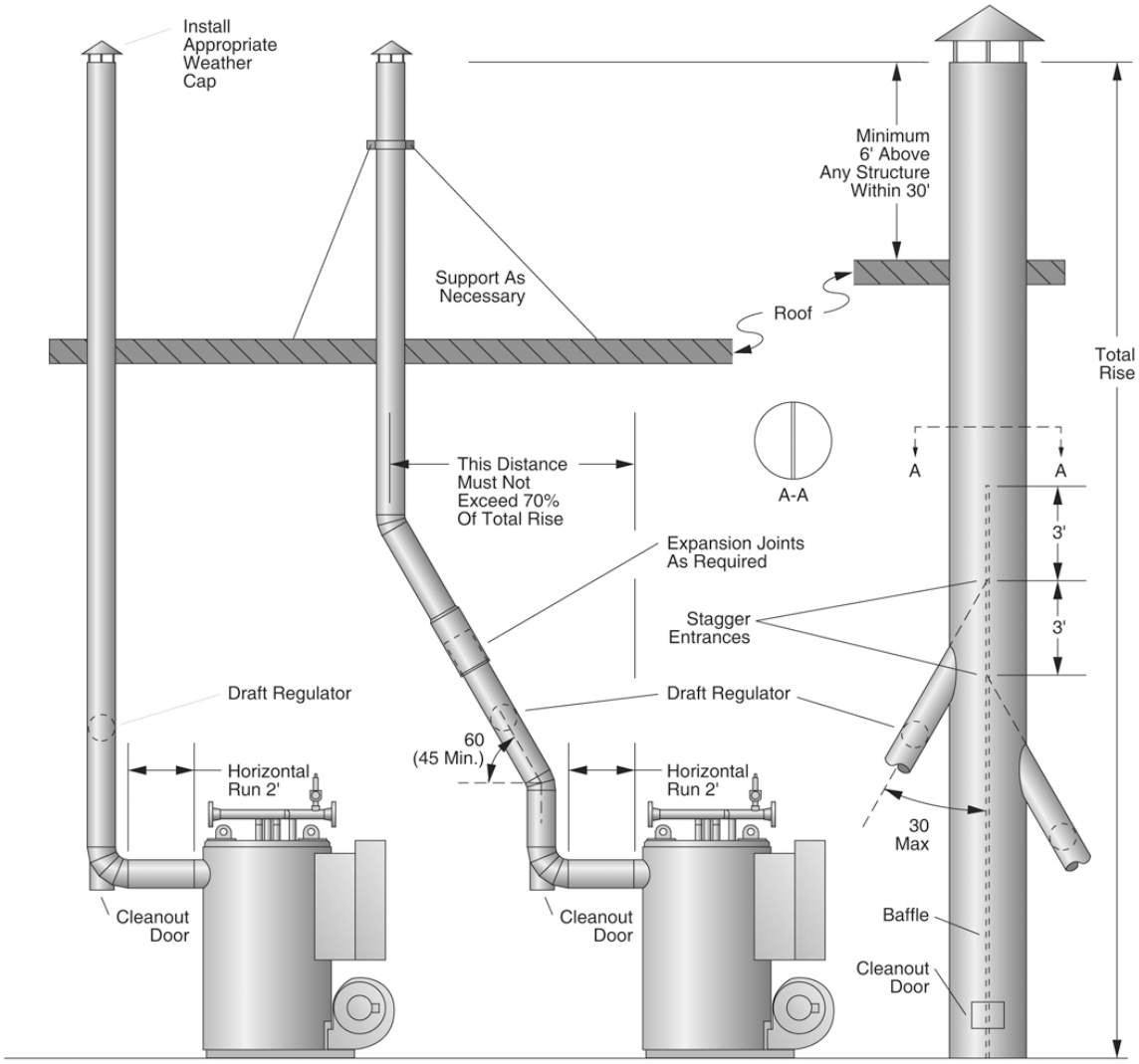
1. An appropriately sized stack should be connected to the flue gas outlet at the heater unit. The stack should be the same diameter as the flue gas outlet for an FT-0080-C, and at least one size larger for coil design models FT-0120-C and larger.
2. The stack should rise continuously to the connection of the chimney and should contain no more than two bends, at 45° angles or less.
3. There should be two feet of straight, horizontal flue before any change in direction, fitting, or draft regulator. This is to prevent potential pilot or main flame failures due to back pressure buildup during ignition.
4. Any alternative stack arrangement must supply negative .02 to 04" water column.
5. The run in the total distance of stack ducting, as measured in a straight line from the outlet of the heater to the outlet of the stack, should not exceed 70% of the rise. See diagram below.

Note

With the exception of the duct run previously described, horizontal sections of ducting must be avoided and should not exceed four feet total.

6. The stack, chimney, and any components associated with the stack, such as heat reclaimers or assist fans, must be constructed from material that is rated for a 1200°F operating temperature.
7. Adequate provision must be made for the support of the weight of the chimney and stack to avoid having a load imparted to the outlet connection of the heater.

Typical Stack Arrangements



11. Conditions

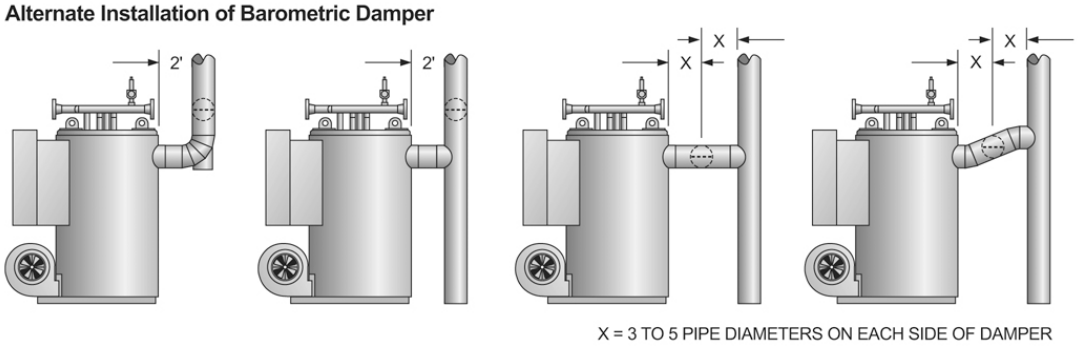
a) The draft when firing should be negative and constant. A reading of .02 to .04 inches w.c. negative when the unit and stack are cold usually indicates sufficient draft. When the unit is running and the stack is hot, the draft should read 0.04 - 0.08 inches w.c. negative.

b) The installation of a draft regulator by the client/contractor is recommended at all installations. This will help to maintain the required draft. The placement of the draft regulator should be as shown in the diagram labeled “Alternate Installation of Barometric Damper.”

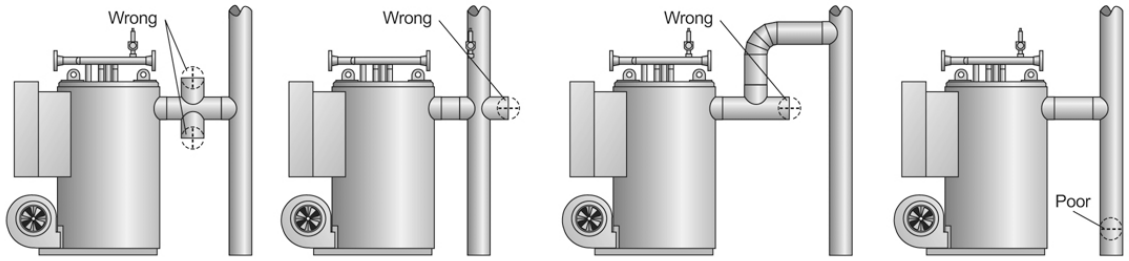
c) To maintain a reasonable temperature in the heater area and ensure safety to personnel, the section of chimney duct within the building should be insulated.

Installation of Barometric Damper

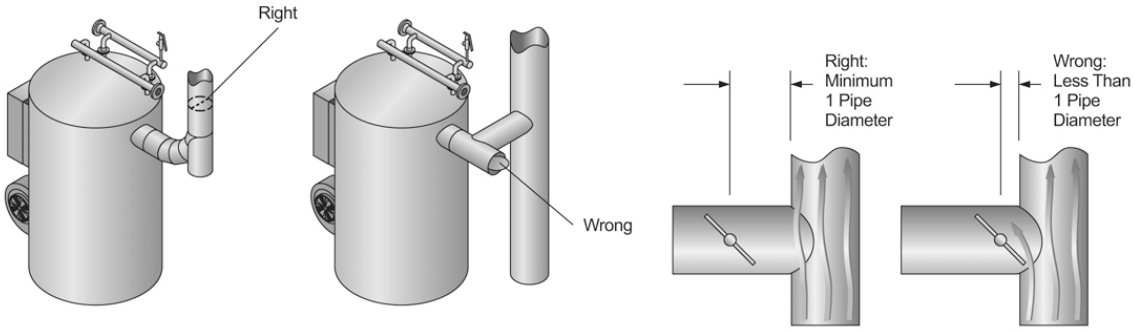
Alternate Installation of Barometric Damper



Wrong or Improper Installations of Barometric Damper



Proper and Improper Teeing of Damper



12. Pipework Systems

a) Certain properties of thermal fluid, including low surface tension, make it necessary to pay particular attention to containing the fluid. Good pipework system design, welded construction, proper flanging, gaskets, and other appropriate means of eliminating potential leakage must be employed.

13. General

a) All components exposed to thermal fluid flow, including pipe, valves, and screens, must not be made out of copper, copper alloys, aluminum, or cast iron. Cast iron is porous to thermal fluids, and copper and aluminum act as catalysts in the degradation of some thermal fluids. Carbon or stainless steel, or ductile iron, are recommended.

b) For standard applications, all components must be rated to 650°F unless otherwise stipulated.

c) All pipework, valves, and user equipment must be suited to the maximum operating pressure of the heater. The maximum pressure stamped on the heater nameplate is typically 150 psig (690 kPa).

d) If an isolating valve is completely closed, the pressure in the system will rise to the deadhead pressure of the pump. Suitably sized pipe will enable the system to withstand the total head generated by the circulating pump, should this occur. In applications where it is desirable to design to pressures lower than 100 psig, an alternative safeguard is to install appropriately sized safety valves.

e) Where secondary circulating pumps are installed, the system must be suitable for the aggregate head, against a closed valve, of both pumps.

f) During construction of the installation, ensure that no dirt, water, or residue from welding is left in the system.

14. Equipment

a) Heaters that are skid mounted with pumps and tanks are equipped with a y-strainer, a flex connector and a valve in the inlet run between the pump and the combination tank. Piping between the discharge of the pump and the inlet of the heater will include a flex connector and a valve.

15. Piping

a) All pipework should be constructed from seamless mild steel pipe, conforming to ASME SA 106B or SA 53B, Schedule 40 or equal.

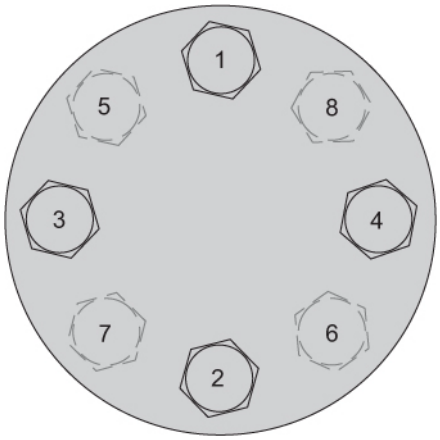
b) Expansion joints or properly designed and sited loops should be provided to accommodate thermal expansion. Thermal expansion should be calculated using the maximum possible utilization fluid temperature, regardless of whether the pipe considered is in the feed or return circuit. Steel pipe will expand approximately 1 “ per 100’ over a 100° F. temperature rise (1 mm. per meter over 100°C. rise).

c) Supports and anchors must be provided for all pipes where necessary to prevent undue stresses from being placed on items of equipment, including pumps, valves, and the heater. Supports and anchors which will not interfere with thermal expansion should be chosen.
d) All pipe joints should be of either welded or flanged construction. Screwed joints must be avoided where possible. In no instance should screwed joints be used in the flow circuit.
e) All flanges should be welded to the pipe and not screwed. Flanges should be 150# or 300# raised face flanges, SA105.
f) Gasketing material suitable for use with thermal fluids at high temperatures should be used to make all flanged joints. Flexible graphite gaskets are suited for most thermal fluids. Recommended gasket thickness is 1/10 - 1/8 inch.
g) Ensure that all bolts are tightened evenly and to the torque recommended values provided by the gasket manufacturer.

16. Gasket Installation Instructions

a) Lubricate nuts, bolts and washers with a graphite/oil mixture.
b) Assure that the flange surfaces are clean and free from damage.
c) Center gasket properly over flange. In retrofit, use pry bar to spread flange apart enough that the gasket will not be damaged when sliding in place.
d) Install all flange nuts and bolts.
e) Hand tighten.
f) Utilizing a torque wrench, tighten all bolts to 20% final torque specification following a “star” pattern. (This means do not tighten bolts in order as a clock. This will result in a poor seat between 12 o’clock and 1 o’clock.)
g) Tighten all bolts to 40% final torque specification following a “star” pattern.
h) Tighten all bolts to 60% final torque specification following a “star” pattern.
i) Tighten all bolts to 80% final torque specification following a “star” pattern.
j) Tighten all bolts to 100% final torque specification following a “star” pattern.
k) Following a sequential pattern, ensure that all bolts are tightened to 100% final torque specification.
l) It is important that all bolts are checked and re-torqued after flanges have been heated and cooled down for the first time.

Bolting Sequence for 4 and 8 Bolt Flanges



Standard gaskets supplied by Fulton are JM Clipper Elastograph for operating temperatures up to 650^{o}F.

Recommended Loads for JM Clipper elastograph 150# Gaskets
SAE Grade 5 Bolts (typical) or Equal

Nominal Flange Size Inches	Number of Bolts	Diameter of Bolts Inches	Preferred Torque Required per Bolt Ft-Lbs.
1/2	4	1/2	30
3/4	4	1/2	30
1	4	1/2	30
1 ¼	4	1/2	30
1 ½	4	1/2	30
2	4	5/8	60
2 ½	4	5/8	60
3	4	5/8	60
4	8	5/8	60
5	8	3/4	100
6	8	3/4	100
8	8	3/4	100
10	12	7/8	160

Recommended Loads for JM Clipper elastograph 300# Gaskets
SAE Grade 5 Bolts (typical) or Equal

Nominal Flange Size Inches	Number of Bolts	Diameter of Bolts Inches	Preferred Torque Required per Bolt Ft-Lbs.
1/2	4	1/2	30
3/4	4	5/8	60
1	4	5/8	60
1 ¼	4	5/8	60
1 ½	4	3/4	100
2	8	5/8	60
2 ½	8	3/4	100
3	8	3/4	100
4	8	3/4	100
5	8	3/4	100
6	12	3/4	160
8	12	7/8	245
10	16	1	160

17. Piping

a) High point bleeds are to be installed at all high points in the system piping. 1/2” x 12” nipples welded in the top of the piping with ball valves & plugs attached are to be used.

b) It will save a considerable amount of time during the cold filtration if the thermal system piping is cleaned prior to assembly.

c) The mill scale (the results of oxidation) on the inside of the piping as well as construction debris can foul the oil and cause the need for the filters to be

cleaned more than need be. This can range from simply using a rag to ordering pickled pipe. (“Pickling” is a process where the piping is first soaked in an acid bath, then soaked in a neutralizing bath, then given a protective oil coating.)

d) All pipes should be installed with a pitch to facilitate draining and venting.

Standard gaskets supplied by Fulton for operating temperatures above 650°F are Flexitallic Spiral Wound.

Recommended Loads for Flexitallic Spiral Wound Class 150# Gaskets

SAE Grade 5 Bolts (typical) or Equal

Nominal Flange Size Inches	Number of Bolts	Diameter of Bolts Inches	Preferred Torque Required per Bolt Ft-Lbs.
1/2	4	1/2	45
3/4	4	1/2	45
1	4	1/2	45
1 ¼	4	1/2	45
1 ½	4	1/2	45
2	4	5/8	90
2 ½	4	5/8	90
3	4	5/8	90
3 ½	8	5/8	90
4	8	5/8	90
5	8	3/4	150
6	8	3/4	150
8	8	3/4	150
10	12	7/8	240

Recommended Loads for Flexitallic Spiral Wound Class 300# Gaskets

SAE Grade 5 Bolts (typical) or Equal

Nominal Flange Size Inches	Number of Bolts	Diameter of Bolts Inches	Preferred Torque Required per Bolt Ft-Lbs.
1/2	4	1/2	45
3/4	4	5/8	90
1	4	5/8	90
1 ¼	4	5/8	90
1 ½	4	3/4	150
2	8	5/8	90
2 ½	8	3/4	150
3	8	3/4	150
3 ½	8	3/4	150
4	8	3/4	150
5	8	3/4	150
6	12	3/4	150
8	12	7/8	240
10	16	1	368

18. System Connections

a) If screwed connections have to be made, e.g. to items of control equipment, then a thread sealant suitable for use with fluids at elevated temperature must be used. Teflon tape, standard pipe dope, or hemp and paste are not acceptable.

b) Screw threads must be carefully and accurately cut. If possible, new tools should be used. Threaded connections larger than 1" are not to be used. It is recommended that GR5 or better tensile steel bolts be used for all flanged joints.

Note

The system pump is not to be used to fill the system.

c) The system is usually filled from the lowest point, with the aid of a pump. On skid-mounted units, a drain and fill connection is provided in the inlet piping to the pump.

Drain and Fill Connection

19. Heater Connections

a) The outlet of the pump should connect directly to the inlet of the heater via an isolating valve and pump flexible connector.

b) The heater outlet should be piped directly to the system, via an isolating valve.

c) A safety relief valve may be shipped in the parts box accompanying the fuel-fired heater, and must be installed in the outlet manifold. On all units, the outlet must be piped to a safe discharge area. The piping from the outlet of the safety valve must be piped to a catch tank. The discharge flow must not be restricted, i.e. no valve should be installed. The weight of the piping must be properly supported in order to prevent damage to the safety valve. If the valve body becomes warped, leakage may result.

20. Gauges

a) The range in which readings are expected to fall should comprise mid-scale on the pressure gauge chosen. Pressure gauges must be able to withstand overpressure equal to the rating of the safety relief valves, normally 100 psig.

b) Thermometers should read up to 650°F.

21. Valves

a) Vent and drain valves should normally be 1/2” or 3/4” with internal seals made from materials suited to use with thermal fluids. They may be of the screw type if installed on stalks not less than 12” long.

b) Gasketing material specifically suited to the task must be used.

c) Drain valves should be fitted at all low points in the pipework system and ventilating valves should be fitted at all high points in the installation.

d) Valves must be fitted with either the conventional packed stuffing box seal or a bellows seal as required. Where the stuffing box is specified, it should be as

deep as possible and packed with Grafoil packing or equal. The valves should have a backseating to allow re-packing without draining the system. In all units, a “Y” type strainer should be installed in the fluid return line, between the deaerator tank and the circulating pump.

e) As previously stated, this strainer is provided on all skid-mounted units. Valves must be provided (unless the heater has been skid-mounted with the tank) so that the strainer can be isolated for cleaning of the element. The strainer element should be 60 mesh and must remain in place during normal operation of the system.

f) The pump suction pressure should be checked periodically, under similar operating conditions. A vacuum reading on the suction gauge indicates that the screen must be cleaned. For isolating purposes, globe, wedge, gate, ball, or other shut-off valves should be used. When there is a likelihood that some manual balancing will be required, a ball or globe valve should be used.

g) Manual control and isolating valves should be the flanged or weld type, manufactured from cast or forged steel or ductile iron, with internals and gland seals made from materials suitable for use with high temperature fluids.

h) When ordering valves, the maximum possible service temperature and type of fluid must be indicated on the order.

i) A partial list of manufacturers known to market valves of acceptable quality follows:

    1. Jenkins Brothers
    2. Lunkenheimer Company
    3. Nibco Incorporated
    4. Stockham Valves and Fittings Company
    5. Velan
    6. Vogt Machine Company
    7. Worcester Valve Company

j) Automatic Fluid Control Valves

    1. Because of the widely varied processes Fulton Thermal Fluid Heaters are used in, it is not possible to set down specific rules for the selection of automatic fluid control valves. Generally, these valves must satisfy the materials and construction requirements described above.
    2. The type of operation and design of porting are governed by the degree of control required as well as the particular application.

k) Bypass Valves

1. When process flow requirements do not match heater flow requirements, a by-pass valve must be installed.
2. If the process flow will vary with the system load, a suitable bypass system can be recommended by Fulton Thermal Corporation.

22. Testing

a) Upon completion of the installation, a pneumatic test not exceeding 15 psig should be conducted. Soap tests should be made at all welds and joints to ensure that the system is free from leaks.

b) Under no circumstances should the system be filled with water. Make sure that the air supply is as free from moisture as possible.

c) The most satisfactory method of testing is to introduce bottled nitrogen through a pressure control valve. Check pressure ratings on all the equipment in the system to make sure that it is capable of withstanding the pressure involved.

d) The time needed to be spent during boilout directly corresponds to the amount of moisture in the system. Boilout can take anywhere from two to three days to complete. Pressure testing on the system should be done by means of an inert gas, such as nitrogen, or by an air compressor producing dry air (air with a dewpoint of 50^{o} F or less). Never perform a hydrostatic test on the system.

23. Insulation

a) After the appropriate system tests have been satisfactorily completed, all hot pipework, including manifolds on the heater, must be adequately insulated with material suited to the temperature and application to prevent both heat loss and personnel injury.

Caution

For reasons of safety, the hot exhaust gas duct and chimney must be insulated or shielded within the locality of the heater.

b) The deaerator section of the combination tank must be insulated. The expansion section of the combination tank must not be insulated, nor should the thermal buffer section.

c) On units operated with inert gas blankets above the fluid in the expansion tank, the entire combination tank, including the expansion and thermal buffer sections, may be insulated, but is not necessary.

d) It is recommended that for inspection and maintenance, pumps, flanges, valves, and fittings be left un-insulated but suitably shielded for safety.

e) Hot oil pipe insulation should be a minimum of 2” thick, high temperature, laminated, foamglass cellular glass insulation as manufactured by Pittsburgh Corning Corporation, or equal.

24. Thermal Fluids

Thermal Fluids at Elevated Temperatures

a) Plant engineers must be familiar with the nature of potential hazards when working with thermal fluids at operating temperatures.

b) Unlike steam or high-pressure water systems, thermal fluid attains extremely high temperatures without a corresponding increase in pressure. While this lack of high pressure in the system yields many advantages, a false sense of security should not be allowed to develop on account of this alone.

c) Certain types of thermal fluid may have operating temperatures reaching 650°F (345°C) and above, so all exposed pipework is hazardous and should be insulated, as indicated in the preceding sections.

d) Flanged joints must be checked for tightness during and after the first warming up of the system. After these checks, exposed hot flanges, pumps, valves and fittings should be fitted with some sort of shield.

e) It is important to remember that there is pressure generated in the system by the circulating pump. Great care should be exercised when opening any drain or vent valves in the system.

f) This is especially important during commissioning, when any air trapped in the system is vented at high points, and when water, which will flash into steam, is either expelled from the deaerator vent or drained off at low points.

Caution

During operation, any leaks are usually detected by a small amount of vapor. Leaks should be attended to as soon as possible because under certain circumstances, such as saturated insulation, thermal fluid can ignite when exposed to air and heat.

g) If a fire does occur, extinguish using CO2, foam or dry chemical. DO NOT USE WATER.

h) Selecting a Thermal Fluid

1. The selection of the thermal fluid most suited to your application is very important. Factors to be considered include efficiency, thermal stability, adaptability to various systems, and physical

properties, including vapor pressure, freezing point, and flash and fire points.

2. Heat transfer fluids of both mineral and synthetic origin have been specially developed to give thermal stability over a very wide range of temperature. A wide variety of thermal fluids have been used successfully in Fulton Thermal Fluid Heater systems, however, your final selection should be made in conjunction with Fulton Thermal Corporation or the fluid manufacturer.
3. The Fulton coil design heater is a fired heat exchanger and the safe control and monitoring of the thermal fluid temperature is of paramount importance.
4. The safe maximum bulk temperature of the fluid must be strictly adhered to. The safe maximum temperature of the fluid varies, but a typical maximum for many types of mineral oil based fluids is 600°F (320°C).
5. Special care must be taken when consulting fluid manufacturers' literature, as maximum fluid temperatures quoted are the actual limit to which any of the fluids may be subjected. It is important to remember that in any fired heater there exists a "film temperature" which is higher than the temperature of the "bulk" of the fluid.
6. It is the BULK fluid temperature and NOT the FILM temperature that is indicated by the instruments.
7. As a general guide, the following list of fluids that have given satisfactory service over many years is provided.
8. This is by no means a complete list. Any fluid specifically designed for heat transfer use may be considered; multipurpose oils are not acceptable.

a.	AMOCO	Transfer Oil 4199
b.	CHEVRON	Teknifax
c.	DOW	Dowtherm A or G
d.	EXXON	Caloria HT 43
e.	MOBIL	Mobiltherm 603 or 605
f.	MONSANTO	Therminol
g.	MULTITHERM	PG1, IG4, IG1
h.	PARATHERM	Paratherm NF or HE
i.	PETROCANADA	CalFlo, AF, Purity FG, CalFlo LT
j.	SHELL	Thermia 23
k.	TEXACO	Texatherm

9. Any fluid specifically designed for heat transfer use must also exhibit these characteristics:
    a. Be a stable and homogenous liquid to a temperature of at least 100°F over and above the maximum intended temperature of utilization, compatible with metals used in the installation, and tolerating contact with atmospheric air.
    b. The absence of any solid matter in suspension.
    c. Non-toxic in the case of leakage.
    d. Sufficient lubricity, i.e. not likely to cause seizure.
10. The thermal fluid manufacturer must guarantee the characteristics of the product, and verify that the fluid bulk temperature limitation exceeds the expected operating temperature.
11. After a fluid is selected, refer to the manufacturer's recommendations, published in compliance with OSHA.
12. If the fluid expansion volume from 50^{o} F to 600°F exceeds 20% of the initial fluid volume, consult Fulton Thermal Corporation.

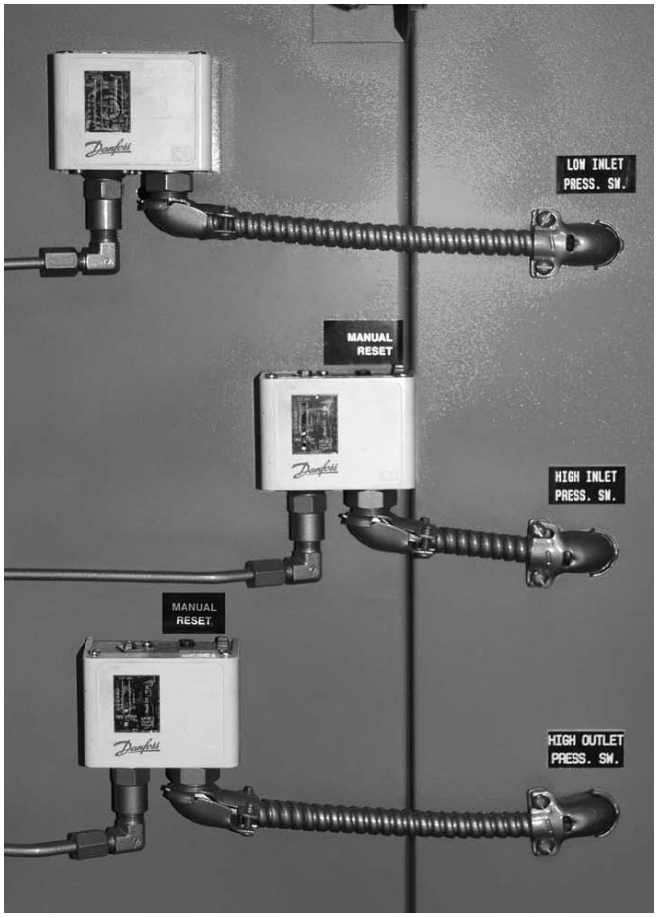
Note

Fulton Thermal Corporation cannot be held responsible in the case of accident or damage resulting from the use of inadequate fluid.

i) Routine Analysis of Heat Transfer Fluid

1. Nearly all leading manufacturers of heat transfer fluids provide an after sales service to monitor the condition of the fluid in operation and make recommendations when replacement becomes necessary.
2. Each fluid manufacturer has procedures for regular testing and analysis of the fluid. These usually allow for a sample to be taken and analyzed at least once a year, although actual frequency will depend on operating temperature, number of hours operated weekly, and the results of tests made during the first weeks of system operation.
3. Fulton Thermal Corporation recommends that the thermal fluid in your system be analyzed within the first two months after start-up.

4. During the first few months of operation, sampling may be carried out at frequent intervals to confirm that system performance has been predicted correctly.
5. If the supplier of your thermal fluid does not contact you within four weeks of commissioning, contact the supplier and make certain that the “fill” is registered for routine analysis.

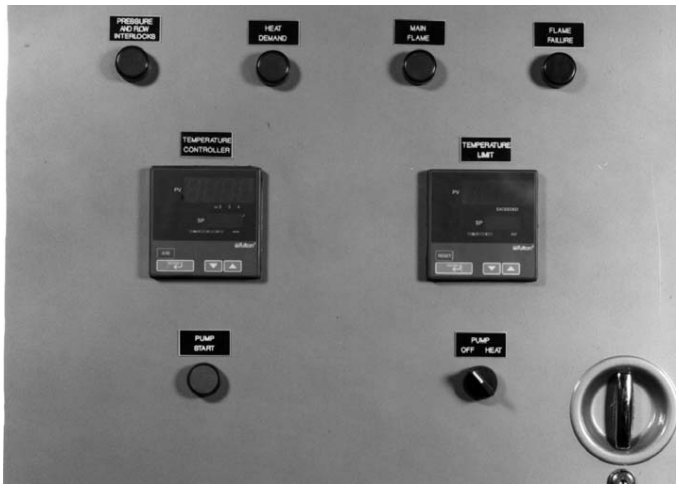


j) Thermal Fluid Breakdown

1. The possibilities of thermal fluid breakdown are very slim in a typical closed loop thermal fluid system. Fulton’s D/A tank creates a “cold seal” of fluid that is slightly above ambient temperature. This prevents oxidation that will happen when high temperature fluid contacts air.
2. This will also occur when hot thermal fluid contacts air at a leak in the system piping. Oxidized thermal fluid becomes acidic and will damage the thermal fluid system. Thermal fluid breakdown can occur in sections of piping where there is a low flow

condition. A low flow rate through the heater will result in high film temperatures leading to breakdown of the thermal fluid.

3. Multiple pressure switches and a differential pressure switch are used to prevent this condition from occurring. These safeties must not be bypassed at any time.
4. Exceeding the maximum operating temperature of the thermal fluid will also result in thermal fluid breakdown. Fulton heaters are equipped with a temperature limit switch (located on the front of the panel box) to prevent this from occurring.



5. A high temperature limit switch acts as an over temperature safety device. If the high temperature limit shuts down the unit, the manual reset button on the limit switch must be pressed. The reset button on the flame programmer must also be pressed to reset the unit before it can be restarted.

Section 3

Section 3 – Operation

1. Start-Up Preparation & Installation Review

a) Check with local authorities where approval for start-up is required. In some localities, final inspection of services may be required.

b) Review the installation section of this manual carefully. Confirm accordance with installation guidelines, including:

1. In general, ensure that the heater area is in conformance with established heater room requirements. Review national and local codes.

2. Preparation

a) Check for total absence of water in pipework and fluid. To help the system, open all drains; blow air nitrogen if available into a high point bleed through a pressure regulating valve.

Note

Unless specially filtered, compressed air will introduce moisture into the system. Dry air or Nitrogen is recommended.

b) Make sure that there are no obstructions left in the thermal fluid circuit from pressure leak testing such as blanking plates in flanged joints.

c) Check that pipework is free to expand naturally when hot. Open all valves to user circuits including air bleed valves at high points and drains at low points in the piping system, and the liquid level test connections in the expansion section of the combination tank.

3. Filling the System

a) The viscosity of thermal fluid is generally very high (500 cS) at ambient temperature. Below 50°F (10°C) some fluids become very thick. Fluid should be in a pumpable liquid form prior to filling the system.

b) Filling must be carried out from the lowest point in the system in order to prevent air pockets from forming.

c) A drain and fill point (generally a 3/4” threaded coupling) is provided on the inlet to the pump suction on skid-mounted units. Typically a portable, high velocity pump, such as the type used for chemical transfer, is appropriate for filling the system. Where only one or two drums of fluid are required, a handheld pump may be practical.

Note

Some plastics can be dissolved by thermal fluid.

Note

Do not use system circulating pump for system filling.

Note

A pump that has been used for water or a different thermal fluid should not be used prior to extensive cleaning. Thermal fluid can be damaged by contact with moisture or other fluids.

Warning

Pressurizing a drum to force fluid into the system is not recommended. The drum can easily explode, creating a hazard to personnel and equipment.

Drain and Fill Connection

d) Filling Procedure

1. Fill the system slowly, closing all opened bleed and drain valves as fluid reaches them.
2. When the fluid reaches and flows from the expansion tank low level manual test connection, begin slowing down the filling process.
3. Close the low level connection and continue to fill until the liquid level switch closes. After fluid appears in the low level connection, only a small amount of additional fluid should be required.

4. If fluid is observed coming from the expansion section high level manual test connection, drain fluid from the tank until the level is between the liquid level switch and the high level connection.
5. Filling is complete when the fluid has reached the lowest level in the expansion tank required to actuate the liquid level switch. Check to see that the liquid level switch operates freely. To confirm operation of the liquid level switch, manually trip the liquid level switch. Unit should shut down; pump will stop.

4. For Systems Equipped with Inert Blankets

a) Follow the instructions listed under “Filling The System”.
b) Pay close attention to notes and warnings.
c) Inspect the system to be sure all valves are open and all drains are closed.
d) Open all high point air vents.
e) Do not pressurize the system with nitrogen at this point.
f) Inspect the liquid level switch and be sure the switch is functioning properly.
g) Begin filling the system.
h) Fill the system until the liquid level switch indicates there is oil in the expansion tank.
i) Pressurize the system slightly with nitrogen. Leave the high point vent connections open, as the nitrogen should be isolated from the vents by the oil in the system. The pressure required in the system at this point is only 2-3 psi. If too much pressure is applied, the nitrogen will bubble through the oil and vent to atmosphere. If this happens, reduce the pressure.
j) Continue filling the system. If liquid level switch is made, be sure to observe the high point vents as oil is now entering the elevated portion of the pipe work. As oil reaches the vent, close it. After all vents have been closed, and you believe the system to be full, stop filling. Start the circulating pump as described under “Cold Circulation.” Leave the fill equipment connected as cleaning the strainer may create the need for more oil in the system.
k) The final nitrogen pressure is determined by measuring the difference between the D.A. Tank inlet and the highest point in the system. Divide that number by 2.31 (this will indicate the nitrogen pressure the system should be set for). Adjustment can be made via the regulator mounted on top of the D.A. tank.

Note

Tanks are non-code as a standard. Non-code tanks cannot be pressurized over 15psig. Tanks built to ASME code Section VIII Div 1 are available upon request.

5. Circulating Pump

a) Read manufacturer's instruction manual thoroughly. If the pump is supplied by Fulton Thermal Corporation, manufacturer's literature is included in this manual.

Note

Do not run the pump before filling it with fluid.

b) The pump should never be run without fluid in the casing. For pumps equipped with mechanical or air-cooled seals, air must be bled out of the stuffing box area to ensure that thermal fluid has lubricated all seal and bearing areas. Operation of the pump even a short time without bleeding first will damage the pump.

c) Also use the thermal fluid as a barrier fluid. Remove the 3/8" plug at the barrier fluid fill port. Fill the cavity with thermal fluid until it comes out of the overflow tube. Replace the 3/8" plug.

d) Mechanical/Air Cooled Seal

1. Open the air bleed connection located directly over the pump shaft. Replace plug when a steady stream of thermal fluid, free of entrained air, flows from the port.
2. If flow has not started after two to five minutes, remove the coupling guard and rotate the pump shaft by hand in the proper direction. This should help move the cold viscous fluid through close tolerance seal areas. Replace plug when flow is steady.
3. If this fails to induce flow, introduce fluid through the bleed port and rotate the shaft by hand to work the fluid around the seal area. Continue to add fluid and rotate the shaft until no more fluid can be added.
4. Replace the plug and run pump for five to ten seconds. Stop the pump, remove the plug and wait for flow to start. If after two minutes flow has not started, add more fluid as described above and run the pump for five minutes.
5. Constantly check the bearing area (located immediately behind the casing) for overheating. Remove the plug and check for flow.
6. If flow has not started at this point, the fluid may be too viscous to move through the seal area. Start the system normally by selecting heat on the control panel, and raise the temperature 50°F. Continue to raise the system temperature by 50°F increments. Keep checking the pump until flow starts.

Caution

1. **Use extreme caution opening plug when system temperature is elevated.**
2. **Wear eye and hand protection.**
3. **Back the plug out slowly to the last two or three threads. Allow any pressure under plug to bleed slowly to prevent a spray of hot oil.**

7. The pump should not be subjected to thermal or pressure shock. The thermal fluid should, therefore, be allowed to flow into the casing slowly.
8. Check field work and make sure that all connections have been made in the proper places. Check electrical connections to the motor.
9. Rotate the pump shaft by hand to be sure there is no binding or rubbing within the pump or driver. Correct any problems immediately.
10. Check to see that pump is properly aligned while cold.
11. The pump is properly aligned before it leaves the factory. Because the system expands in operation, the pump must be realigned when the system is at operating temperature.
12. The coupling alignment of the pump and driver must be carefully checked for angular and axial alignment. Check pump manufacturers instructions for these specifications. The use of a dial indicator to check the axial and angular alignment is recommended.
13. Realign at operating temperature, if necessary.
14. Make sure that the pump is properly greased or oiled.

e) *Pumps with Packed Seals*

1. Make sure that the gland is finger tight before filling the system.

6. Initial Start-Up

a) These instructions are for use when the unit is being started up for the first time, or after prolonged shutdown. They are to be used in conjunction with the specific procedure information in titled section, “Routine Operation.”

7. Start-Up Service

a) If start-up service has been included in the order, the factory should be contacted after the installation has been successfully completed and approved by the client's representative or engineers. Where possible, contact the factory at least one week before a Fulton service engineer is required on site.

b) All procedures covered in Operating Instruction sections "Start-Up Preparation" and Filling the System," including installation review, air testing of piping, pump alignment, and filling the system must be completed before the service person's arrival.

c) Depending on the size of the system and the amount of service time contracted for, start-up service includes firing the heater, boiling out the system, checking, verifying and adjusting all safety settings.

d) Careful preparation can expedite the commissioning of your heater. Most delays can be avoided by following the instructions in this manual. Failure to complete required procedures properly can result in the need for further service time, at extra cost to the customer.

e) Service people will not commence start-up if there are obvious system deficiencies. However, start-up service in no way constitutes a system design check or approval of the installation.

f) In addition to commissioning the heater, the service person will also familiarize heater room personnel with the operation of all Fulton equipment. Personnel must be qualified to understand the basic operation and function of controls.

8. Cold Circulation

a) Turn on the main power switches.

b) Check for proper fluid level in the expansion section of tank.

c) A centrifugal pump cannot be operated with the discharge valve closed without heating up dangerously.

d) The pump should be started with the suction valve full open and the discharge valve open a slight amount.

e) Check pump rotation. Operating the pump in reverse rotation may cause extensive damage.

f) Turn the three position switch located on the front of the panel box door to "Pump".

g) Jog the green pump motor starting button and observe the direction of rotation. Rotation should be in the direction of the arrow shown on pump casing.

h) If the rotation direction is incorrect, turn the three position switch back to "Off" immediately. Change the wiring connections and recheck.

i) Check for proper alignment. Realign, at temperature.

j) With the control switch set to “Pump” push and hold the pump start button, check all manual resets on pressuretrols. The circulating pump will run, but the burner will not fire.

k) If the pump stops when the button is released, check for proper flow in the system, and review settings of high and low fluid pressure switches and differential pressure switch. Check liquid level switch.

l) Check that all pressure gauge readings remain stable. Pressure exceeding 100 PSIG or identical readings at inlet and outlet gauges indicate a closed valve.

m) If an extremely high vacuum (i.e.15” Hg or more) is indicated on the compound gauge, the valve between the circulating pump and the combination tank may have been left closed. In this case, little or no pressure will be indicated by other gauges.

9. Filtering the System

a) Initially, readings on the compound gauge will indicate zero or slightly positive pressure. During the first few moments of flow, this reading will go towards vacuum, indicating that the strainer is becoming plugged.

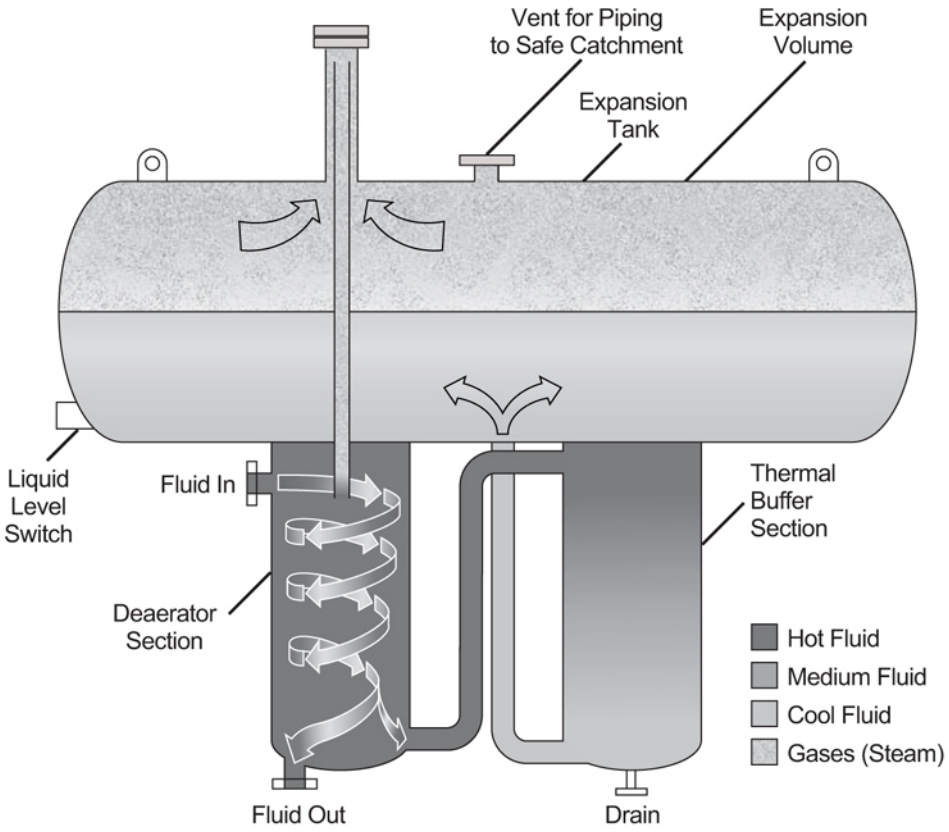
b) Typically, a reading of 3” Hg or greater vacuum on the pump suction gauge indicates that the strainer must be cleaned. The strainer screen should be back flushed or pulled, cleaned and replaced.

c) Strainers should be cleaned by means of compressed air. A rag will merely force the smaller particles into the mesh of the strainer. It is recommended to place a lint free rag in the center of the strainer and blow air from the outside, trapping the debris in the rag.

d) Allow the pump to run again for several minutes and repeat the filtering process until pump suction pressure remains steady after cleaning. The amount of time which must be allotted for filtering varies with the system.

e) When the system is initially brought up to temperature, additional pipe scale and welding slag will loosen and enter the fluid stream. This will be trapped in the strainer causing vacuum at the pump suction. This procedure must be followed as necessary in the course of heater operation.

Illustration indicates proper fluid level in the expansion section of the deaerator tank.



10. Firing the Heater/Heater

Pressure Gauges

Warning

During a system boil out, it is imperative that all system legs or paths are open to flow to ensure no water is trapped in the system.

Warning

Never open a cool or unheated user leg of a system when the rest of the system is above 250°F.

a) Check for correct fuel feed. All air must be eliminated from fuel lines, gas piping, preheaters, etc.
b) All manual valves in the fuel oil supply line must be open. Do not run the fuel pump dry or without fuel lines connected to fuel source. Do not allow the fuel oil pump to pull a vacuum.
c) Check safeties.
d) Disable N2 blanket if equipped and open vent line on DA tank.
e) Set control switch to “Heat”. The burner will begin the call for heat if oil temperature is below setpoint.
f) With burner firing and pump running, keep checking the gauges indicating pump and circuit pressures. Make sure they remain stable.
g) In case of pressure fluctuations, stop the burner, but allow the pump to continue to circulate fluid.
h) When pressures have stabilized, start burner again.

i) Continue in this manner up to the maximum operating temperature. Throughout the initial warm-up, the expansion tank and its overflow pipe must be watched to detect the formation of steam, indicating the presence of water. If this occurs, burner should be shut down.

j) If steam is forcing thermal fluid out of the expansion tank vent, turn the heater off, but leave the pump on. This is to circulate the hot fluid through the piping without flushing the steam too quickly. Once steam and thermal fluid stop leaving the expansion tank unit, the heater can be turned on. Increase the temperature very slowly to prevent fluid from being forced out of the tank.

Note

Do not open drain or vent valves during operation.

Note

If excessive amounts of thermal fluid is vented from the system, additional thermal fluid may be required in the system.

Note

Flash steam may be generated at any point up to the operating temperature. Watch for gauge fluctuations.

k) Continue bringing unit up to temperature slowly, with a temperature rise not exceeding 100°F (38°C) per hour. Do not exceed specified maximum outlet temperature. In the absence of specific information, consult the factory before proceeding.

l) Once up to temperature, check the fluid level in the expansion section by opening the high level manual test connection. If a permanent flow of fluid results when this valve is opened, and if all previous precautions have been followed, the expansion tank is too small for the capacity of the fluid in the installation. A larger tank must be installed.

m) After fifty hours of operation at operating temperature, check all flanges and connections for tightness.

Note

Start-up technician should verify that all valves are opened prior to establishing flow and heat-up.

Note

If fluid or piping is added to the system the boil out procedure must be followed, as water has to be introduced into the system.

11. Procedure for First Shutdown

a) The heater system should be shut down after no more than 24 hours of operation at full operating temperature. At this time, the following maintenance items will need to be completed to meet warranty conditions.

b) While pump is still at operating temperature, align circulating pump(s) to pump manufacturer's specifications. This should be done by means of a dial indicator.

c) Isolate Y-strainer(s) in system and clean regardless of pump suction pressure. Make sure that the temperature is low enough to handle safely or provision has been made to handle materials at high temperature. Generally, temperatures below 150°F are acceptable to perform operation with regular work gloves.

d) With piping system cooled to ambient temperature, torque all bolts on skid and throughout system to gasket manufacturer's specifications using proper flange torquing practices such as incremental torque increases, star pattern, etc. Refer to Installation Section.

e) Visually inspect all thread fittings and valve packings. Repair leaks and tighten valve packings to the point of stopping leak.

f) Upon putting unit back into operation, check all gauge readings and compare to values given to you by the start-up technician. Note any discrepancies and contact Fulton.

12. Required Pressure Drop Across the Heater

a) The thermal fluid pressure drop across your heater is critical. This should be recorded at the completion of start-up. The pressure drop value is obtained by subtracting the heater outlet pressure from the heater inlet pressure when the thermal fluid is at normal operating temperature.

b) At the recommended standard flow rates, and .7 sp gr, the pressure drop across the heater should be as shown in the chart at the top right.

c) In the event of an abnormal reading, contact Fulton Service immediately. Failure to take immediate action in the event of reduced fluid flow may result in rapid and serious degradation of the fluid, with possible damage to the heater.

Required Pressure Drop Across the Heater

Model	Recommended GPM (Schedule 40)	Recommended GPM (Schedule 40)	Pressure Drop PSI
FT-0080-C	44	50	25
FT-0120-C	66	75	27
FT-0160-C	88	100	20
FT-0240-C	132	150	30
FT-0320-C	N/A	250	25
FT-0400-C	220	250	25
FT-0600-C	330	375	26
FT-0800-C	440	500	26
FT-1000-C	550	615	18
FT-1200-C	660	730	27
FT-1400-C	N/A	800	27
FT-0400-S	N/A	400	18
FT-0600-S	N/A	600	16
FT-0800-S	N/A	800	19

NOTE: The DP switch should never be set less than 2 psi below the required pressure drop.

13. Burner Cycles

Gas Fired Burners

a) The burner is of forced draft cone design.

b) Pressure regulators on both the pilot and main gas supply, supply pressure to the proper level. Note the maximum inlet pressure rating of each regulator and supply a step-down regulator if required.

c) Combustion air is delivered by a centrifugal blower fan. An air switch monitors the pressure and is part of the flame programmer safety interlock circuit.

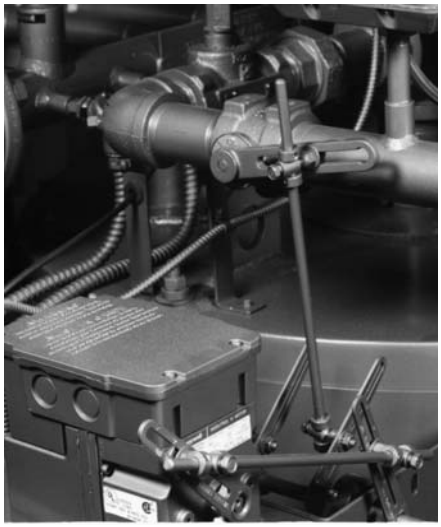
d) The flame programmer monitors the safe operation of the burner. Functions include pre-purge of the combustion chamber, provision of ignition via the ignition transformer and electrode, opening the pilot gas valve, monitoring the pilot flame signal via the flame sensor, opening main gas valves and providing post-purge of the combustion chamber.

e) Ignition of the pilot gas must result in a stable pilot flame before the flame programmer will open the main gas valve.

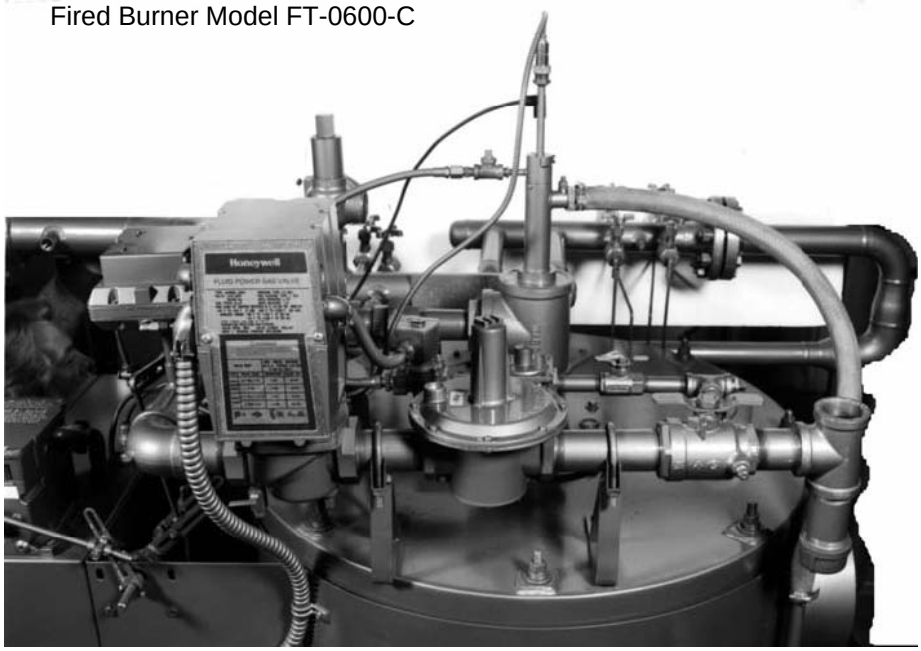
f) The flame is monitored by a flame sensor. In the event of insufficient, unstable, or non existent pilot or main flame, the flame sensor will cause a safety lockout of the flame programmer. Safety lockout can also be caused if the flame sensor is

improperly positioned or grounded. After fault has been corrected, reset by pressing the red push button on the casing of the burner control box.

Top of a Dual Fuel (Gas/Oil) Fired Burner Model FT-0600-C



Modulation Motor



Typical Gas Train for Models FT-0080-C through FT-0240-C

g) Modulating Burner

1. The function of the flame programmer must be greatly extended in a modulated system. Along with limit controls, operating controls and interlock devices, the programmer automatically controls the operation of the burner, blower motor, ignition, main fuel valves and modulating motor.

2. The sequence of operation begins with power on, limit switch and fuel valves closed, and modulating limit controller closed and calling for heat. The flame programmer begins its cycle and the blower motor starts pre-purge. The modulating circuit closes, driving the air dampers to maximum for pre-purge.
3. The air flow proving switch must be closed now. After timed pre-purge, the modulating motor drives the air damper to its low fire position. All start interlocks must be proven or the flame programmer will lockout.
4. (Units with Gas Pilot) Ignition and pilot are energized and a timed trial for pilot ignition begins. After the pilot flame is proven, the main fuel valve is energized. Ignition and pilot fuel are turned off and the modulating motor is released to automatic.
5. (Units with Spark Ignition) The spark and oil valves are energized and a timed trial for ignition begins. With the flame proven, the control advances through its main light off sequence, and the ignition shuts off. At this time, with the flame proven, the modulating motor is released to automatic.
6. When the modulating motor is released to automatic, it receives its signal from the modulating temperature controller. The modulating motor then drives the modulating fuel valve and air damper in proportion to the heat demand.
7. During the initial call for heat, the modulating fuel valve and air damper will drive to their full-fire position. As the temperature set point is approached, the modulating motor will continue to reduce the input until low-fire position is reached. Input automatically increases and decreases according to load demand.
8. When the fluid temperature reaches the set point of the on/off temperature controller or of the optional operating limit controller, all fuel valves will close and the flame programmer will advance to the purge cycle. When the postpurge cycle begins, the modulating motor will be in the low fire position. At the end of postpurge, the burner motor stops and the entire system is ready for restart on demand.

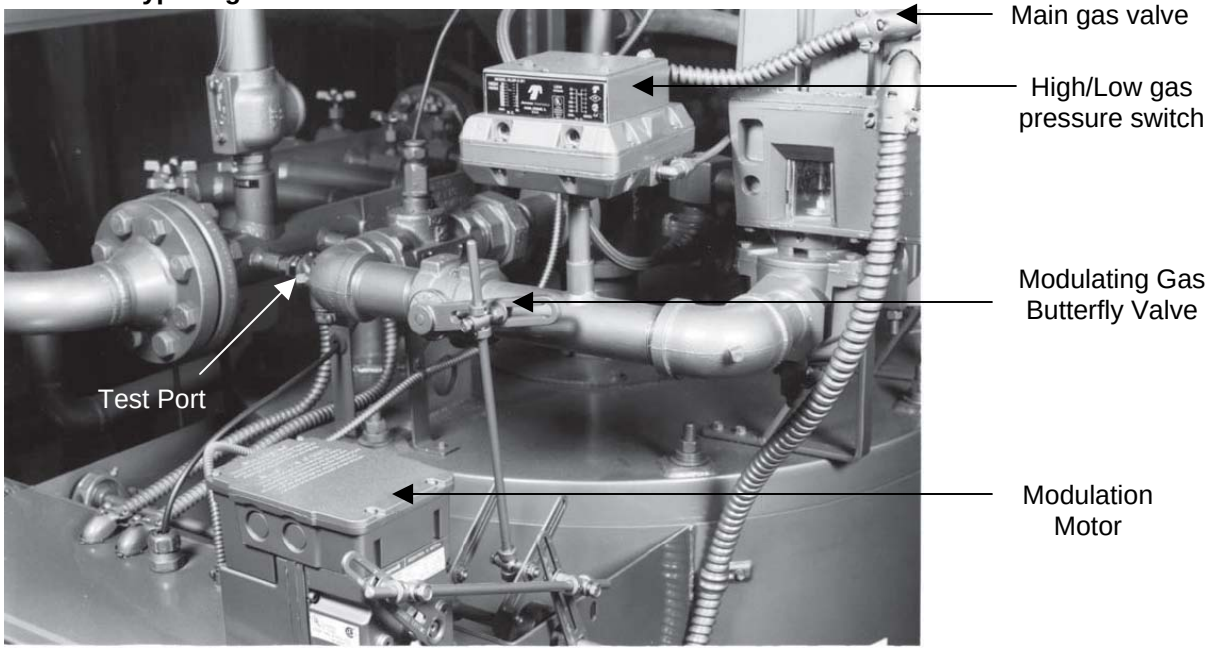
14. Fireye Linkageless Modulation

a) The Fireye Linkageless system takes the place of the Fireye E110, UT-350, Mod Motor, Linkage rods and arms. This control is a microprocessor based on Flame

Safeguard and parallels positioning combustion controller. This control has 3 levels of password protection.

1. The site Pass Code is used by the end customer to make changes to the setpoint and to the PID values of the system.
2. The Adjust Ratio Code is used by a competent burner technician to make adjustments to the air and to the gas based on combustion analysis. In this mode you can also change the setpoint and the PID values.
3. The Commissioning Ratio Mode is used by the factory to setup the parameters that are used in the Nexus control. In this mode you can modify all the parameter settings and set up the profiles for gas/air control.

Typical gas train for Models FT-0240-C and below



15. Nexus Display

a) The top line of the Nexus display shows the oil temperature and mode "Auto/Man". This line can not be changed. It is possible to change the second line of the display by using the Left or Right Arrow key, by pressing the key you will see the following: Setpoint, Fault Number, "If Control is in Fault", Hours Run, Flame Signal "range is 0-100 with a minimum signal of 10" and % of modulation.

b) In the event of a Fault on the Nexus, you will need to Press Fault Mute (Mode) key to reset the control.

c) Site Pass Code and Parameters-Default Value is 154:

1. The site pass code allows the “Adjustment of some parameters”, the default code is 154 and it is adjustable. You will be able to view all the options even though you cannot change them.
2. The options that you can change are the following:
    a. 6.3 Setpoint 1 Control Value
    b. 6.4 Setpoint 1 Proportional Band
    c. 6.5 Setpoint 1 Integral Term
    d. 6.6 Setpoint 1 Derivative Term
    e. 7.1 Setpoint 1 Low Limit Value
    f. 7.2 Setpoint 1 High Limit Value
    g. 7.5 Setpoint 1 Warming Limit
    h. 7.6 Setpoint 1 Warming Time
3. The same for Setpoint 2 if enabled.
4. To change the setpoint you Press Com (Enter) key, enter the Site Pass Code using the Up/Down keys then Press Com (Enter) key.
5. Use the Up/Down keys to advance through the options. Note: Pressing the Button too hard can cause you to skip over an option!
6. Advance through the options until you reach 6.3. Use the Left/Right Arrows to select the parameters then use the Up/Down keys to make the changes required. When a change is made Press Com (Enter) key. Use the Left/Right arrow to leave the parameter, then use the Up key to advance through the option list. To leave the Option parameters, Press Data (Run) key then Press Com (Enter) key.

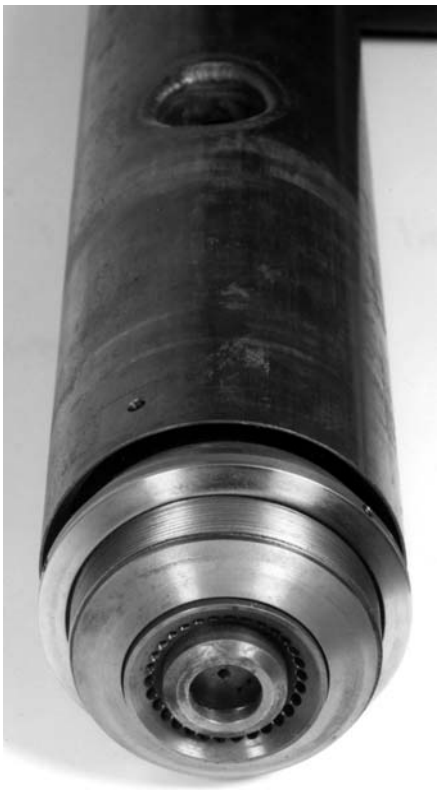
d) Engineers Key

1. The engineers key is a hidden key under the Fireye logo on the display. With the use of the engineers key, it is possible to read the values of the internal system variables and external input and output states. It is also possible to see the values of fault subsets in order to obtain more detailed information about a fault that has occurred.
2. After pressing the Fireye logo use the Up/Down keys to move through the parameters. When using the engineers key it is not possible to change any parameters. To leave this screen, press the Fireye logo and this will bring you out of the engineers parameters.

3. The engineers key parameter list begins on page 55 in the Nexus manual.

e) Nexus Fault Code Display

1. The Nexus 3100 uses the LED lights on the front of the control to provide diagnostic capability to enable the operator to identify faults when they occur. The fault listing begins on page 52 of the Nexus manual.



Oil Nozzle dual fuel burner
Models FT-0600-C through FT-1400-C

Gas Nozzle with orifice dual fuel burner
Models FT-0600-C through FT-1400-C

Complete dual fuel assembly

16. Siemens Linkageless Modulation

a) Setting Pilot

1. Verify the main burner switch is in the OFF position.
2. Supply power to the heater. The AZL will display “system test” and them move to the main menu.
3. Select PWLogin, press Enter. Select AccessServ. Press Enter. (This type of step will be shown as PWLogin – AccessServ for the remainder of this section. Enter the service passwords using the arrow key. The password is case sensitive. The case of a letter can be changed by pressing the other arrow key. (For example, if you used the right arrow key to get to the letter A, press the left arrow key to get a). After you have pressed Enter on the last character of the password, press Enter once more to accept the password. If you do not have the password, contact your Fulton Authorized Representative to perform the changes. Service=NB# or OEM=AAAA (Enter after each A).
4. Select Params&Display. Press Enter. Select Ratio Control. Press Enter. Select ProgramStop. Press Enter. Change the Program Stop to 44 Interv1 by using the arrow keys. Confirm the change by pressing Enter. This will set the burner management system to a ‘pilot hold’ setting.
5. Verify that the current value “curr” changes to 44 Interv 1. The full listing of program stops are:
    a. 24: Air damper in the prepurge position
    b. 32: Traveling to the FGR position (if the unit is equipped with FGR)
    c. 36: Ignition position (before pilot ignition)
    d. 44: Ignition position (after pilot ignition)
    e. 52: Ignition position (after main burner ignition)
    f. 72: Air damper in the postpurge position
    g. 76 – Traveling to the FGR position (if the unit is equipped with FGR)
6. Press Escape 4 times to get back to the main menu.
7. Under ManualOperation – Setload, change the load to 0% by using the arrow keys. Press enter and verify the 0% has been acknowledged in the “curr” field.
8. Press Escape once to get back to the ManualOperation menu.

9. Under Auto/Manual/Off, change the operation to Burner On by using the arrow keys. Press enter and verify that “Burner On” is acknowledged in the current field.
10. Press Escape twice to get back to the main menu.
11. Turn the main burner switch to On position.
12. Increase the set point. Under operation-Heater set point go to set point W1 using the arrow key then press Enter. Change the set point under new, using the arrows and press Enter. The new set point should appear under actual and displayed in degrees.
13. After several seconds the burner control will start its pre-ignition phase and the blower will start.
14. You can observe the status of the burner by going to the main menu (by pressing Escape) then selecting OperationalStat – NormalOperation.
15. The unit will purge then drive to the ignition position and the pilot should light.
16. The burner control will stay at this pilot hold stage so you can inspect and adjust the pilot as needed.
    a. The pilot gas pressure should match the test fire sheet.
    b. The flame signal should be greater than 90% when viewed from the top menu of the Siemens AZL display.
17. Once the pilot is adjusted properly and you are ready to light the main burner, press Escape to the main menu.

b) Setting Main Burner Ignition

1. Under Params&Display – RatioControl – ProgramStop, change the Program Stop to 52 Interv2. This is the main burner ignition position. Press enter and confirm that 52 Interv2 is acknowledged in the current field. This change moves the control to the main burner ignition point in the burner sequence.
2. This will allow the main burner to ignite. Should the burner not light, the gas and air servo motors are not synchronized to produce a combustible mix.
    a) Turn the ON/OFF switch on the panel box to OFF.
    b) To reset the alarm: Press Escape on the AZL once. Press Enter on the AZL to reset the control. The red light should go out.

c) To change the setting, return to the front menu by pressing Escape until you are to the main menu. Then select Params&Display – RatioControl – GasSettings – SpecialPositions – IgnitionPos, adjust the gas servo position by using the arrow key to move down to Gas servo if needed. Press Enter to select the servo. Move the gas servo to its new position with the arrow keys. Press Enter to confirm the new value. Use the down arrow to move to the air servo setting if needed. Press Enter to select the servo, use the arrow keys to set the new value. Press Enter to confirm this.

d) Switch the ON/OFF switch back to ON. The heater will re-start.

The light off point for main flame can be set at a higher input than low fire.

3. Press Escape 6 times to get back to the main menu.
4. You can observe the status of the burner by going to OperationalStat – NormalOperation.
5. Verify that the flame signal on the display is great than 90% and check combustion. Adjust the burner to match the test fire sheet for main burner ignition. The procedure described in step 2c is used.
6. Once the ignition position has been adjusted properly, you are ready to check the burner throughout its modulation range. Press Escape twice to get back to the main menu.

c) Setting Main Run Modulation

1. Upon releasing the heater to main run modulation (step 3), the heater will drive to low fire.
2. It is necessary to set combustion through the entire range of modulation first to enable high fire to be reached. Once high fire is achieved, the incoming gas pressure can be set. Fine-tuning of the servo setting throughout the range should be performed only once high fire settings are confirmed.

Note

If the burner loses flame while driving to a point then:

- **Turn the main ON/OFF switch to OFF. Reset the loss of flame fault. Press Escape on the AZL once. Press Enter on the AZL to reset the control. The red light on the panel box door should go out.**

- **Adjust the air and gas servos for that point while the burner is off. Follow steps d1-d2 below.**
- **Turn the main ON/OFF switch to ON.**

3. Under Params&Display – RatioControl – GasSettings – ProgramStop, change the program stop to deactivated by using the arrow keys. Confirm that 'deactivated' is acknowledged in the current field.
4. This change will allow the burner to modulate. The burner will now drive to low fire.

Remember, it is only important at this stage to set low fire to be stable and with clean combustion. Exact setting is to be performed once high fire is confirmed.

5. Press Escape 5 times to get back to the main menu.
6. You can observe the status of the burner By going to OperationalStat/NormalOperation.
7. Verify the flame signal on the display, measure input if gas meter is available. If not, match last elbow pressures and combustion for test fire sheet. Adjust the burner as needed.

To adjust the servo position, follow steps 1-2 below.

d) Setting Low Fire

Note

As soon as a servo position is altered, the servo will move to that position. Only change servo settings by a maximum of 0.5° at a time before verifying combustion.

1. Go to Params&Display – RatioControl – GasSettings – CurveParams.
2. Wait for the spinning line on the left to disappear. Press Enter. The number 1 should appear to the right of the cursor, this is the Point Number.
3. Press Enter once. Select ChangePoint by pressing the arrow keys to highlight and then press Enter to select. This will cause the servo motors to move to this low fire point.

4. Check combustion and adjust the servo motors as required. To adjust a servo motor, arrow to it and press Enter. Then adjust the setting as required and press Enter. You can now adjust another servo motor if needed.
5. When combustion is properly set for that point, press Escape once more. If it asks you to store the point, press Enter. Note the AZL will only ask to save if either servo value has been altered.
6. Low fire is now set and stored.

e) Setting the Complete Range

1. Remember it is only necessary to approximate the setting through the modulation range until high fire conditions are established.
2. Press Enter once more to have access to the point number field. Increase the point number by one and press Enter. Select ChangePoint and press Enter. The servos will now move to that point.
3. Verify combustion is satisfactory.
4. Measure input or monitor last elbow pressure. Verify that these points are in general correspondence with the test fire sheet. Repeat step 2 until the point position has a load value of 100%. You are now at high fire. Verify combustion is per test fire sheet.
5. Once at high fire, adjust the incoming gas pressure at the main gas regulator to match the test fire report. Adjust the gas servo motor to change the last elbow pressure to match the test fire report. Adjust the air servo motor to adjust the emissions as needed.
6. Repeat step d1 but start at the high fire point number. Continually decrease the point number after combustion has been verified at each point.
7. Once all the points have been verified, press Escape until you are back to the main menu.
8. You can observe the status of the burner by going to OperationalStat – NormalOperation.
9. Turn the main ON/OFF switch to OFF. The control will now postpurge.
10. Follow steps 16a3-17 and b1-4 again to verify ignition with the new gas pressures.
11. Turn the main burner switch to OFF. The control will now post purge.

12. Under Manual Operation – Auto/Manual/Off, change the operation to Automatic and press Enter and confirm Automatic is entered in the current field.
13. Press Escape twice to get back to the main menu.
14. Under Updating – ParamBackup, select LMV51 – AZL. This will store all of the adjustments that have been made in the LMV base module to the display. If the base module fails in the future, the display can be used to download all of the parameters into a new base module.
15. The heater is now ready to run. Adjust your setpoint on the temperature control to the desired temperature and turn the main ON/OFF switch to ON for the burner to operate.

f) Before Leaving the Installation

1. Check all controls to insure they are operating properly. Cycle the heater several times by raising and lowering operating temperature on the thermostat.
2. Make sure the installation complies with all applicable codes.

g) Changing Set Point on the AZL

1. Hit ESC to Select Operation than hit enter and scroll to Heater Set point, hit enter to Set point W1 hit enter and enter new set point with Select buttons.
2. Done hit enter than ESC 3 times to Operational Stats hit enter to Normal Operation, hit enter to main screen.

h) For Manual Operation

1. Hit ESC and scroll to Manual, hit enter to Auto / Manual / Off, change to manual and hit ESC to Set Load, change to 0 or desired load range with the select buttons.
2. Done hit ESC and scroll to Operational Stats, hit enter to Normal Operation, hit enter to main screen.
3. To return back to Auto operation repeat step 1 & 2.

i) Replacing a Servo Motor

1. If it is determined that a servo motor needs to be replaced, the first step in this process is to verify the model number of the new servo motor is the same as the old servo motor.
2. The model number starts with the letter SQM and is displayed on a label on the side of the motor. Once the new motor has been verified to be correct, turn power to the heater off.
3. Turn off all electricity to the heater.
4. Remove the cover on the servo motor to be changed.

5. Remove the green wiring plugs and the conduit termination point from the motor by pulling them towards you. A black grounding wire runs from the motor to the conduit termination point. Pull it off from the conduit termination point.
6. Also note the location of the jumper of the left side of the motor.
7. Loosen the allen screws on the motor end of the motor end of the motor to valve coupling.
8. Unbolt the motor from the mounting bracket and remove the motor.
9. Turn the valve so it is in the closed position and can rotate clockwise to open.
10. Mark the coupling or valve shaft if needed so the position of the valve can be determined when the servo motor is installed.
11. Bolt the new servo motor on to the mounting bracket with the motor shaft inserted into the coupling.
12. Rotate the valve shaft/coupling assembly closed as stated above.
13. While holding the valve closed, tighten the allen screws on the coupling.
14. Install the wired green wiring plugs and the conduit termination point on the new motor. Connect the black grounding wire form the motor to the conduit termination point.
15. Verify the jumper on the motor is located on the same pins as the motor that was replaced.
16. Turn power to the heater on.
17. The screen will display ‘system test’. The fault “Fault Feedback Air Actuator’ will be displayed. DO NOT RESET THIS FAULT YET. Press Escape twice to clear the fault from the screen.
18. Press Escape to get to the main menu. Under Params&Display – Actuators – Addressing, select either the gas actuator or air actuator depending upon which was replaced. The control will run an actuator check then display ‘Start Address Assignment with ENTER’. Press Enter. The display will then have you press the addressing button on the actuator. This is the red button on the actuator. The screen will then display ‘Actuator Address Assignment Successful’.
19. Press Escape until the main menu is reached. Under OperationStat – Status/Reset, reset the fault.

Caution

The heater emissions may not be correct after changing the servo motor. Verify the emissions throughout the range of modulation. If emissions are off, the servo motor can be adjusted by following the procedure in the Commissioning the Heater section of this manual.

17. On/Off Burner

a) The sequence of operation begins with power on, limit switch and fuel valves closed, and temperature controller calling for heat. The flame programmer begins the cycle and the blower motor starts prepurge.
b) The air proving switch must be closed now. Air dampers remain in maximum position.
c) (Gas Pilot) Provided all safety interlocks are proven, ignition and pilot are energized and a timed trial for pilot ignition begins. After the pilot flame is proven, the main fuel valve is energized. Ignition is turned off after main flame is established.
d) (Spark Ignition) Provided all safety interlocks are proven, the spark is on and oil valves are opened. When the flame is proven, the spark is shut off.
e) When the fluid temperature reaches the setpoint of the operating temperature controller, all fuel valves are closed.
f) The burner motor stops and the entire system is ready for restart on demand.

18. Oil Fired Burner

a) The following refers to the design and operation of the on/off burner utilizing fuel oil which requires no preheating. This burner is of high pressure, mechanical atomization design.
b) An oil pump is used to obtain necessary atomizing pressure before the fuel oil reaches the nozzle.
c) The fuel oil is divided into fine particles in the nozzle and imparted with a rotating motion before escaping from the nozzle as a cone of finely atomized oil.
d) Combustion air is supplied by a centrifugal fan. A damper provides throttling of the inlet opening. The air from the fan reaches the burner head after going through a turbulator, accomplishing correct distribution and mixture of air and atomized fuel oil.
e) An electric spark between two electrodes provides ignition of the atomized mixture, except where code requires a gas pilot. This spark is produced by a high voltage transformer.

f) The flame programmer circuit controls normal operation of the burner. The sequence includes purging of the combustion area for a set period, ignition and opening of magnetic valves on the oil circuit; post-purge of combustion area and return to re-start position.

g) An ultra-violet scanner mounted on the burner casing and facing the light of the flame monitors the flame.

h) Safety lock out occurs within a preset minimum time in the event of insufficient, unstable or non-existent flame. After fault has been corrected, reset programmer by depressing the red push button on the casing of the burner control box.

i) Proper fuel pressure at the burner nozzle is essential. The correct firing rate is obtained by setting the fuel oil pump to give the design pressure for each unit. This is done at the factory.

j) Pressure is measured by connecting a 0-400 PSI (0-25 bar) test pressure gauge to the gauge connection on the fuel pump. The fuel pressure gauge indicates the pressure of the fuel at the burner nozzle.

k) Typical pressures range between 160-350 PSI (12-22 bar). Note the correct setting upon commissioning. Modulating units should have a second pressure gauge monitoring the pressure in the return pipe from the burner. This gauge will indicate the variation of oil flow caused by modulation of the burner. Gauge readings should be recorded at start-up and checked periodically.

19. Dual Fuel Burner

Changing Fuel

a) The following instructions apply only to units supplied with dual fuel burners. These procedures should be performed only when the fluid is cold, unless sufficient safeguards are provided to prevent contact with hot fluid piping in the vicinity of the burner.

b) Set the fuel switch to "Off" and the heat selector switch to either "Pump" or "Off".

c) Gas to Oil

1. Turn off the manual gas cocks in the gas train. Remove the gas nozzle orifice assembly from the burner. Install the oil nozzle assembly and attach the oil whips to the assembly. Open all oil manual shutoff valves.

d) Oil to Gas

1. Turn off all oil manual shutoff valves. Detach the oil whips and remove the oil nozzle assembly. Install the gas nozzle orifice assembly and open the gas cocks in the gas train. Reset the hi/low gas pressure switch.

2. Set the fuel selector switch to the proper fuel. Restart unit normally.

20. Operating Controls

a) The following specifications, data, equipment and operating descriptions apply to typical Coil Design units. These sections are provided for general information purposes only, and do not necessarily reflect the specific details of individual systems.

b) *Liquid Level Switch-When Combination Tank is Supplied*

1. In the event of system fluid loss, the level in the expansion section of the combination tank will drop, and the liquid level switch will shut the unit down. Control power will be lost to the panel.
2. To confirm operation, manually trip the liquid level switch. Unit should shut down; pump will stop.

Combination Deaerator/Expansion Tank

c) Air Safety Switch

1. This switch requires that the blower fan deliver combustion air before energizing any fuel valves.
2. While firing, disconnect the copper line from the fitting in the top cover of the air switch. The burner should shut down. Attempt to restart the unit by resetting the flame programmer.
3. Blower motor will start, but firing sequence should not begin.

d) Blower Motor Starter-For units equipped with manual trip test button or motor starter

1. While firing, actuate the manual trip button on blower motor starter. Unit should lock out. Attempt re-start by resetting the flame programmer. Purge cycle will not begin.

2. Reset motor starter; blower should start and purge cycle will begin.

e) Differential Pressure Switch

1. The heater is dependent on proper flow for operation; therefore, a differential pressure switch is used to sense the pressure drop across the heater. The differential pressure switch will shut the unit down in the event of loss of flow.
2. The differential pressure switch can be tested while only the pump is running. Remove the metal cover on top of the switch and increase the setpoint until the pump shuts down. Next, decrease the setpoint back to its initial value and depress the pump start button to verify the pump will re-start.

Differential Pressure Switch

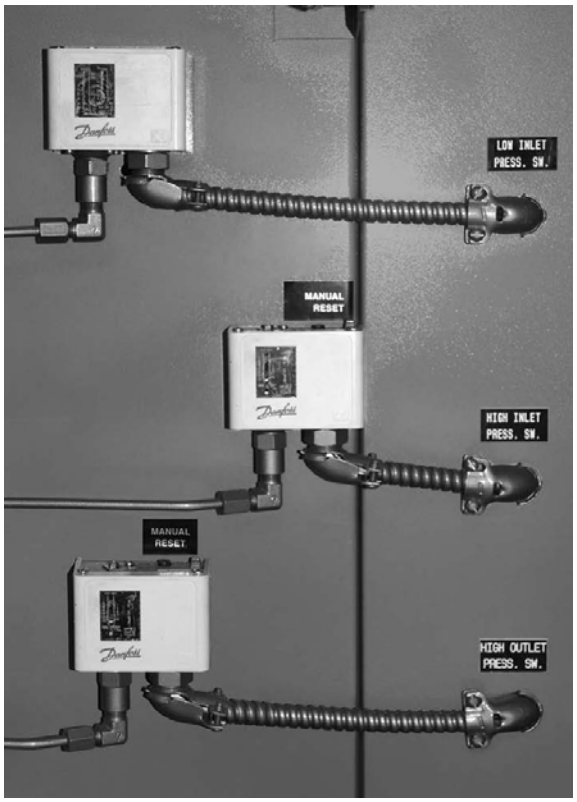
f) Pump Motor Starter

1. While firing, actuate the manual trip button on the pump motor starter. Pump and burner will shut down. The blower should continue to run for approximately thirty seconds. Attempt to restart pump by setting the selector switch to “Pump” and depressing the pump start push button. The pump should not start. Reset starter and start pump.

g) High and Low Fluid Pressure Switches

1. The only pressure required in the thermal fluid system is the pressure required to maintain the proper flow. Pressure changes are monitored with these switches, which will shut the unit down in case of a change in the fluid flow.

2. With three position switch set to “Pump”, remove the cover from the pressure switch and manually activate. Pump should shut down.
3. Repeat for each switch; replace covers. Note, if the burner was on, it would also stop.
4. To set the low fluid pressure cutout switch, raise the setpoint with the fluid at operating temperature and pump running, until the pump shuts down. Note the setpoint and lower by 10 PSI, then re-start pump. The setpoint at cutout should correspond to the reading on the output pressure gauge.
5. With the unit cold and pump running, lower the high fluid pressure cutout switch until the pump shuts down. Note the setpoint and raise by 10 PSI, then re-start pump. The setpoint at cutout should correspond to the inlet gauge reading.

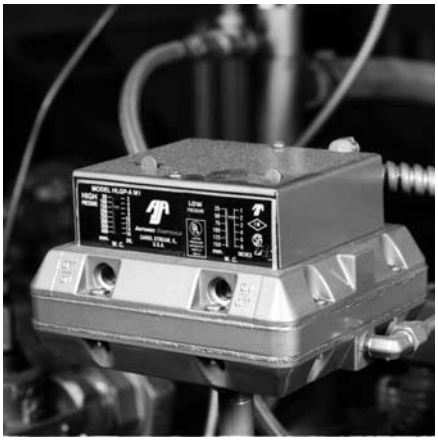


High/Low Fluid Pressure Switch

h) Gas Pressure Switch-Gas Fired Units Only

1. While firing, shut main gas cock.
2. Unit will lock out.
3. Attempt restart by resetting flame programmer.
4. Unit will start purge and lock out.

5. Open main gas valve and reset flame programmer.
6. Reset high side of switch, unit will start purge and fire.



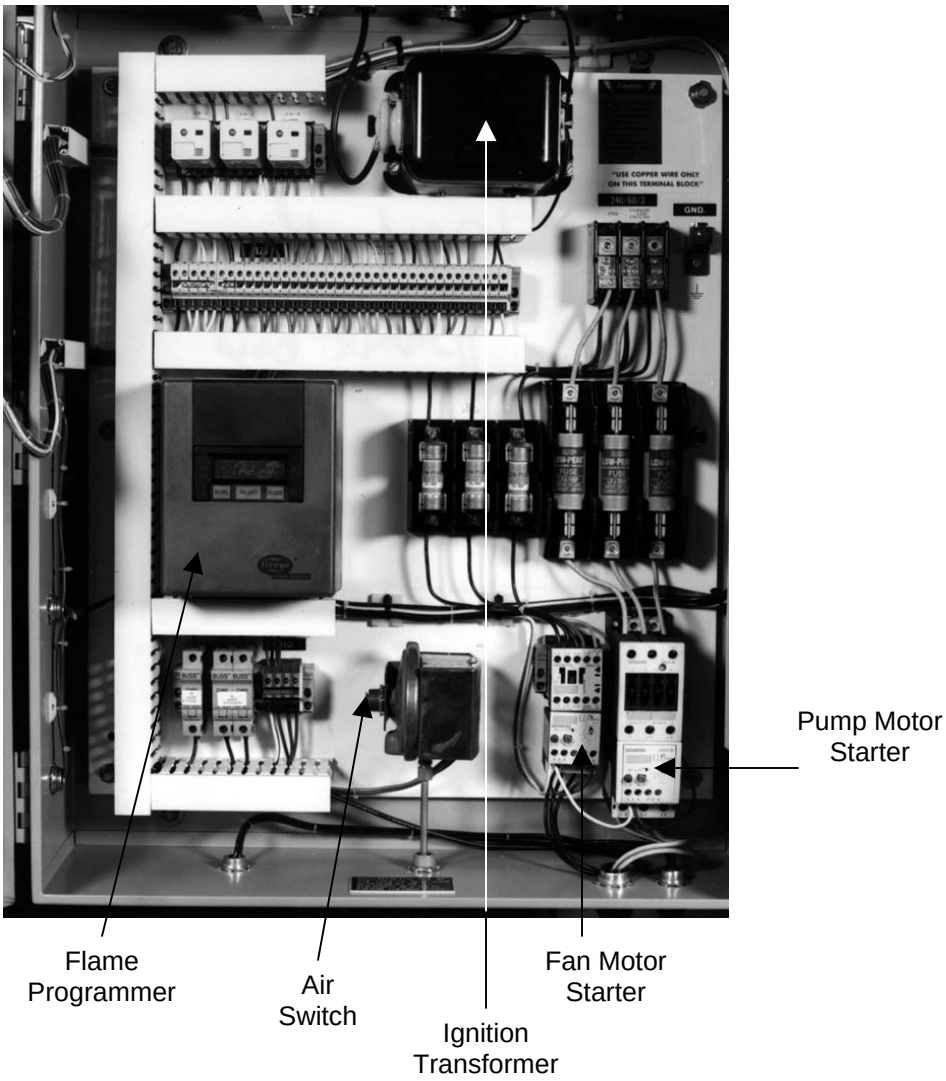
High/Low Gas Pressure Switch

i) Operating Temperature Controls

1. The Coil Design unit is a fired heat exchanger and the safe control and monitoring of the thermal fluid temperature is of vital importance. The safe maximum temperature of the fluid must be strictly adhered to.
2. When consulting fluid manufacturer's literature for the safe maximum fluid temperature, note that the temperatures quoted are the actual limit to which any of the fluids may be subjected. It is important to remember that in any fired heater there exists a "film" temperature which is higher than the temperature of the bulk of the fluid.
3. Temperature controllers measure the bulk temperature and not the film temperature. This must be taken into consideration when setting the temperature controls.
4. These approximate guidelines for temperature settings are not to override the system design parameters.
5. These instructions should be used with information from the system designer. Manufacturer's literature on the temperature controller is provided in the last section of this manual.
6. Standard primary temperature control sensing point location for On/Off and Modulating heaters is on the heater outlet.
7. When optional inlet location of the primary controls is specified. the following instructions may still be used with some modification. For instance when primary controls are located on the inlet, the dead band range will be much narrower than on

heaters with outlet control. In addition, temperature changes will not be as immediately apparent.

8. An indicating temperature controller is used to regulate the thermal fluid temperature. Typically the indicating control is a thermocouple.
9. The thermocouple is directly immersed in the thermal fluid in the heater manifold. The setpoint of the controller is regulated by the keypad.



j) High Temperature Limit Switches Safety (All units)

1. All units are fitted with high temperature limit controllers which monitor the fluid temperature at the heater outlet. This limit controller provides over temperature protection. A high temperature limit switch acts as an over temperature safety

device. If the high temperature limit shuts down the unit, the manual reset button on the limit switch must be pressed. The red button on the flame programmer must also be pressed to reset the unit before it can be restarted. The high temperature limit controller is factory set to 0°F. This must be set to the lowest of the following:

a. Maximum operating temperature of the fluid.
b. Maximum operating temperature of the equipment.
c. 15°F over maximum system operating temperature.

2. Do not set this controller too close to the normal outlet temperature in order to avoid nuisance lockouts due to small transient over temperatures.
3. Several consecutive lockouts caused by the high temperature limit controller indicate the need for immediate installation review, beginning with fluid level in the expansion tank, firing rate, and circulating pump performance.

k) Operating Limit Controller

1. The limit controller is mounted in the panel box door. This limit controller senses temperature in the outlet manifold. The temperature setpoint in the controller can be adjusted following instructions in the component data sheet section of this manual.

l) On/Off Controls

1. Typically one controller is provided to sense the temperature on the heater outlet. This controls the operation of the heater by switching it on and off. An adjustable two point differential between shut off and start up is built into the controller. This prevents frequent cycling of the burner. The controller is set to provide the desired outlet fluid temperature.
2. Due to the temperature rise through the unit, this may be considerably higher than the inlet temperature.
3. If the unit is equipped with an on/off controller, it will be located on the face of the electrical cabinet. The temperature setpoint in the controller can be adjusted following the instructions in the component data sheets section of this manual.

m) Modulating Controls

1. All coil models are standardly equipped with modulating controls.
2. The modulating temperature controller continuously regulates the outlet fluid temperature between the minimum firing rate and high fire. When the unit is on low fire and the temperature

continues to climb past the setpoint, the heater will shut down. It will typically re-start when the process temperature drops 7°F below setpoint.

3. Minimum load depends on the degree of modulation provided. Typically 3:1 or 5:1 modulation is provided. In this case minimum load is one third of full firing rate.
4. The modulating temperature controller is set to maintain the desired fluid outlet temperature. Due to the temperature rise across the heater, this may be considerably higher than the inlet temperature.
5. If the unit is equipped with a modulating controller, it will be located on the face of the electrical cabinet. The temperature setpoint in the controller can be adjusted following the instructions in the component data sheet section of this manual.

n) Additional Modulating Controls

1. The modulating motor is controlled by a temperature controller located in the control panel. Its function is to drive modulating fuel valves and air damper to their correct position as dictated by the flame programmer during pre-purge and post-purge, and to correctly position both during the normal firing cycle as required by the proportioning temperature controller. A modulating valve is positioned in the main fuel line to control the fuel input according to demand by the modulating motor.

o) Pressure Gauges

1. All units have two pressure gauges measuring the thermal fluid pressure at the inlet of the heater and at the outlet of the heater. The difference between the readings of the two gauges indicates the pressure loss across the heater. The difference must not fall below the recommended value. Recommendations are based on heater size and are listed in Section Two.
2. The gauge indicating the pressure of the fluid at the inlet is labeled “Inlet“. The “Outlet” gauge indicates the pressure at the outlet, and in effect indicates the resistance of the external pipework circuit. The pressure gauge indicating pressure at the inlet of the pump is labeled “Suction .”

p) Flow Proving Device

1. The heater is dependent on proper flow for operation; therefore, three pressure switches and a differential pressure switch are

used to sense flow across the heater. Any one of these switches will shut the unit down in the event of loss of flow.

21. Daily Start-Up

a) Check positioning of all system valves to ensure flow is not dead-headed.
b) Visually check relative position of minimum level float switch in the combination tank.
c) Turn on power supply switches.
d) Where applicable, open water cooling valve and check that water flows correctly. (For water cooled pumps only.)
e) Open fuel valves.
f) Set three position switch to “Pump”. Push and hold manual pump start button, monitoring pressure gauges on heater.
g) Push reset on high fluid pressure switch located on the side of the control panel. Release pump start switch. Pump should continue to run.
h) When ready to begin heating, move three position switch from “Pump” to “Heat”. After a short delay resulting from the purge period, the burner will ignite. Make sure that the temperature setpoint is as desired.
i) On gas units, pilot valve activation will be indicated after pre-purge cycle has completed, followed by main flame activation. Check the presence of the flame by observing flame signal strength from flame programmer or testing device. Operator attendance during warm-up is a recommended precaution.
j) Start-up is considered complete when the unit begins to throttle back or shutdown on target temperature.

22. Daily Shutdown

a) Set control switch to “Pump” pump running, burner off.
b) Allow the fluid to circulate for approximately 20-30 minutes and then set the control switch to the “Off” position.
c) When using fluid cooled pump, continue to circulate cooling water to pumps for 30 minutes after stopping circulation.
d) Open power supply switches.
e) Units switched off by an automatic time switch should have an extra relay fitted to allow 20-30 minutes of fluid circulation after stoppage in order to prevent localized over heating of fluid .
f) Close fuel valves if required. Closing of system valves is not generally necessary unless maintenance of components requires a partial draining of the system.

g) Because of the high temperatures usually applied, leaks are not expected to occur when cool down is achieved, provided pipework is free to contract naturally when cold.

Section 4

Section 4 – Maintenance

Minimum equipment necessary to start and maintain fuel-fired thermal fluid heaters:

- Digital Multimeter
- Combustion Analysis Equipment
- Draft Gauge

1. Required Maintenance at First Shutdown

a) The thermal fluid system should be shut down after no more than 24 hours of operation at operating temperature. At this time, the following maintenance items will need to be completed to meet the condition of warranty.

b) While pump is still at operating temperature, align circulating pump(s) to pump manufacturer specifications. This should be done by means of a dial indicator.

c) Isolate Y-strainer(s) in system and clean regardless of pump suction pressure. Make sure that the temperature is low enough to handle safely or provision has been made to handle materials at high temperature. Generally, temperatures below 150°F are acceptable to perform operation with regular work gloves.

d) With piping system at ambient temperature, torque all bolts on skid and throughout system to gasket manufacturer specification using proper flange torquing practices (incremental torque increases, star-pattern, etc). These values are available in the installation section of the manual..

e) Visually inspect all thread fittings and valve packings. Repair leaks and tighten valve packings to the point of stopping leak.

f) Upon putting unit back in operation, check all gauge readings and compare to values given to you by the start up technician. Note any discrepancies and contact manufacturer.

2. General Maintenance Schedule

Daily

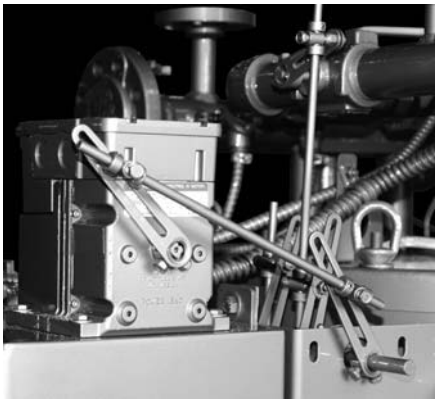
a) Complete the log sheet attached at the end of this section at least once per day as a minimum. It is recommended that the log sheet be filled out twice per shift of operation. The log sheet is available from the Fulton Service Department or www.fulton.com

b) Make visual inspection of the entire system for leaks. Make repairs as soon as possible.

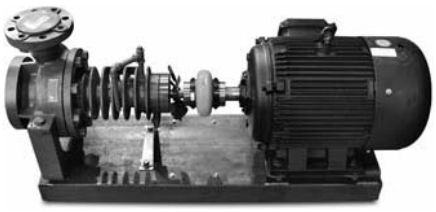
c) Note any failures on the flame programmer noting fault number, fault code, fault annunciation, fault hour, fault cycle and fault time.

d) Check the exhaust for the presence of smoke. If smoke is present, contact Fulton Service Department at (315) 298-7148 or contact your local Fulton Thermal Representative.

e) In systems utilizing linkage, check all linkage components for tightness.

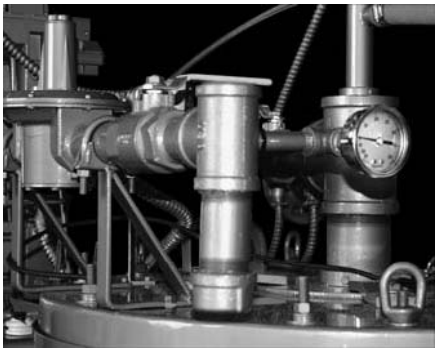


f) In systems utilizing a water cooled thermal fluid circulating pump, check level of lubricating oil in self-leveling reservoir and check cooling water circulation loop for proper operation.



Weekly

a) Check inlet gas pressure at the beginning of the gas train. This should be accomplished by the installation of an appropriately scaled gauge.

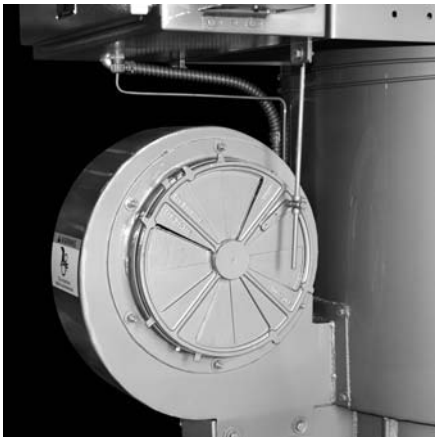


b) Check manifold gas pressure at high and low fire and compare to Thermal Combustion Checklist filled out by start up technician. This should be accomplished by the installation of an appropriately scaled gauge. Readings should be with .02" w.c. of Thermal Combustion Checklist.

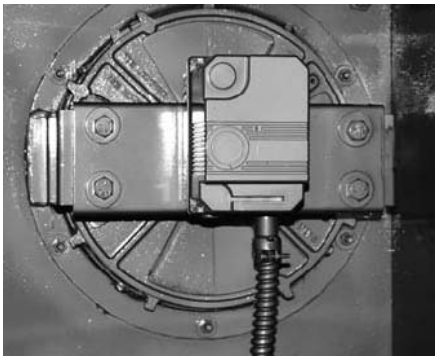
Monthly

a) Clean fuel filters.

b) Check burner blower. Clean if necessary.

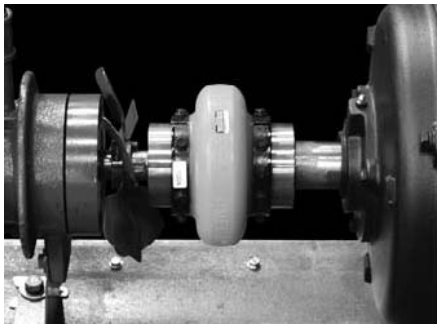


c) Clean or change air filter if applicable.



d) Manually check fluid level in the expansion tank. Drain ½ gallon of thermal fluid from the expansion tank. If water is present, continue to drain ½ gallon until no water is present.

e) Check operation of all safeties. Refer to the instructions at the end of this section.
f) With the burner running, remove or disconnect the flame detection device. The flame programmer should lockout within 3 seconds.
g) Review daily log sheets noting any deviations from the norm.
h) Check the tightness of all couplings, including the fuel oil pump drive (oil-fired units), fan impeller, circulating pump, etc.



Semi-Annually

a) Pull burner and inspect for heat stress or soot. Clean or replace as necessary.

b) Inspect pilot tube assembly and ignition electrode. Clean or replace if necessary. Reset ignition settings to manual specifications.

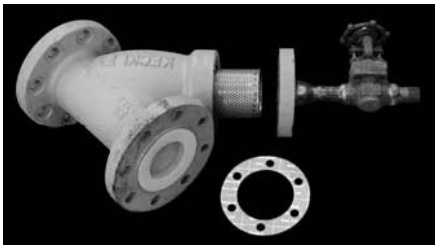
c) Inspect internal surfaces of the heater. Inspect refractory for cracks. Cracks larger than ¼" wide will require repair or replacement of the refractory. Inspect coil for sooting. If soot is present, it can be removed by utilizing a brush or compressed air for light sooting.
d) Have combustion checked for efficiency.
e) Review daily log sheets noting any deviations from the norm.

Annually

a) Replace the ignition electrode(s).

b) If the unit utilizes a flame rod, replace.

c) Clean all strainers in the thermal fluid system.



d) Take a one quart sample of thermal fluid and return to the thermal fluid manufacturer for analysis.

e) Schedule to local Fulton representative or factory service technician to perform an annual preventative maintenance.

3. Maintenance Procedures

Lubrication

a) Different motor manufacturers recommend various intervals for lubrication schedules. Load variations will dictate the frequency and amount of lubrication required.

b) When developing your lubrication schedule, consider the thermal fluid pump and all system pumps.

c) If you have a thermal fluid circulating pump with a packed seal, the condition of the pump packing should be checked regularly. If fluid leakage increases, tighten the packing ¼ turn daily.

Soot Cleaning

a) If your coil inspection indicates severe sooting, the following procedure should be followed:

1. Drain fluid from the coil (using a pump).
2. Remove the burner and lower access doors.
3. Wire brush coils and use compressed air where accessible.
4. Vacuum loose soot where accessible.
5. Reinstall the burner and lower access doors.
6. Fire the heater to roughly 300°F.
7. Remove the burner again and fill the heater with a water/detergent or water/caustic mix to the flue outlet. The water to caustic mix should be at a ratio of 25 gallons to one pound of caustic soda. The amount of caustic for each heater is as follows:

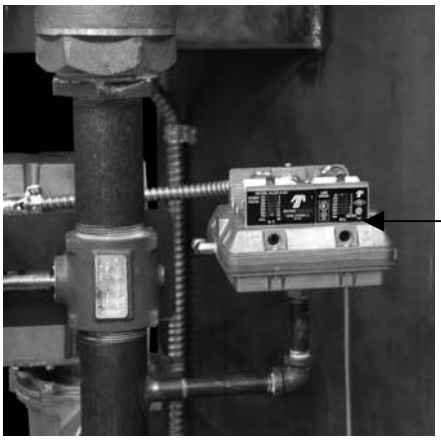
Heater Size	Pounds of Caustic Soda
FT-0080-C	1
FT-0120-C	1 ¼
FT-0160-C	1 ½
FT-0240-C	2
FT-0400-C	3
FT-0600-C/FT-0400-S	4
FT-0600-S	4
FT-0800-C/ST-0800-S	5
FT-1000-C	6
FT-1200-C	7

8. Stir the mixture occasionally and let the wash continue for at least one hour.
9. To drain the heater, pump out. Rinse heater thoroughly when finished before reassembling heater.

4. Safety Check Procedures

Liquid Level Switch

a) Manually turn liquid level switch cam counterclockwise. Micro-switch will open contacts and control voltage will be lost. Release cam and micro-switch will make and control voltage will be restored.

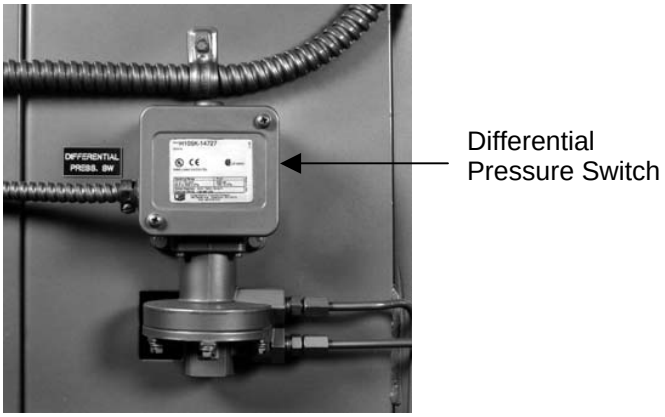


Stack Limit

a) The limit manufacturer presets the stack limit. Testing can be performed by removing switch from stack and applying heat over that of the switch set point for several seconds. The switch can then be reset and re-installed.

Differential Pressure Switch

a) With the circulating pump running, observe the difference in pressure between the heater outlet gauge and the heater inlet gauge. Remove the top cover of the differential pressure switch. Note the original setting of the switch and turn adjustment knob clockwise until switch trips. The pointer on the switch should be within 2 psi of the observed pressure difference. Reset switch to the original set point.



Low Inlet Pressure Switch

a) Slowly close the valve on outlet of main circulating pump observing heater inlet pressure gauge. Note the pressure at which the switch trips. This pressure should be roughly the set point of the switch minus any differential that is set.

High Inlet Pressure Switch

a) Note the original setting of the switch and turn adjustment screw counterclockwise while observing heater inlet pressure gauge until switch trips. The pointer on the switch should be within 2 psi of the observed pressure. Reset switch to the original set point.

High Outlet Pressure Switch

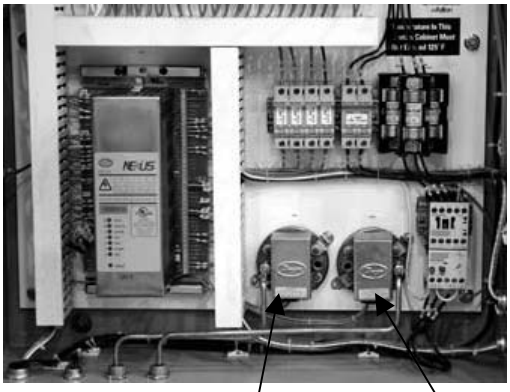
a) Note the original setting of the switch and turn adjustment screw counterclockwise while observing heater outlet pressure gauge until switch trips. The pointer on the switch should be within 2 psi of the observed pressure. Reset switch to the original set point.

Air Switch

a) Remove the ¼" copper tubing from the bottom of the air switch with the fan running. Air switch should trip the interlock circuit. Re-attach copper tubing and reset flame programmer.

Air Filter Box Switch

a) With heater running at high fire, block opening to air filter box by 50%. Slowly close off further until switch trips. Air switch should trip at just over 50% blockage.



Temperature Limit(s)

a) Adjust set point(s) of temperature limit(s) down to a point lower than the PV (process variable is typically the current fluid temperature at the heater outlet). Solid-state controls will deactivate a control relay powering a set of n.c. contacts in the interlock circuit. Analog controls will open their contacts in the interlock circuit. Trip temperature should be within 5 degrees of PV temperature. Reset temperature limit if reset exists and reset flame programmer.

High/Low Gas Pressure Switch

a) Shut off the main gas valve prior to the gas train and attempt to light the unit. After the gas valves open during the ignition trial, the low gas pressure switch will trip. Reset the low gas pressure switch and flame programmer. Open main gas valve prior to gas train and close gas valve between last actuated gas valve and burner. Attempt to light the unit. After the gas valves open, the high gas pressure switch will trip. Reset the high gas pressure switch and the flame programmer.

5. Recommended Maintenance Schedule (See log sheet)

Daily

a) Complete log-sheet at least once per day. Twice per shift of operation is recommended. (Log sheet is available from the Fulton Service Department or on the web at www.fulton.com)

b) Make visual inspection of entire system for leaks. Repair as soon as possible.

c) Note any failures on flame programmer noting fault number, fault code, fault annunciation, fault hour, fault cycle, and fault time.

d) Check the exhaust for the presence of smoke. If smoke is present, contact Fulton Service Department (315) 298-7148 or your local Fulton Thermal Representative.

Weekly

a) Check inlet gas pressure at beginning of gas train. Appropriately scaled gauge should be installed to facilitate this.

b) Check last elbow gas pressure at high fire and low fire and compare to Thermal Combustion Checklist filled out by start up technician. Appropriately scaled gauge should be installed to facilitate this. Readings should be within 0.2" w.c.

Monthly

a) Clean fuel filters.

b) Check blower fan. Clean if necessary.

c) Clean or change air filter if installed.

d) Manually check fluid level in expansion tank.

e) Check operation of all safeties. Contact Fulton service department for instructions.

f) When the unit is running, disconnect the flame sensor. Heater should shut off on flame failure immediately (within 3 seconds).

g) Review log sheets and note any deviations from the norm.

h) Drain ½ gal. Of oil from thermal buffer section of DA tank.

Semi-Annually

a) Pull burner and inspect for heat stress or soot. Clean or replace if necessary.

b) Inspect pilot tube assembly and ignition electrode. Clean or replace if necessary. Reset ignition settings to manual specifications.

c) Inspect refractories for cracks. Make sure there are no pieces of refractory loose on the bottom of the unit. Cracks 1/8" wide can be patched. If cracks are ¼" or larger, refractories need to be replaced.

d) Review log sheets and note any deviations from the norm.

e) Have combustion checked for efficiency.

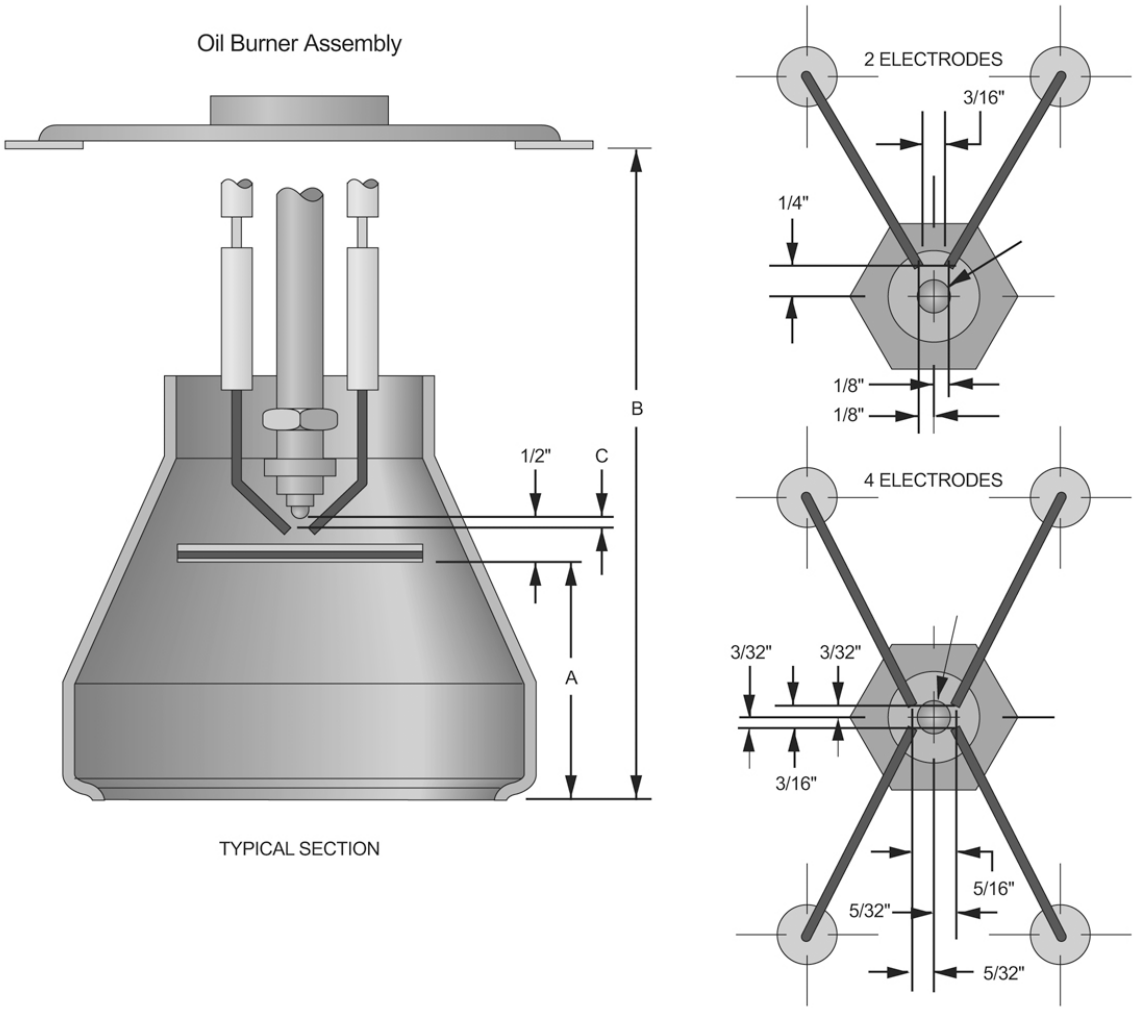
f) Check coil for soot buildup. Clean if necessary

Annually

a) Replace ignition electrode.
b) Clean all the strainers in the thermal fluid system.
c) Take a quart sample of thermal fluid and have it analyzed per fluid manufacturers instructions.
d) Schedule the local representative or factory technician to perform preventative maintenance on the system.

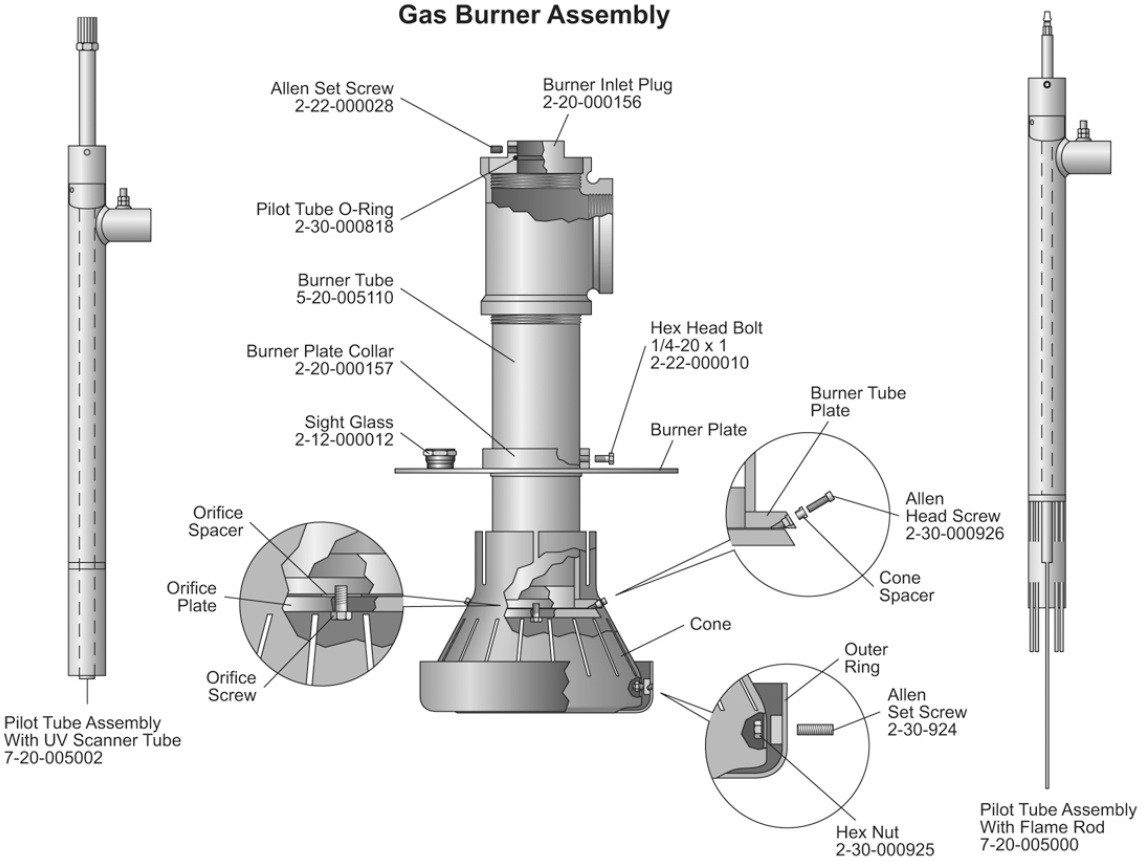
Note

All of the above maintenance procedures should be completed by trained personnel. Appropriate training and instructions are available from the Fulton Service Department at (315) 298-7148 or your local Fulton Thermal Representative.



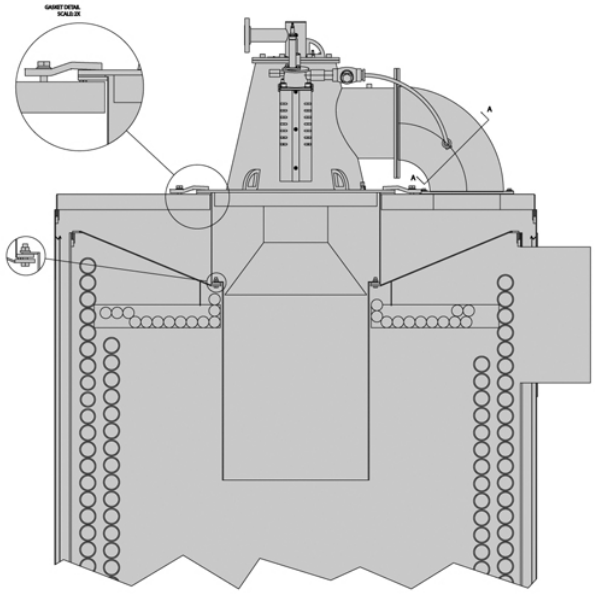
Model FT	0080 w/6 1/8" Cone	0080 w/6 1/8" Cone	01201 0160	0240	0320	0400
A	2 ¾ "	3 ¾"	3 15/16"	3 11/16"	3 5/8"	3 9/16"
B	*	*	11 9/16"	14 ¼ "	15 ½"	17 11/16"
C	¼"	¼"	¼"	¼"	¼"	¼"

Gas Burner Assembly

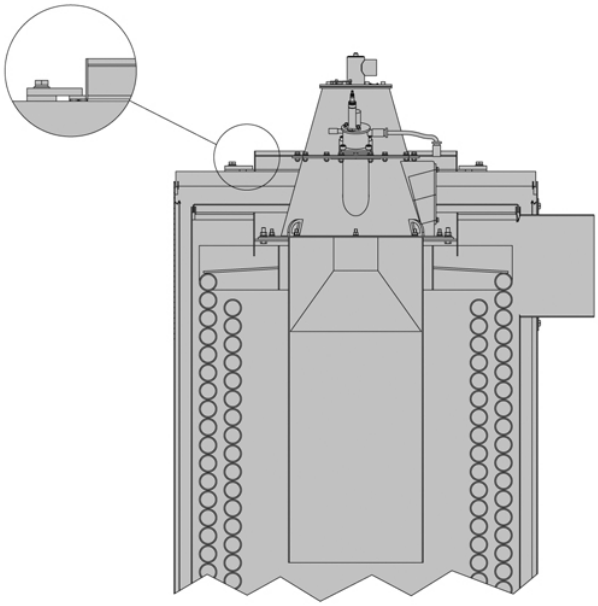


Model FT	**0080**	**0120**	**0160**	**0240**	**0320**	**0400**
Outer Ring	2-30-910	2-30-910	2-30-910	2-30-911	2-30-911	2-30-912
Cone w/ Outer Ring	2-30-909	2-30-664	2-30-664	2-30-665	2-30-670	2-30-666
Cone Spacer	2-20-185	2-20-184	2-20-184	2-20-184	2-20-184	2-20-183
Allen Head Screw	2-30-928	2-30-928	2-30-928	2-30-928	2-30-928	2-30-928
Orifice Plate	2-20-173	2-20-173	2-20-173	2-20-172	2-20-172	2-20-171
Orifice Spacer	2-20-178	2-20-177	2-20-176	2-20-175	2-20-175	2-20-174
Orifice Screw	2-30-918	2-30-918	2-30-918	2-30-918	2-30-918	2-30-817
Burner Tube Assembly	7-30-5000	7-30-5000	7-30-5000	7-30-5002	7-30-5002	7-30-5004
Burner Plate Assembly	5-52-4000	5-52-4000	5-52-4000	5-52-4004	5-52-4004	5-52-4006
Complete Burner Less Pilot	7-30-4000	7-30-4001	7-30-4002	7-30-4004	7-30-4005	7-30-4006

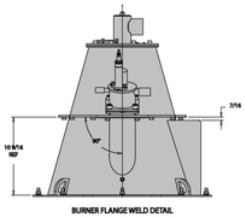
Burners Used for LE Heaters



Maxon Optima Burner
FT800-C through FT1400-C



Maxon MPakt Burner
FT320-C through FT600-C



6. Troubleshooting

Flow Circuit/Circulating Pump(s)

a) The flow circuit is the electrical circuit that enables the circulating pump(s). Your thermal fluid pump(s) will remain on until the flow circuit opens to disable the pump starter or the Off / Pump / Heat switch is turned to the "Off" position.

b) Items in the flow circuit may include paddle type flow switches, a high inlet pressure switch, a low inlet pressure switch, a high outlet pressure switch and a differential pressure switch.

c) Low Inlet Pressure Switch

1. All C-Model heaters have a Low Inlet Pressure Switch. This is a normally open switch that closes with proper heater inlet pressure. This switch is generally a mercury bulb type switch. Mercury will rest towards the green cap of the mercury bulb in a "made" condition.
2. The purpose of the Low Inlet Pressure Switch is primarily to protect the heater from a low flow condition. The Low Inlet Pressure Switch should be set at 5 psi below normal heater inlet pressure as read at operating temperature assuming that none of the conditions mentioned below are true. A tripped Low Inlet Pressure Switch is an indication of one of the following.
3. If your Low Inlet Pressure Switch is not making, check the following items:

d) *Plugged circulation pump strainer basket*

1. A plugged strainer will result in a decrease of flow through the heater. High vacuums developed from plugged strainers can also stress the seals of the pump causing the pump to fail.
2. A "Pump Suction" gauge is provided on Fulton Thermal skids to help determine when a strainer needs cleaning. Generally this point is between 0 and -5" Hg.
3. If the strainer is plugged, isolate the strainer and drain that section of piping being mindful of the temperature of the thermal fluid.
4. Remove the strainer and clean with compressed air, high-pressure water or a cleaning solution. Replace and observe new pump suction pressure.

e) Failed circulation pump coupling

1. A failed coupling will result in a decreased or no flow condition through the heater. The coupling can be checked by removing the coupling guard between the pump and pump motor.
2. The coupling should not be torn or misshapen. If the coupling needs to be replaced, it is recommended to re-align the circulating pump first at ambient temperature and again when it's at operating temperature. Alignment should be within pump manufacturers' specifications.

f) Cavitation of the circulating pump

1. Cavitation occurs when a pump experiences a loss of head or if any low heater flashes to gas at the impeller. During this time, the pump impeller spins without actually circulating any thermal fluid.
2. If Fulton Thermal Corporation provided the heater skid, loss of head to the pump is extremely unlikely with proper fluid level in the combination tank.
3. The most common low heater in a thermal piping system is water, which needs to be boiled out at startup or anytime new piping or fluid is added to the thermal oil system.
4. Once the system has been brought up to full operating temperature, assuming that the entire system has seen flow, there should be no further occurrence of low heater contamination apart from possible heat exchanger failure.

g) System is Open

1. Lack of back-pressure. If control valving is improper or pressure drop across the system is too low, the resulting minimal back-pressure may not provide enough resistance for the flow to make the pressure switch. Check the thermal fluid system for proper operation of control valves.

h) Blocked sensing line on pressure switch

1. A blocked sensing line will give an inaccurate pressure reading to the pressure switch. A blocked line will need to be replaced or cleaned. Most installations have block valves at the heater to facilitate safe isolation and cleaning of the sensing line.

i) Improper switch setting

1. The Low Inlet Pressure Switch should be set at 5 psi less than the pressure read on the heater inlet pressure gauge at full operating temperature of the system.

j) Faulty Switch

1. If pressure is verified and reads correctly above set point on switch and the sensing line to the pressure switch is open, the pressure switch is faulty. Replace switch, set for desired set point and test for proper operation.

k) High Outlet Pressure Switch

1. All C-Model heaters have a High Outlet Pressure Switch. This is a normally closed switch that opens with excessive heater outlet pressure.
2. This switch is generally a mercury bulb type switch. Mercury will rest towards the green cap in a "made" condition.
3. The purpose of the High Outlet Pressure Switch is primarily to protect the heater from building too much pressure. Typical coil model heaters have a maximum working pressure of 150 psi with 100 psi safety valve(s) on the heater outlet manifold.
4. The High Outlet Pressure Switch should be set at 5 psi over the heater outlet pressure as read at ambient temperature assuming that none of the conditions mentioned below are true.
5. A tripped High Outlet Pressure Switch is an indication of one of the following and will require the manual reset button on the switch to be pushed:

l) An obstruction downstream of the heater

1. Any obstruction downstream of the heater will increase the pressure that the heater outlet sees. This obstruction will generally result from an improper valve setting.
2. Observe heater outlet pressure at temperature with all users / heat exchangers calling for heat (100% user). Observe heater outlet pressure at temperature with all users / heat exchangers not calling for heat (100% bypass). Bypass regulating valve(s) should be adjusted to equal flow condition through users.
3. Call or e-mail Fulton for further details. It may be possible that an automatic control valve has failed. If this is the case, the valve actuator should be inspected and possibly replaced.

m) Improper switch setting

1. The High Outlet Pressure Switch should be set at 5 psi over than the maximum pressure read on the heater outlet pressure gauge during proper operation at the coldest ambient temperature expected.

n) Faulty Switch

1. If pressure is verified and reads correctly below set point on switch and the sensing line to the pressure switch is open, the pressure switch is faulty. Replace switch, set for desired set point and test for proper operation.

o) Flow Switches

1. Units older than mid-1993 have Flow Switches on the inlet of each pipe in the coil. These are normally open switches that close, making a micro-switch, upon flow establishment.
2. The purpose of the Flow Switch(es) is to protect the heater coil from too high of a temperature and to protect the thermal fluid from exceeding its maximum film temperature. Each flow switch is wired in series requiring flow through each pipe in the coil.

Flow Switches Not Making

a) An obstruction downstream of the Flow Switch(es)

1. Any obstruction downstream of the flow switch(es) will increase the pressure that the heater outlet sees. Any increase in outlet pressure will result in diminished flow. This obstruction will generally result from an improper valve setting.
2. Observe heater outlet pressure at temperature with all users / heat exchangers calling for heat (100% user). Observe heater outlet pressure at temperature with all users / heat exchangers not calling for heat (100% bypass).
3. Bypass regulating valve(s) should be adjusted to equal flow condition through users. Call or e-mail Fulton for further details.
4. It may be possible that an automatic control valve has failed. If this is the case, the valve should be replaced.

b) Plugged circulation pump strainer basket

1. A plugged strainer will result in a decrease in flow through the heater. High vacuums developed from plugged strainers can also stress the seals of the pump causing the pump to fail.
2. A "Pump Suction" gauge is provided on Fulton Thermal skids to help determine when a strainer needs cleaning. Generally this point is -2 psi (5 in. Hg).

3. If the strainer is plugged, isolate the strainer and drain being mindful of the temperature of the thermal fluid. Remove the strainer and clean with compressed air, high-pressure water or a cleaning solution. Replace and observe new heater inlet pressure.

c) Failed circulation pump coupling

1. A failed coupling will result in a decreased or no flow condition through the heater. The coupling can be checked by removing the coupling guard between the pump and pump motor. The coupling should not be torn or misshapen. If the coupling needs to be replaced, it will be necessary to re-align the circulating pump first at ambient temperature and again when it's at operating temperature.

d) Cavitation of the circulating pump

1. Cavitation occurs when a partial vacuum presents itself at the eye of the pump impeller due to loss of head or if any low heater flashes to gas at the impeller.
2. During this time, the pump impeller spins without actually circulating any thermal fluid. If Fulton Thermal Corporation provided the heater skid, loss of head to the pump is extremely unlikely with proper fluid level in the tank.
3. The most common low heater in a thermal piping system is water, which needs to be boiled out at startup.
4. Once the system has been brought up to full operating temperature, assuming that the entire system has seen flow, there should be no further occurrence of low heater contamination apart from heat exchanger failure.

e) Plugged coil pipe(s)

1. If too low of a flow condition has occurred for too long a period of time or if the maximum operating temperature of the oil has been exceeded, it is possible, however unlikely, that a pipe or pipes in the coil could plug with solids. If this occurs, it will be necessary to shut down the system and clean the coil. Fulton Thermal Corporation should be consulted in this matter.

f) High inlet pressure switch

1. Units newer than mid-1993 have a High Inlet Pressure Switch. This is a normally closed switch that opens with improper heater inlet pressure.

2. This switch is generally a mercury bulb type switch. Mercury will rest towards the green cap in a "made" condition. The purpose of the High Inlet Pressure Switch is to protect the heater from building too high of a pressure.
3. Typical coil model heaters have a maximum working pressure of 150 psi with 100 psi safety valve(s) on the heater outlet manifold. The High Outlet Pressure Switch should be set at 5 psi over the heater outlet pressure as read at ambient temperature assuming that none of the conditions mentioned below are true.

Tripped High Outlet Pressure Switch

a) An obstruction downstream of the heater

1. Any obstruction downstream of the heater will increase the pressure that the heater outlet sees. This obstruction will generally result from an improper valve setting.
2. Observe heater outlet pressure at temperature with all users / heat exchangers calling for heat (100% user). Observe heater outlet pressure at temperature with all users / heat exchangers not calling for heat (100% bypass).
3. Bypass regulating valve(s) should be adjusted to equal flow condition through users. Call or e-mail Fulton for further details.
4. It may be possible that an automatic control valve has failed. If this is the case, the valve should be replaced.

b) Plugged coil pipe(s)

1. If too low of a flow condition has occurred for too long a period of time or if the maximum operating temperature of the oil has been exceeded, it is possible, however unlikely, that a pipe or pipes in the coil could plug with solids. If this occurs, it will be necessary to shut down the system and clean the coil. Fulton Thermal Corporation should be consulted in this matter.

c) Improper switch setting

1. The High Inlet Pressure Switch should be set at ambient temperature. The setting should be 5 psi over than the maximum pressure read on the heater outlet pressure gauge during proper operation.

d) Differential Pressure Switch

1. Units newer than mid-1993 have a Differential Pressure Switch. This is a normally open diaphragm switch that closes with a proper heater differential pressure between the heater inlet and outlet.

2. The purpose of the Differential Pressure Switch is to protect the heater coil from too high of a temperature and to protect the thermal fluid from exceeding its maximum film temperature. Each heater model number has a specific minimum differential pressure.
3. See Section 1 if you do not know this pressure. This pressure is the difference in pressure between the heater inlet pressure gauge and the heater outlet pressure gauge.

Differential Pressure Switch Break

a) An obstruction downstream of the heater outlet

1. Any obstruction downstream of the flow switch(es) will increase the pressure that the heater outlet sees. Any increase in outlet pressure will result in diminished flow. This obstruction will generally result from an improper valve setting.
2. Observe heater outlet pressure at temperature with all users / heat exchangers calling for heat (100% user). Observe heater outlet pressure at temperature with all users / heat exchangers not calling for heat (100% bypass).
3. Bypass regulating valve(s) should be adjusted to equal flow condition through users. Call or e-mail Fulton for further details.
4. It may be possible that an automatic control valve has failed. If this is the case, the valve should be replaced.

b) Plugged circulation pump strainer basket

1. A plugged strainer will result in a decrease in flow through the heater. High vacuums developed from plugged strainers can also stress the seals of the pump causing the pump to fail.
2. A "Pump Suction" gauge is provided on Fulton Thermal skids to help determine when a strainer needs cleaning. Generally this point is 5-10 psi (10-20 in. Hg).
3. If the strainer is plugged, isolate the strainer and drain being mindful of the temperature of the thermal fluid. Remove the strainer and clean with compressed air, high-pressure water or a cleaning solution. Replace and observe new heater inlet pressure.

c) Failed circulation pump coupling

1. A failed coupling will result in a decreased or no flow condition through the heater. The coupling can be checked by removing the coupling guard between the pump and pump motor. The coupling should not be torn or misshapen. If the coupling needs

to be replaced, it will be necessary to re-align the circulating pump first at ambient temperature and again when it's at operating temperature.

d) *Cavitation of the circulating pump*

1. Cavitation occurs when a partial vacuum presents itself at the eye of the pump impeller due to loss of head or if any low heater flashes to gas at the impeller. During this time, the pump impeller spins without actually circulating any thermal fluid.
2. If Fulton Thermal Corporation provided the heater skid, loss of head to the pump is extremely unlikely with proper fluid level in the tank. The most common low heater in a thermal piping system is water, which needs to be boiled out at startup.
3. Once the system has been brought up to full operating temperature, assuming that the entire system has seen flow, there should be no further occurrence of low heater contamination apart from heat exchanger failure.

e) *Plugged coil pipe(s)*

1. If too low of a flow condition has occurred for too long a period of time or if the maximum operating temperature of the oil has been exceeded, it is possible, however unlikely, that a pipe or pipes in the coil could plug with solids.
2. If this occurs, it will be necessary to shut down the system and clean the coil. Fulton Thermal Corporation should be consulted in this matter.

f) *Improper switch setting*

1. The Differential Pressure Switch should be set at operating temperature. The setting should be 2 psi below the minimum differential pressure for that particular heater model number. If the minimum required pressure is not known, compare model of heater to chart on page 1-x of this manual.

Call For Heat

a) The call for heat circuit is the circuit that enables burner operation. Fulton Thermal Corporation has used a variety of Temperature Controllers to act as the Call for Heat.

b) Generally these controls work in combination with a control relay. When the Temperature Controller calls for heat, a signal is sent to the coil of a control relay that closes a normally open set of contacts in series with the burner circuit.

c) When the call for heat is met, the signal is removed and the contacts return to their open state. Situations that may interfere with the Call for Heat circuit include the following:

1. Programming problem
    a. Fulton has a general program for each of the temperature controllers we have used over the years. Compare your current temperature controller program to Fulton's general program.
    b. See the back of this section for general programming sheets for standard Fulton heaters.
    c. Make changes as necessary. Contact Fulton service department with any questions.
2. Temperature controller failure
    a. If the temperature controller is calling for heat but is not putting power on the output to the control relay, the relay will not close the normally open contacts and the heater will remain disabled. If this is the case, some controllers have separate sets of contacts that may be utilized in replacement of the damaged contacts. Some rewiring and/or reprogramming will be needed. Contact Fulton service department if necessary.
3. Temperature sensor failure
    a. Different temperature controllers use different types of temperature sensors. These may be Type J thermocouples, mercury bulbs, RTDs or another type of sensor. It is possible for these sensors to malfunction. To verify proper sensor operation, use an alternate source of temperature detection such as an infra-red temperature sensor to sense temperature at the same point.
4. Control relay may have failed
    a. Many temperature controllers energize a relay with a call for heat that in turn closes a normally open set of contacts to energize the burner circuit.
    b. If your temperature controller is sending an output signal to the control relay but the burner does is not initiated, check resistance across coil of the relay. An open reading indicates that the relay needs to be replaced. If the coil shows resistance, energize coil and check

contacts. With coil energized, normally open contacts should close resulting in a reading of control voltage on both the common and normally open contact.

c. If voltage exists on common but not on normally open contact either switch contacts if another set of normally open contacts are available or replace relay.

Burner Interlock

a) The burner interlock is the electrical circuit that enables the flame programmer. Your thermal heater needs to have the items in the burner interlock 'made' before ignition can occur. Items in the burner interlock may include an air switch, air filter switch, auxiliary blower motor starter contacts, high temperature limit(s), high gas pressure switch, low gas pressure switch, and / or low oil pressure switch.

b) Air Switch

1. All C-model heaters have an Air Switch. This is a normally open switch that closes with proper burner fan outlet pressure. This switch is generally a diaphragm type switch.
2. The Air Switch is a safety device that proves that there is an adequate pressure and volume of make up air for proper combustion and mixing. There is no manual reset on the air switch itself to indicate a trip. The most likely time of an air switch trip is at low fire purge or low fire. If this switch trips, it is generally one of the following issues.

c) The combustion blower fan is dirty

1. If the cups of the squirrel cage type fan become dirty, less air will be moved by the fan. If the fans are dirty enough, there will not be enough air flow for the air switch to prove. You should assure that the combustion blower fan is clean, reset the flame programmer and try to light unit again.

d) The sensing line is plugged, crimped or pointing in the wrong area

1. If the sensing line to the air switch is crimped or blocked, the switch will not sense the proper pressure. Ensure that the sensing line is clear and not crimped by removing both sides of the sensing line and using compressed air to blow through the line. Also ensure that the elbow acting as an air scoop is pointing directly into the air stream. Reset the flame programmer and try to light the unit again.

e) The switch setting is improper

1. The adjustment screw for the air switch is located opposite the electrical connections. A gray cap covers the screw. Turn the

screw clockwise to increase setting, counter-clockwise to decrease setting. To set switch, run unit at low fire. Increase setting 1/2 turn every 5 seconds until unit trips on interlock. Decrease setting by 2 full turns. Reset unit.

f) Air Filter Switch

1. C-model heaters with an air filter box or ducted supply air have an Air Filter Switch. This is a normally closed switch that opens on too high of a suction pressure at the burner fan inlet. This switch is generally a diaphragm type switch.
2. The Air Filter Switch is a safety device that proves that there is not too negative of a pressure at the combustion blower inlet. This switch is only used on units that have a built in air box for use as a duct connection or air filtering device.
3. There is no manual reset on the air filter switch itself to indicate a trip. The most likely time of an air filter switch trip is at high fire purge or high fire. If this switch trips, it is generally one of the following issues.

g) The air filter is dirty

1. If the air filter becomes dirty, the fan will generate greater suction. Too much suction will result in not enough airflow for proper combustion and mixing and will cause air switch to trip. You should regularly change filters on a schedule dependent on how dirty the makeup air is. After checking or changing air filter, reset the flame programmer and try to light unit again.

h) There is an obstruction in the make-up air ducting

1. Units that have make-up air ducting need to assure that blockage to the ducting does not occur. Check outside termination and any bends in the ducting for blockage. Clear blockage, reset flame programmer and try to light unit again.

i) The sensing line is pointing in the wrong area

1. The sensing line for the air filter switch is supposed to provide the static pressure of the air box. The termination of the sensing line should be pointing in a direction that limits its contact with moving air.
2. If the sensing line is pointing perpendicularly to entering air stream, the switch will not sense the proper pressure and could give a false indication of air box suction. Reset the flame programmer and try to light the unit again.

j) The switch setting is improper

1. The adjustment screw for the air switch is located opposite the electrical connections. A gray cap covers the screw. Turn the screw clockwise to increase setting, counterclockwise to decrease setting. The switch setting should be set in such a way that with 50% of the air box opening blocked, the switch will trip. Reset switch setting, reset the flame programmer and try to light the unit again.

k) Auxiliary Blower Motor Starter

1. All C-model heaters use an auxiliary set of contacts on their blower motor starter to prove that the burner motor is latched on. This is a normally open set of contacts mounted on or built in to the blower motor starter.
2. The Auxiliary Blower Motor Contacts are a safety device that proves that the blower motor starter is latched in. These contacts work in redundancy to the air switch to prove that there is proper makeup air. There is no manual reset on the auxiliary contacts themselves to indicate a trip. If the contacts do not make, it is generally one of the following issues.

l) The blower motor starter coil is bad

1. If this is the case, the blower starter will not latch in. Check for voltage to the coil. If proper voltage is present and the starter does not pull in, that proves the coil is bad. Replace the starter, reset the flame programmer and try to light unit again.

m) The auxiliary contacts are burned or pitted

1. Visibly inspect contacts. With power off, attempt to clean or replace starter if damaged. Reset flame programmer and try to light unit again.

n) High temperature limit

1. All thermal fluid heaters have at least one High Temperature Limit. The high temperature limit(s) is/are normally closed switch(es) that break on a temperature rise over set point.
2. The switch may be either a solid state controller or a bulb and capillary type switch. The High Temperature Limit is a safety device that protects the thermal fluid and heat transfer coil from excessively high temperatures.
3. Solid-state high temperature limits will have a manual reset. Bulb and capillary type limits will not have a manual reset. If this/these switch(es) trips, it is generally one of the following issues.

o) Flow rate is too low

1. Too low of a flow rate will result in a higher rate of heat transfer to the thermal fluid and heat transfer coils. This will result in a higher temperature difference between inlet temperature and outlet temperature.
2. It is important to make sure that the minimum flow rate as specified by Fulton for that specific model is maintained.
3. Check inlet and outlet pressures of the heater to determine differential pressure and flow rate. Ensure that this flow rate meets or exceeds minimums specified by Fulton (see chart). Also check differential pressure switch for proper operation and setting.

p) The heater is over-fired

1. If the heater has more fuel input than design, it is probable that the heat transfer rate will increase beyond design.
   Check input to heater at high fire for modulated heaters or at the standard rate for on / off units. This can be done by either using a corrected gas meter reading or measuring gas pressure supplied to the burner compared to factory test-fire settings.
2. If input is improper, inspect burner as described below. If burner is not damaged or have improper components, adjust fuel input and combustion to specification.

q) Gas-fired burner is damaged

1. Pull and inspect the burner. Primary areas of concern for gas-fired units are the orifice plate, pilot assembly seating and orifice plate gap.
2. If the orifice plate is warped or burned through, pilot assembly is not seated or gap between orifice plate and gas tube is improper, more fuel than designed for will enter the furnace.
3. This will cuase the heater to have more fuel input than designed for. The design flow rate will then be too low causing the fluid to heat up higher than it should.

r) High Gas Pressure Switch

1. All gas-fired modulating or IRI rated thermal fluid heaters have a High Gas Pressure Switch. This is a normally closed diaphragm switch that opens on a pressure increase over set point.
2. The High Gas Pressure Switch is a safety device that protects the burner from receiving too high of a gas pressure. The switch

senses this pressure downstream of the last gas valve, upstream of the modulation valve on units that modulate.

3. This switch is most likely to trip at low fire. If this switch trips, it is generally one of the following issues.

s) Gas pressure setting on the main regulator is too high

1. With unit running at high fire, make sure that the modulated gas valve is at full open.

Note

Since unit lights at low fire, it may be necessary to increase high gas pressure setting or jumper contacts to allow unit to modulate to where modulation gas valve back pressure is lessened.

2. Check net last elbow gas pressure and compare to factory test fire sheet. Net gas pressure is running gas pressure minus p urge pressure. Make sure net pressure reading is within .2" w.c. of factory reading. If there is a difference, adjust main regulator. Adjust for proper combustion throughout range.

t) Low fire gas valve setting is too low

1. Because the sensing point of the High Gas Pressure Switch is upstream of the modulating gas valve, the highest pressure read will occur during low fire.
2. Check net last elbow gas pressure and compare to factory test fire sheet. Net gas pressure is running gas pressure minus purge pressure. Make sure net pressure reading is within .1" w.c. of factory reading. If there is a difference, adjust modulating gas valve linkage. Adjust for proper combustion throughout range.

u) Gas orifice plate is warped

1. If above two items are proper, check the pressure that the high gas pressure switch is sensing by way of a tee installed in the line. Hold unit at low fire and check pressure. Setting on switch should be 10% over pressure read. Call Fulton if you have any questions.

v) Gas pressure switch setting is improper

1. If above two items are proper, check the pressure that the high gas pressure switch is sensing by way of a tee installed in the line. Hold unit at low fire and check pressure. Setting on switch should be 10% over pressure read. Call Fulton if you have any questions.

w) Gas regulator has failed open

1. This is highly unlikely. Regulators will usually fail safe in the closed position. The gas regulator can be checked by checking upstream pressure and comparing to downstream pressure. Make sure that the upstream pressure is not above the rating of the regulator. Make sure that the downstream pressure does not exceed the range of the spring. If regulator has failed, replace, reset input and adjust input throughout the range.

x) Low Gas Pressure Switch

1. All gas-fired modulating or IRI rated thermal fluid heaters have a Low Gas Pressure Switch. This is a normally closed diaphragm switch that opens on a pressure decrease below set point.
2. The Low Gas Pressure Switch is a safety device that protects the burner from receiving too low of a gas pressure. The switch senses this pressure just downstream of the gas regulator. This switch will most likely trip at high fire. If this switch trips, it is generally one of the following issues.

y) Gas pressure setting on the main regulator is too low

1. At high fire, the modulating gas valve is full open resulting in the least amount of back pressure in the gas train. With unit running at high fire, check net last elbow gas pressure and compare to factory test fire sheet. Net gas pressure is running gas pressure minus purge pressure. Make sure net pressure reading is within .2" w.c. of factory reading. If there is a difference, adjust main regulator. Adjust for proper combustion throughout range.

z) Gas orifice plate is damaged

1. If the orifice plate is damaged, it may be holding back less gas creating a lower pressure on the sensing switch. Pull burner and inspect gas orifice plate. Plate should in no way be warped or degraded. If it is, replace. After reinstallation, recheck input and adjust combustion throughout range.

aa) Gas pressure switch setting is improper

1. If above two items are proper, check the pressure that the low gas pressure switch is sensing by way of a tee installed in the line. Hold unit at high fire and check pressure. Setting on switch should be 10% under pressure read. Call Fulton if you have any questions.

bb) Gas regulator has failed closed

1. Regulators will usually fail safe in the closed position. The gas regulator can be checked by checking upstream pressure and comparing to downstream pressure. Make sure that the upstream pressure is not above the rating of the regulator. If regulator has failed, replace, reset input and adjust input throughout the range.

cc) Low oil pressure switch

1. All oil fired modulating thermal fluid heaters have a Low Oil Pressure Switch. This is a normally closed diaphragm switch that opens on a pressure decrease below set point. The Low Oil Pressure Switch is a safety device that protects the burner from receiving too low of an oil pressure. The switch senses this pressure just downstream of the gas pump. If this switch trips, it is generally one of the following issues.

dd) Oil pressure setting on the back pressure valve is too low

1. At low fire, the modulating oil valve is at its most open position resulting in the least amount of back pressure in the fuel train. With unit running at low fire, check oil pressure and compare to factory test fire sheet. Make sure oil pressure reading is within 10 psi of factory reading. If there is a difference, adjust back pressure regulator. Adjust for proper combustion throughout range.

ee) Fuel oil pump may have lost its prime

1. An air bubble in the pump will result in a momentary loss of prime that will be enough to cause the Low Oil Pressure Switch to trip. Ensure that oil pump is primed properly and all connections are tight. Check the pump seal. A blown seal will allow air in the pump housing.

ff) Fuel oil pump motor may have failed

1. Check the pump motor for proper voltage. If voltage is proper but motor does not turn, replace or rebuild motor. If there is no voltage, check motor starter for input signal and incoming 3-phase power.

gg) Fuel oil pump coupling may have failed

1. A failed coupling will result in the pump not turning. Check coupling. Replace if necessary.

Pilot Flame Failure

a) A Pilot Flame Failure is a flame failure that occurs when the unit is trying to establish an adequate flame signal. Solid-state controllers indicate a Pilot Flame Failure by showing as a fault code either Fault 28 for Honeywell 7800 series controllers.

b) Flame Failure PTFI on Fireye E110 series controllers or Fault 9 on Fireye Nexus controls.

c) For electro-mechanical controls, you need to witness when the failure occurs.

d) A Pilot Flame Failure indicates that either a strong enough pilot flame was not generated or the means of sensing the pilot flame strength has failed. All gas fired units have a gas pilot. Oil fired units may be 2-stage, in which the 1st stage to light would be considered the pilot, or may have a gas pilot. In either case, during the pilot proving period, the flame programmer must sense a strong enough flame to initiate the opening of the main valves.

e) Pilot flame strength is inadequate

1. Cycle the unit. During the pilot trial for ignition, carefully observe the pilot flame strength.
2. On Honeywell controllers, the pilot flame strength must be between 1.25 to 5.0 VDC. On Fireye controllers, the pilot flame strength must be greater than 10 VDC.
3. Current controls are supplied with a test switch that can hold the programmer in the pilot trial for ignition stage. If a pilot signal greater that 0.0 but less than the minimum required is detected, look through the sight hole provided on the burner plate of the heater to visibly detect flame. If flame is seen, make small adjustments to increase pilot gas and air to provide larger flame.

f) Pilot sensing device does not work properly

1. Cycle the unit. If a pilot signal of 0.0 is detected, look through the sight hole provided on the burner plate of the heater to visibly detect flame.
2. If flame is seen, your flame detection device or amplifier may be faulty. If the unit has a flame rod, lockout and tag heater's electrical circuit and fuel supply. Pull pilot assembly out of unit. Inspect the flame rod. If the flame rod is corroded, shows isgns of heat impingement, has been burdned off or has cracks in the porcelain, replace with a new flame rod.
3. Reinstall and cycle unit. If the unit has a U.V. scanner, lockout and tag heater's fuel supply. Remove U.V. scanner from U.V. sight tube. Make sure that the lens of the scanner is clean. Use a

lighter or match and make a flame in front of the scanner eye. Lens should flicker. If unti does not flicker, change U.V. scanner. If this change does not work, change U.V. amplifier. Reinstall and cycle unit.

g) Room air pressure is different from outside air pressure

1. Check room air pressure relative to outside air pressure. Heater room pressure should equal outside air pressure. Significant differences in pressure will result in an erratic flame, which will not deliver a strong flame signal.

Main Flame Failure

a) Main Flame Failure is a flame failure that occurs while the unit is trying to establish an adequate flame signal during the Main Flame Trial for Ignition.

b) Solid state controllers indicate a Main Flame Failure by showing as a fault code of either Fault 19 for Honeywell 7800 series controllers, Flame Failure MTFI on Fireye E110 series controllers, or a Fault 09 for Fireye Nexus controls. For electro-mechanical controls, you need to witness when the failure occurs.

c) A Main Flame Failure indicates that either a strong enough main flame was not generated or the means of sensing the main flame strength has failed. During the main flame proving period, the flame programmer must sense a strong enough flame to hold the main valves open. If you are experiencing Main Flame Failures, check the following items.

d) Main flame strength is inadequate

1. Cycle the unit. During the main flame proving period , carefully observe the pilot flame strength. Current controls are supplied with a test switch that can hold the programmer in the main flame proving period.
2. If a main signal is greater than 0.0 but less than the minimum required is detected, look through the observation port to try to visibly see flame. A combustion change may be necessary to establish main.
3. If observed flame is blue, slightly decrease the air damper setting and recycle. If flame is red or orange, slightly increase air damper setting and recycle. Once adequate flame signal is established, reset input and combustion throughout range of modulation.

e) Flame sensing device does not work properly

1. Cycle the unit. If a signal of 0.0 is detected, look through the sight hole provided on the burner plate of the heater to

visibly detect flame. If flame is seen, your flame detection device or amplifier may be faulty.

2. If the unit has a flame rod, lockout and tag heater's electrical circuit and fuel supply. Pull pilot assembly out of unit. Inspect the flame rod. If the flame rod is corroded, shows signs of heat impingement, has been burned off or has cracks in the porcelain, replace with a new flame rod. Reinstall and cycle unit.
3. If the unit has a U.V. scanner, lockout and tag heater's fuel supply. Remove U.V. scanner from U.V. sight tube Make sure that the lens of the scanner is clean. Use a lighter or match and make a flame in front of the scanner eye. Lens should flicker. If unit does not flicker, change U.V. scanner. If this change does not work, change U.V. amplifier. Reinstall and cycle unit.

f) Room air pressure is different from outside air pressure

1. Check room air pressure relative to outside air pressure. Heater room pressure should equal outside air pressure. Significant differences in pressure will result in an erratic flame, which will not deliver a strong flame signal.

g) Unit is experiencing too great of a restriction

1. At the breaching of the heater, take a draft reading. Draft should read between -.02" w.c. and -.04" w.c. with the heater off and between -.04" w.c. and -.08" w.c. with the unit on. A restrictive draft would be a draft that was positive. A restrictive draft is usually the result a stack that is undersized, a stack with too many elbows or a stack whose cap or piping is warped and damaged. Another source of restriction results from broken refractory. If the unit's refractory breaks, large enough pieces could block the flue passes. The burner should be pulled for refractory inspection. A broken refractory should be cleaned out and replaced.

7. Fulton Thermal Fluid Heater Log Sheet

Fulton Thermal Fluid Heater Log Sheet

Date	Time	Pump Status	Heater Status	Heater Inlet Pressure	Heater Outlet Pressure	Differential Pressure	Pump Suction Pressure	Setpoint Temperature	Current Temperature	Nitrogen Level	Pilot Flame Signal	Run Flame Signal	Stack Temperature
Date	*Time*	*On or Off*	*On or Off*	*psi*	*psi*	*or greater*	*psi*	*F*	*F*	*psi*			

Section 5

Section 5 – Parts & Warranty

Part Number	Description	Approx. lbs.	Weight kgs.	Lead Time
Air Filter Box (filters and air filter switch required)				
5-21-006625	Air Filter Box-0080C (1-20”x 20” filter required			Stock
5-21-006617	Air Filter Box	45.6	20.8	Stock
5-21-006600	Air Filter Box			Stock
5-21-006620	Air Filter Box			1 Week
2-30-000620	Air Filter-20”x20”x2”	4.1	1.9	Stock
2-30-000621	Air Filter-24"x24”x2”	5.1	2.3	Stock
Barometric Dampers				
2-30-000097	10” M&MG2 Barometric Control	8.0	3.64	1-2 days
2-30-000098	12” M&MG2 Barometric Control	12.0	5.45	1-2 days
2-30-000099	14” M&MG2 Barometric Control	16.0	7.27	1-2 days
2-30-003010	18” M&MG2 Barometric Control	31.0	14.0	1-2 days
2-30-003011	24” M&MG2 Barometric Control	66.0	60.0	
2-30-003012	28” M&MG2 Barometric Control	93.0	42.2	1-2 days
BURNERS				
Gas Burners				
7-30-004000	Complete FT-0080-C Gas Burner Less Pilot Tube	28.5	12.95	Stock
7-30-004001	Complete FT-0120-C Gas Burner Less Pilot Tube	28.68	13.04	Stock
7-30-004002	Complete FT-0160-C Gas Burner Less Pilot Tube	28.88	13.13	Stock
7-30-004004	Complete FT-0240-C Gas Burner Less Pilot Tube	42.8	19.45	Stock
7-30-004005	Complete FT-0320-C Gas Burner Less Pilot Tube	42.8	19.45	Stock
7-30-004006	Complete FT-0400-C Gas Burner Less Pilot Tube	46.52	21.15	Stock
7-30-004008	Complete FT-0600-C Gas Burner Less Pilot Tube	205.0	93..2	Stock
7-30-004010	Complete FT-0800-C Gas Burner Less Pilot Tube	155.0	70.5	Stock
Gas Burner Parts				
2-20-000054	UL Style Electrode	0.36	0.16	Stock
2-20-000071	UL Style Flame Rod	0.4	0.18	Stock
2-45-000025	Electrode Terminal-Female 90°			Stock
2-45-000392	Flame Rod Terminal-Male 90°			Stock
2-45-000026	Bakelite Terminal-Female Straight			Stock
7-20-005000	Pilot Tube w/Flame Rod	3.96	1.8	Stock
7-20-005002	Pilot Tube for U.V.-new style-3/01	3.94	1.79	Stock
7-20-005004	Inner Pilot Assembly w/ UV-new style-3/01	1.86	0.85	Stock
7-20-005020	Inner Pilot Assembly w/Flame Rod	1.86	0.85	Stock
7-20-005030	UV sight Tube only-new style-3/01	1.0	0.45	Stock
5-20-000810	Ground fins-for Flame Rod (6 required)			Stock
7-20-005010	Pilot Casing Assembly			Stock

1" Sight Glass				
2-11-000107	Peep Hole Casting	0.15	0.06	Stock
2-12-000014	1" Pyrex Disc	0.02	0.01	Stock
2-12-000015	Peep Hole Gasket	0.03	0.01	Stock
¾" Sight Glass				
2-12-000012	Flame Sight Glass	0.05	0.01	Stock
2-30-000568	1"Air Hose			Stock
2-30-000569	1" clamp			Stock
2-30-000924	Ring Screw	0.0	0.0	Stock
2-30-000925	Ring Nut	0.0	0.0	Stock
2-30-000910	FT-0080/0120/0160-C Outer Ring	1.76	0.8	Stock
2-30-000911	FT-0240/0320-C Outer Ring	2.72	1.24	Stock
2-30-000912	FT-0400-C Outer Ring	4.6	2.09	Stock
Miscpart	FT-0600-C Outer Ring	7.0	3.18	
2-30-000926	Cone Screw-4 required 0080-0320C/8 required 400C and up	0.0	0.0	Stock
2-20-000185	Cone Spacer .035 for FT-0080-C – 4 required	0.0	0.0	Stock
2-20-000184	Cone Spacer .079 for FT-0120/0160/0240/0320-C-4 required	0.0	0.0	Stock
2-20-000183	Cone Spacer .114 for FT-0400-C – 8 required	0.0	0.0	Stock
2-20-000182	Cone Spacer .121 for FT-0600-0800-C – 8 required	0.0	0.0	Stock
2-30-000909	Flame Cone FT-0080-C w/ ring*	2.88	1.31	Stock
2-30-000664	Flame Cone FT-0120-C & FT-0160-C w/ring*	5.22	2.37	Stock
2-30-000665	Flame Cone FT-0240-C w/ring*	4.88	2.22	Stock
2-30-000666	Flame Cone FT-0400-C w/ring*	10.52	4.78	Stock
2-30-000667	Flame Cone FT-0600-C w/ring*	13.38	6.08	Stock
2-30-000668	Flame Cone FT-0800-C w/ring*	28.3	12.9	Stock
2-30-000670	Flame Cone FT-0320-C w/ring*	4.88	2.22	Stock
5-21-006518	Refractory Spider-0080-0160C	15.0	6.0	Stock
5-21-006519	Refractory Spider-0240C	20.0	8.0	Stock
5-21-006498	Refractory Spider-0320C	20.0	8.0	Stock
5-21-006499	Refractory Spider-0400C	15.0	6.0	Stock
Miscpart	Plywood form for top Refractory	12.0	4.8	Stock
5-10-000494	FT-0600C Gas Burner Tile	205.0	93.2	Stock
5-10-000492	FT-0800C Gas Burner Tile	120.0	54.6	Stock
2-20-000186	Orifice Spacer .035 FT-0080-C Nat Gas (3 total)	0.02	0.01	Stock
2-20-000177	Orifice Spacer .052 FT-0120-C Nat Gas (3 total)	0.02	0.01	Stock
2-20-000176	Orifice Spacer .0158 FT-0160-C Nat Gas (3 total)	0.04	0.02	Stock
2-20-000175	Orifice Spacer .0140 FT-0240/0320-C Nat Gas (3 total)	0.06	0.03	Stock
2-20-000174	Orifice Spacer .0200 FT-0400/0600-C Nat Gas (6 total)	0.06	0.03	Stock
2-20-000216	Orifice Spacer .0235 FT-0800-C Nat Gas (6 total)	0.06	0.03	Stock
2-30-000918	Orifice Screw FT-0080/0120/0160/0240/0320-C (3 total)	0.04	0.02	Stock
2-30-000817	Orifice Screw FT-0400/0600/0800-C (6 total)	0.04	0.02	Stock
2-20-000173	Orifice Plate FT-0080/0120/0160-C **	1.84	0.84	Stock

2-20-000172	Orifice Plate FT-0240/0320-C**	3.94	1.79	Stock
2-20-000171	Orifice Plate FT-0400-C**	5.14	2.34	Stock
2-20-000170	Orifice Plate FT-0600-C**	7.4	3.36	Stock
2-20-000217	Orifice Plate FT-0800-C**	26.52	12.05	Stock
5-52-004000	FT- 0080/0120/0160 -C Burner Plate	5.34	2.43	Stock
5-52-004004	FT-0240/0320/0400 -C Burner Plate	9.7	4.41	Stock
5-10-002173	FT-0600 -C Burner Plate			Stock
5-10-002175	FT-0800 -C Burner Plate			Stock
7-30-005000	FT- 0080/0120/0160 -C Burner Tube	8.32	3.78	Stock
7-30-005002	FT- 0240/0320 -C Burner Tube	12.02	5.46	Stock
7-30-005004	FT-0400 -C Burner Tube	13.32	6.05	Stock
5-30-004025	FT-0600 -C Burner Tube	14.0	6.37	Stock
5-30-004030	FT-0800 -C Burner Tube	15.0	6.82	Stock
5-30-004020	Burner Inlet Tee	8.44	3.84	Stock
2-30-000818	Burner Tee O-Ring	0.01	0.0	Stock
			***Cone Screws are required with purchase** ****Orifice Screws are required with purchase**	
Oil Burners and Parts				
7-30-004020	FT-0080C/0120C/0160C Oil Burner less nozzle assembly	13.7	6.2	Stock
7-30-004023	FT-0240-C Oil Burner less nozzle assembly	29.4	13.4	Stock
7-30-004024	FT-0400C Oil Burner less nozzle assembly	37.6	17.1	Stock
7-30-004035	FT-0600C Oil Burner less nozzle assembly			Stock
7-30-004038	FT-0800C Oil Burner			Stock
2-20-000258	FT-0080C through FT-0320C Holder Electrode			
2-30-000782	FT-0080/120/0160C Flame Spreader	0.44	0.2	Stock
2-30-000783	FT-0240-C Flame Spreader	0.46	0.21	Stock
2-30-000785	FT-0400/0600-C Flame Spreader	0.2	0.09	Stock
2-30-000786	FT-0800C Flame Spreader	0.9	0.41	Stock
Oil Burner Nozzle Assemblies				
5-30-004275	FT-0080C on/off			1 week
5-30-004270	FT-0080C modulated			1 week
5-30-004276	FT-0120C on/off			1 week
5-30-004271	FT-0120C modulated			1 week
5-30-004277	FT-0160C on/off			1 week
5-30-004272	FT-0160C modulated			1 week
5-30-004273	FT-0320C modulated			
5-30-004278	FT-0400C modulated			
5-30-004274	FT-0240C modulated			1 week
5-30-004279	FT-0600C modulated			
Oil Cones & Assemblies				
2-30-000656	FT-0080C/FT-0120C Flame Cone	3.0	1.36	Stock
2-30-000657	FT-0240C Flame Cone	3.62	1.65	Stock
5-30-000657	FT-0240C Oil Flame Cone with Outer Ring & Refractory			3 days

2-30-000658	FT-0400C Flame Cone	4.38	1.99	Stock
5-30-000658	FT-0400C Oil Flame Cone with Outer Ring & Refractory			3 days
2-30-000659	FT-0600C Flame Cone	6.0	2.73	Stock
5-10-000495	FT-0600C Oil Flame Cone & refractory assembly			1 week
2-30-000660	FT-0800C Flame Cone	10.0	4.55	Stock
2-20-000259	FT-0800C Oil Flame Cone & refractory assembly	.		1 week
2-20-000053	Electrode FT-0080/0120/0160/0240-C	.22	.1	Stock
2-20-000069	Electrode (2.p) FT-0400/0600/0800C (field straighten)	.24	.11	Stock
2-20-000072	Electrode Holder for 2-20-69	.24	.11	Stock
2-20-000259	Electrode Holder for FT-0400/0600C			Stock
Oil Nozzles				
2-30-000671	FT-0080C 5Gal 60 Degree Modulated Nozzle	.04	.02	Stock
2-20-000121	FT-0080C 5Gal 60 Degree on/off Nozzle	.06	.03	Stock
2-30-000688	FT-0120C 8Gal 60 Degree Modulated Nozzle	.06	.03	Stock
2-30-000689	FT-0120C 8Gal 60 Degree on/off Nozzle	.04	.02	Stock
2-30-000673	FT-0160C 12Gal 60 Degree Modulated Nozzle	.08	.04	Stock
2-20-000122	FT-0160C 12 Gal 60 Degree on/off Nozzle	.08	.02	Stock
2-30-000674	FT-0240C 17.5Gal 60 Degree Modulated Nozzle	.06	.03	Stock
2-20-000120	FT-0240C 17.5Gal 60 Degree on/off Nozzle	.06	.03	Stock
2-20-000200	FT-0320C 19.5Gal 60 Degree Modulated Nozzle			
2-30-000675	FT-0400C 24 Gal 60 Degree Modulated Nozzle	.06	.03	Stock
2-30-000153	FT-0400C 35Gal 60 Degree Tip & Disc	.06	.03	Stock
2-30-000676	FT-0600C 30Gal 60 Degree Modulated Nozzle	.06	.03	Stock
2-30-000158	FT-0600C 55Gal 60 Degree E180H Tip & Disc	.1	.05	Stock
2-30-000682	FT-0800C 85Gal 60 Degree E180H Tip & Disc	.12	.05	Stock
2-30-000159	FT-1000C 100Gal 60 Degree E180H Tip & Disc	.12	.05	Stock
2-30-000161	FT-1200C 120Gal 60 Degree E180H Tip & Disc	.12	.05	Stock
5-10-003305	Inlet/Outlet Block	.6	.3	Stock
2-30-000600	O'ring for inner oil line			Stock
5-20-004070	Inner oil line	.1	.05	Stock
2-30-G00010	3/8" Check valve			Stock
Dual Fuel Burner Parts				
7-30-004025	Complete FT-0400C Gas burnerless pilot tube-dual fuel/UV Scanner Tube	124.0	56.4	Stock
7-30-004026	Complete FT-0600/0800C Gas burnerless pilot tube-duel fuel/ scanner tube			Stock
7-30-004027	Complete FT-1000/12..C burnerless pilot tube-duel fuel/ scanner tube			Stock
5-20-005499	Air adjustment ring 0400-0800C dual fuel	.9	.4	Stock
5-20-005502	FT-1000C/FT-1200C Flame Cone			Stock
5-20-005508	Oil delivery tube assy – 0400-1200C- dual fuel	7.5	3.4	Stock
5-20-005523	Nozzle adapter-used on 5-20-5508			Stock

5-20-005524	End cap-used on 5-20-5508			Stock
5-21-005506	Gas supply tube assy 0400-0800C	31.5	14.4	Stock
2-20-000087	Orifice retaining collar-0400-0800C	1.7	.8	Stock
5-20-003497	Flame Cone 0400C	13.3	6.1	Stock
5-20-005498	Dual flame cone 0600C			Stock
5-20-005495	Dual flame cone 0800C			Stock
5-20-005547	Gas orifice nozzle assy – 0400-0800C	3.5	1.6	Stock
7-20-005526	Oil/air mixing Nozzle weldment 0400-0800C	.5	.3	Stock
7-20-004015	Dual fuel pilot assy 0400-1400C	3.0	1.2	Stock
5-20-005535	Outer tube assy 0400-1400C-dual fuel	1.0	.46	Stock
5-20-005537	Inner tube assy 0400-1400C-dual fuel	1.0	.46	Stock
5-20-005540	Insulator	.05		Stock
5-20-005541	Insulator	.05		Stock
5-20-005538	Electrode cap			Stock
Miscpart	Rod for electrode cap connector	.02	.2	Stock
2-12-000251	FT-0600C/0800C refractory	210.0	95.5	Stock
2-12-000250	Refractory FT-1000C/1200C			Stock
7-20-005045	Scanner tube 0400-1400C			Stock
5-20-005503	Sleeve 0400-1400C			Stock
2-45-000390	Electrode nut 0400-1400C			Stock
5-21-003000	Screen LoNox			Stock
FANS / BLOWERS / AIR GATE ASSEMBLY				
Blowers				
2-40-000707	1-1/2hp blower motor TEFC 208/480/60/3ph	50.0	22.0	Stock
2-40-000599	3hp blower motor TEFC 208/480/60/3ph	55.0	25.0	Stock
2-40-000622	5hp blower motor TEFC 208/480/60/3ph			
2-40-00079	7 1/2hp blower motor TEFC 208/480/60/3ph	80.0	37.0	Stock
2-40-000870	10hp blower motor TEFC 208/480/60/3ph	168.0	76.3	Stock
2-40-000865	15hp blower motor TEFC 208/480/60/3ph	200.0	91.0	Stock
2-40-000840	20hp blower motor TEFC 208/480/60/3ph	316.0	144.0	Stock
Fans/Air Gate parts				
2-30-000573	8-3/8 x 2-1/2 x 1-1/8 FT-0080/0120C	2.92	1.33	Stock
2-30-000561	9-3/16 x 3 x 1-1/8 FT-0160C	4.66	2.12	Stock
2-30-000562	9-15/16 x 3 x 1-1/8 FT-0160C & 0240C	5.14	2.34	Stock
2-30-000419	10-5/8 x 4 x 1-3/8 FT-0400C Dual Fuel	5.14	2.34	Stock
2-30-000443	12-3/16 x 6 x 1-5/8			Stock
2-30-000563	10-5/8 x 4 x 1-1/8 FT-0240/0320/0400C	6.4	2.91	Stock
2-30-000564	10-5/8 x 1-1/8 FT-0600C	7.4	3.36	Stock
2-30-000444	10-5/8 x 1-3/8 FT-0600C	6.2	2.82	Stock
2-30-000571	12-3/16 x 6 x 1-3/8 FT-0800C & FT-0600C dual fuel	1.72	.78	Stock
2-30-001320	13-15/16 x 6-1/2 x 1-5/8 FT-1000/1200/1400C 0800C dual fuel	17.9	8.14	Stock

2-30-000560	9-3/16 x 2-1/2 x 1-1/8	4.4	2.0	Stock
2-20-000050	5/8 x 1-1/8 shaft adaptor	0.56	.25	Stock
5-10-001850	7/8 x 1-1/8 575v shaft adaptor			Stock
2-30-000483	10-5/8 Mod air control-0080C/Air gate	4.0	1.8	Stock
2-30-000484	12-3/16 Mod air control 0120-0600C/Air gate	5.12	2.32	Stock
2-30-000485	15 Mod air control 800-1400C/Air gate	7.06	3.2	Stock
5-10-001792	Air pick up MTG plate FT-0080C	4.8	2.2	Stock
5-10-001702	Air pick up MTG plate FT-0120C-0600C	6.7	3.1	Stock
5-10-001802	Air pick up MTG plate FT-0800C	5.5	2.5	Stock
7-21-000030	Air gate assy FT 1000-1400C	18.2	8.3	Stock
2-21-000110	Motor mounting plate FT-0120-0160-0240C	4.0	1.6	Stock
2-21-000113	Motor mounting plate FT-0320C	4.0	1.6	Stock
2-21-000111	Motor mounting plate FT-0400-0600C	4.0	1.6	Stock
CONTROLS **Differential/Flow switches**				
2-30-000454	UE H105K14727 differential pressure switch	4.0	1.82	Stock
2-30-000448	UE H105K456 differential pressure switch 2-20 psi	4.0	1.82	Stock
2-30-000453	¼" needle valve (block valve)	1.0	.46	Stock
2-35-000330	Swedgelock-straight	.025		Stock
2-35-000329	Swedgelock-90 degree	.025		Stock
2-35-000526	Steel tubing union			
2-10-000211	¼ OD steel tubing			
2-30-000813	Flow switch O'ring – shaft	.001	0.0	Stock
2-30-000814	Flow switch O'ring – casing	.001	0.0	Stock
Fireye Flame Programmer Controls & Accessories				
2-40-000542	EP380 on/off Module			Stock
2-40-000545	E110 Burner control	5.1	2.32	Stock
2-40-000528	E120 Burner control(220v)	5.6	2.55	Stock
2-40-000543	ED510 Display Module-E120&E110	.5		Stock
2-40-000806	EP170 Programmer	.6	.27	Stock
2-40-000540	EUV-1 UV amplifier	.6	.27	Stock
2-40-000532	UV-1A6 UV scanner	.8	.36	Stock
2-40-000531	Base for control 60-1466-2	.5	.23	Stock
2-40-000897	ED550/6 Cable	.01	0	Stock
2-40-000808	Remote mounting kit	.5	.3	Stock
2-40-000804	ERT-1 rect. Flame rod amp			
2-40-000544	PPC 5000 control			
Honeywell Flame Programmer Controls & Accessories				
2-40-000262	RM7800M1037 Programmer	2.5	1.14	Stock
2-40-000264	RM7800L1038 Programmer	2.5	1.14	Stock
2-40-000260	RM7895A1030 Programmer			
2-40-000265	ST7800A1013 7 Sec.			Stock

2-40-000266	ST7800A1039 30 Sec.	.1	.05	Stock
2-40-000268	ST7849A1041 RM7800 amplifier – flame rod	.3	.14	Stock
2-40-000269	ST7849A1031 RM7800 amplifier –UV amp-80-400C	.2	.09	Consult fact.
Miscpart	Fuel air control R7999A1005			Stock
2-40-000273	ST7800A1098 RM7800 amplifier – UV amp 600-1200C	.2	.09	Stock
2-40-000270	Base for RM7800	.5	.23	Stock
2-40-000272	Display module S7800A1019	.5	.23	Stock
2-40-000161	Mini peeper C7027a1049 UV scanner	.5	.23	Stock
2-40-000149	BC7000L Burner control			Stock
2-40-000860	PM720L1030 Program Module	.06	.03	Stock
2-40-000157	Programmer R4140M-1210	5.0	2.27	Stock
2-40-000711	Programmer R4140L-1162	5.0	2.27	Stock
2-40-000713	Flame rod amplifer R7247A-1005	.12	.05	Stock
2-40-000160	UV amplifier R7249a1003	.1	.05	Stock
2-40-000159	Q520A Base	.5	.23	Stock
2-40-000248	Remote mounting cable	.5	.23	Stock
2-40-000247	Remote display mounting bracket			Stock
Pressure Switches & Transducers				
2-40-003040	Danfos pressure switch w/manual reset 150psi			
2-40-003041	Danfos pressure switch w/auto reset 6-50psi			
2-40-000662	6NN54FIA SOR pressuretrol – NEMA 4	1.62	.73	Stock
2-40-000661	6R3-D5 SOR pressuretrol M/R – NEMA 4	2.1	.95	Stock
2-40-000999	Pressure transducer 0-100psi			Stock
2-40-000994	Pressure transducer 0-200psi			Stock
2-40-000998	Pressure transducer 0-15psi			Stock
Stack Limit Switches				
2-40-000688	1000 deg. F stack limit	1.96	.89	Stock
2-40-000697	1100 deg. F stack limit	1.16	.53	Stock
2-40-000731	1000 deg. F stack limit – NEMA 4	1.38	.63	Stock
2-40-000866	1100 deg. F stack limit – NEMA 4	1.98	.9	Stock
Temperature Controls/Limits/Thermocouples				
2-40-000861	UT 350 yokogawa	1.2	.55	Stock
2-40-000862	UT350L yokogawa	1.16	.55	Stock
2-40-000867	UT 550-04 (RSP) yokogawa	1.16	.55	Stock
2-30-000900	Yokogawa window kit NEMA-4			Stock
2-40-000909	FUJI PYZ4-RAY-1-4V	.5	.23	Stock
2-40-000311	EZ relay			Stock
2-40-000816	UE E54 Temp Limit A,N models	1.66	.75	Stock
2-40-000631	Watlow temp control 146E1602	3.0	1.37	Stock
2-40-000800	2 x 8 Thermocouple wire	.16	.07	Stock
2-40-000801	4 x 12 thermocouple N & A models	.2	.09	Stock
2-40-000802	2 x 12 Thermocouple – C models	.2	.09	Stock

2-40-000805	½" NPT spring loaded thermocouple	.2/FT		Stock
2-40-000830	Thermocouple wire	.1	.1/ft	Stock
2-40-000798	Thermocouple splice kit	.1	.05	Stock
2-40-000799	Thermocouple splice kit		.05	Stock
2-40-001000	6"probe 150-170° F Adj. Thermometer			Stock
Deaerator Tank Parts				
2-30-000551	Liquid level HG34	4.3	1.95	Stock
2-30-000552	NEMA 4 Liquid level HW34	10.32	4.69	Stock
2-30-000553	Explosion proof HR34	10.36	4.71	Stock
2-40-000730	Liquid level switch L4 high & explosion proof	4.22	1.92	Stock
2-30-000554	Magnetrol level switch			
4-30-000200	2-way nitrogen kit (SV not included)			2 weeks
2-30-000138	Fairchild N2 reg #66162-2-150#	2.94	1.34	Stock
2-30-000869	¾" gate valve – fill			
2-30-000214	¾" 15# series 19 V stamped brass safety valve	2	.9	Stock
2-30-000215	1" 15# series 19 V stamped brass safety valve	4.3	1.95	Stock
2-30-000216	1-1/4" 15# series 19 V stamped brass safety valve	6.75	3.1	Stock
2-30-000016	1-1/2"15# series 19 V stamped brass safety valve	12.4	5.63	Stock
2-30-000217	2" 15# series 19 V stamped brass safety valve	14.85	6.75	Stock
Electric Heater Parts "N" Model				
2-40-000910	Main grame for Athena sequencer	2.2	1.0	Stock
2-40-000911	Step card (white)	.1	.05	Stock
2-40-000912	Step delay (yellow)	.1	.05	Stock
2-40-000913	Signal card (green)	.1	.05	Stock
2-40-000914	Starter card (black	.1	.05	Stock
2-40-000105	Honeywell 5-step sequencer	10.2	4.64	Stock
2-40-000107	Honeywell 10-step sequencer	11.	5.0	Stock
2-40-000904	120V/240V 10 step solitec sequencer **Note: Above replaces 5 Step Solitec Sequencer 120V/240V**	1.82	.83	Stock
2-40-000025	600V 60amp contactor – 120V	2.5	1.14	Stock
2-40-000024	300V 60amp contactor – 120V	2.3	1.05	Stock
2-40-000022	600V 60amp contactor – 220V	2.5	1.14	Stock
2-40-000852	21KW 230V Element NEMA 4 & 7	15.14	6.88	2-4 weeks
2-40-000850	21KW 380V Element NEMA 4 & 7	15.14	6.88	2-4 weeks
2-40-000847	21WKW 415V Element NEMA 4 & 7	15.14	6.88	2-4 weeks
2-40-000851	21KW 460V Element NEMA 4 & 7	15.14	6.88	2-4 weeks
2-40-000848	21KW 575V Element NEMA 4 & 7	15.14	6.88	2-4 weeks
2-40-000854	11KW 208V Element NEMA 4 & 7	11	5.0	2-4 weeks
2-40-000845	11KW 230V Element NEMA 4 & 7	11	5.0	2-4 weeks
2-40-000846	11KW 380V Element NEMA 4 & 7	11	5.0	2-4 weeks
2-40-000853	11KW 460V Element NEMA 4 & 7	11	5.0	2-4 weeks
2-40-000849	11KW 575V Element NEMA 4 & 7	11	5.0	2-4 weeks

2-12-000068	Element gaskets – 11KW	.04	.01	1 week
2-12-000069	Element gaskets – 21KW	.04	.01	1 week
2-22-000173	2-1/2" element bolt – all thread	.04	.01	Stock
2-35-000348	Nut 5/16"	.04	.01	Stock
2-22-000046	Lockwasher – 5/16"	.03	.01	Stock
FUEL TRAIN COMPONENTS **Manual Gas Valves**				
2-30-000398	¼" mxf brass ball valve			Stock
2-30-000021	1" lube cock	4.86	2.21	Stock
2-30-000022	1-1/4"lube cock	6.5	2.95	Stock
2-30-000013	1-1/2" lube cock	7.0	3.18	Stock
2-30-000012	2" lube cock	10.0	4.55	Stock
2-30-000005	3" lube cock	2.7	1.23	Stock
2-30-000111	½" ball valve	.25	.11	Stock
2-30-000113	1" gas cock	2.0	.91	Stock
2-30-000114	1-1/4" gas cock	3.0	1.36	Stock
2-30-000115	1-1/2" gas cock	4.8	2.18	Stock
2-30-000116	2" gas cock	.08	.36	Stock
Gas Pressure Regulators				
2-30-000102	Maxitrol RV48 ½" (pilot)	.7	.32	Stock
2-30-000104	Maxitrol RV53 1"	1.5	.68	Stock
2-30-000515	Maxitrol RV81 1-1/4"	4.68	2.13	Stock
2-30-000516	Maxitrol RV81 1-1/2"	5.94	2.7	Stock
2-30-000517	Maxitrol RV91 2"	8.28	3.76	Stock
2-30-000518	Maxitrol RV111 3"	16.88	7.67	Stock
2-30-000677	Maxitrol 325-3 – ½" (10 psi)(pilot)	.8	.36	Stock
2-30-000678	Maxitrol210D 1-1/4" (10psi)	5.6	2.55	Stock
2-30-000686	Maxitrol 1-1/2" (10psi)	5.94	2.7	Stock
2-30-000679	Maxitrol 2" (10psi)	10.0	4.55	Stock
2-30-000680	Maxitrol 3" (10psi)	23.44	10.65	Stock
	***14" WC max incoming gas pressure. Consult factory for spring ranges.**			
Safety Shut-off Valves/Actuators				
2-30-000298	½" 8215G20 Pilot Valve	1.64	.75	Stock
2-40-000214	Fluid power actuator V4055V-1031	13.7	6.23	Stock
2-40-000220	Fluid power actuator w/indicator V4055D1043	12.8	5.82	Stock
2-30-000295	Fluid power actuator NEMA 4 V4055D-1027	15.74	7.15	Stock
2-40-000210	Fluid power actuator V4055A1130 – 220V	12.8	5.82	Stock
2-30-000310	1" Honeywell gas valve – V5055A 1004	4.62	2.1	Stock
2-30-000311	1-1/4" Honeywell gas valve – V5055A 1012	4.4	2.0	Stock
2-30-000312	1-12" Honeywell gas valve – V5055A 1020	4.54	2.06	Stock
2-30-000313	2" Honeywell gas valve – V5055A 1038	4.18	1.9	Stock
2-30-000315	2-1/2" Honeywell gas valve – V5055A	4.86		Stock
2-30-000316	3" Honeywell gas valve – V5055A 1053	9.7	4.41	Stock

2-40-000249	1” Honeywell – V5055C 1034	5.0	2.27	Stock
2-40-000252	1-1/4” Honeywell – V5055C1042	5.1	2.32	Stock
2-40-000253	1-1/2” Honeywell – V5055C1059	6.0	3.0	Stock
2-40-000254	2” Honeywell – V5055C1000	9.3	4.23	Stock
2-40-000163	2-1/2” Honeywell – V5055C1018	10.5	4.77	Stock
2-40-000255	3” Honeywell – V5055C1026	11.5	5.23	Stock
Gas Pressure Switches				
2-40-000533	High/Low Gas Pressure Switch 2/16 – 1/6	3.25	1.48	Stock
2-40-000538	High/Low Gas Pressure Switch 5/28 – 2/14	3.16	1.44	Stock
2-40-000539	High/Low Gas Pressure Switch 10/50 – 6/24	3.14	1.43	Stock
2-40-000872	Ashcroft D428B Gas Pressure Switch-Hi	2.8	1.27	Stock
2-40-000871	Ashcroft D429B Gas Pressure Switch-Lo	2.78	1.26	Stock
Vent Valves (used on NFPA85 Fuel Trains)				
2-30-000296	½” Pilot Vent Valve			Stock
2-30-000400	¾” Vent Valve-8215G33	1.8	.81	Stock
2-30-000401	1” Vent Valve-8215C53	3.78	1.71	Stock
2-30-000402	1-1/4” Vent Valve-EF8215C63	5.18	2.35	Stock
2-30-000458	¾” NEMA 4 Vent Valve-EF8215C33	4.58	2.08	Stock
2-30-000447	1” NEMA 4 Vent Valve-EF8215C53	4.6	2.09	Stock
2-30-000446	1-1/4” NEMA 4 Vent Valve-EF8215C63	4.6	2.09	Stock
Butterfly Valves				
2-30-000508	1” Gas Butterfly Valve-Eclipse	2.2	1.0	Stock
2-30-000509	1-1/4” Gas Butterfly Valve-Eclipse	2.3	1.05	Stock
2-30-000510	1-1/2” Gas Butterfly Valve-Eclipse	2.74	1.25	Stock
2-30-000511	2” Gas Butterfly Valve-Eclipse	4.0	1.82	Stock
2-30-000512	3” Gas Butterfly Valve-Eclipse	8.34	3.79	Stock
2-30-000533	24” Pilot Flex Hose	.42	.19	Stock
2-30-000572	18” Pilot Flex Hose	.36	.16	Stock
2-30-000575	24” CGA Flex Hose	.36	.16	Stock
2-30-000570	½” x 36” Flex Hose			Stock
Oil Pumps				
2-30-000127	Oil Pump V023C-40M20	8.34	3.79	Stock
2-30-000212	Oil Pump 18B1H2FX-5B Consult Factory	12.78	5.81	
2-30-000525	Oil Pump 22R2210-5C3	6.82	3.1	Stock
2-30-000526	Oil Pump 22R623C-5C14	8.7	3.95	Stock
2-40-001659	3/4hp TEFC C-Face motor 208/230/460/3ph	20.62	9.37	Stock
5-20-400199	Mounting Bracket-Motor/Pump	4.0	1.82	Stock
Oil Valves				
2-30-000513	N.A. Oil Valve 2-516	9.54	4.34	Stock
2-30-000606	Hauck Oil Valve-S32C	2.02	.90	Stock
2-30-000605	Hauck Oil Valve-S33C	2.46	1.12	Stock
2-30-000514	Hauck Oil Valve-S35C	2.52	1.15	Stock

2-40-000358	Hauck Oil Valve-S39C 400/600C			Stock
2-30-000502	Oil Valve (normally closed) S401AF02V9BFS	1.88	.85	Stock
2-30-000500	Oil Valve 220V	2.0		Consult factory
2-30-000698	Oil Valve-1/4" – 1500PSI-120V	9.2	4.2	Stock
2-30-000685	Oil Pressure Regulator-RV3000	3.04	1.38	Stock
2-30-000497	Maxon Oil Valve W/POC-1/2"	28.0	12.8	Stock
2-30-000G10	Parker Check Valve			
2-30-000780	Oil Pump Coupling L070	.5	.23	Stock
2-30-000033	Coupling Spider L070	.5	.23	Stock
Fuses				
2-45-000368	KTKR2 Amp			Stock
2-45-000366	KTKR4 Amp			Stock
2-45-000367	KTKR5 Amp			Stock
2-45-000365	KTKR8 Amp			Stock
2-45-000380	KTKR10 Amp			Stock
2-45-000465	KTKR12 Amp			Stock
2-45-000655	KTKR15 Amp			Stock
2-45-000464	KTKR20 Amp			Stock
2-45-000268	KTKR25 Amp			Stock
2-45-000249	KTKR30 Amp			Stock
2-45-000152	JKS30 Amp			Stock
2-45-000010	JKS35 Amp			Stock
2-45-000011	JKS40 Amp			Stock
2-45-000012	JKS50 Amp			Stock
2-45-000013	JKS60 Amp			Stock
2-45-000214	LPJ 1-6/10 Amp			Stock
2-45-000151	LPJ2 Amp			Stock
2-45-000360	LPJ3 Amp			Stock
2-45-000361	LPJ4 Amp			Stock
2-45-000250	LPJ5 Amp			Stock
2-45-000363	LPJ7 Amp			Stock
2-45-000267	LPJ10 Amp			Stock
2-45-000266	LPJ15 Amp			Stock
2-45-000265	LPJ20 Amp			Stock
2-45-000278	LPJ25 Amp			Stock
2-45-000264	LPJ30 Amp			Stock
2-45-000263	LPJ35 Amp			Stock
2-45-000262	LPJ40 Amp			Stock
2-45-000261	LPJ50 Amp			Stock
2-45-000260	LPJ60 Amp			Stock
2-45-000382	LPJ70 Amp			Stock

2-45-000343	LPJ80 Amp			Stock
2-45-000374	LPJ100 Amp			Stock
2-45-000270	LPJ125 Amp			Stock
2-45-000271	LPJ150 Amp			Stock
2-45-001000	FNQ2 Amp			Stock
2-45-000381	FNQ3 Amp			Stock
2-45-000998	FNQ4 Amp			Stock
2-45-000995	FNQ5 Amp			Stock
2-45-000272	200 Amp Fuse Block			Stock
2-45-000244	Fuse Block J600-603C			Stock
2-45-000344	Fuse Block J60100-3CR			Stock
2-45-000006	SC-40 Fuse (240V)	.1	.05	Stock
2-45-000007	SC-50 Fuse (240V)	.1	.05	Stock
2-45-000008	SC-60 Fuse (240V)	.1	.05	Stock
2-45-000276	16 Amp Disconnect			Stock
2-45-001050	25 Amp Disconnect			Stock
2-45-001051	40 Amp Disconnect			Stock
2-45-001052	60 Amp Disconnect			Stock
Gaskets & Material				
2-60-000114	Silicone Sealant-red-10 oz	.82	.37	Stock
2-60-000111	Silicone Sealant-clear-10 oz	.82	.37	Stock
2-12-000010	Anti-Seize #76764	1.0	.5	Stock
2-60-000007	Turbo 50-4 oz	.4	.16	Stock
2-12-000052	Graphoil Packaging	.5	.23	Stock
2-12-000060	Kast-o-lite 30 55# per bag (by the pound)	55.0	25.0	Stock
2-12-000210	¼" Rope Gasket			Stock
2-12-000051	3/8" Rope Gasket			Stock
2-12-000003	½" Rope Gasket			Stock
2-12-000049	1" Thermal Bar Gasket-for burner plate			Stock
2-12-000150	Dresser Plate Gasket Material-Omni light			Stock
2-12-000140	Omnilight 8" OD Gasket			Stock
2-12-000141	Omnilight 10" OD Gasket			Stock
2-12-000142	Omnilight 12" OD Gasket			Stock
2-12-000143	Omnilight 4"x9" Gasket			Stock
2-12-000144	Omnilight 4"x14" Gasket			Stock
2-12-000145	Omnilight 6"x12" Gasket			Stock
Elastagraph Ring Gaskets for Flanges				
2-12-000400	½" 150# Gasket	.5	.22	Stock
2-12-000402	¾" 150# Gasket	.8	.44	Stock
2-12-000404	1" 150# Gasket	.1	.05	Stock
2-12-000406	1-1/4" 150# Gasket	.1	.05	Stock
2-12-000408	1-1/2" 150# Gasket	.12	.05	Stock

2-12-000410	2” 150# Gasket	.18	.08	Stock
2-12-000412	2-1/2” 150# Gasket	.22	.1	Stock
2-12-000414	3” 150# Gasket	.14	.06	Stock
2-12-000416	4” 150# Gasket	.32	.15	Stock
2-12-000418	5” 150# Gasket	.4	.18	Stock
2-12-000420	6” 150# Gasket	.42	.19	Stock
2-12-000422	8” 150# Gasket	.45	.2	Stock
2-12-000401	1/2” 300# Gasket	.08	.4	Stock
2-12-000403	3/4” 300# Gasket	.1	.05	Stock
2-12-000405	1” 300# Gasket	.12	.05	Stock
2-12-000407	1-1/4” 300# Gasket	.14	.06	Stock
2-12-000409	1-1/2” 300# Gasket	.18	.08	Stock
2-12-000411	2” 300# Gasket	.18	.08	Stock
2-12-000413	2-1/2” 300# Gasket	.26	.12	Stock
2-12-000415	3” 300# Gasket	.3	.14	Stock
2-12-000417	4” 300# Gasket	.44	.2	Stock
2-12-000419	5” 300# Gasket	.54	.25	Stock
2-12-000421	6” 300# Gasket	.6	.27	Stock
2-12-000423	8” 300# Gasket	.65	.3	Stock
Modulation Parts				
2-40-000722	Modutrol Motor M7284Q-1009 4-20Ma	9.88	4.49	Stock
2-40-000671	Modutrol Motor M9184C-1031 0-135ohm	6.5	2.95	Stock
2-40-000831	Modutrol Motor step transformer 220V/120V			Stock
2-30-000499	CAS-500 Damper Crank Arm-short	.1	.05	Stock
2-30-000506	Superior Linkage Arms-long	.18	.08	Stock
2-30-000507	Superior Linkage Swivels	.06	.03	Stock
2-40-000582	Adjustable Damper Arm	7.5	3.41	Stock
2-30-000335	Bearing Block	.75	.26	Stock
2-30-000839	Lock Collar			Stock
2-10-000144	5/16” Linkage Rod			Stock
2-10-000148	½” Drive Rod			Stock
2-45-000060	4” Handy Box			Stock
2-30-003001	Rubber Linkage Boot Gummi Bellows NEMA 4			Stock
2-40-000200	Contactor R4242 120V Coil	.6	.27	Stock
2-40-000202	Contactor R4243 120V Coil	.5	.23	Stock
Nexus Linkageless Modulation				
2-40-000557	Flame/Temperature Control Module	5.5	2.5	Stock
2-40-000558	Wiring Base	2.3	1.1	Stock
2-40-000574	Display Module	1.6	.8	Stock
2-40-000553	NEMA 1 Servo NX04	2.2	1.0	Stock
2-40-000556	NEMA 4 Servo NX20-1			Stock
2-40-000811	Temperature Sensor	.9	.4	Stock

2-40-000571	220V Air Servo NX04			Stock
2-40-000572	220V Gas Servo NX04-2			Stock
5-20-000420	Small Servo/Butterfly Valve Mounting Bracket			Stock
5-20-000421	Small Servo/Butterfly Valve Adapter Shaft			Stock
5-20-000422	Air Gate Adapter to Servo			Stock
5-20-000423	0120-0600C Linkageless Modulated Air Gate			Stock
5-20-000424	Large Servo Air Gate Adapter			Stock
5-20-000425	Air Gate Center Bracket for Mounting Servo			Stock
5-20-000426	Air Gate End Bracket for Mounting Servo			Stock
5-20-000427	0080C Linkageless Modulated Air Gate			Stock
5-20-000428	0800-1400C Linkageless Modulated Air Gate			Stock
5-20-000429	Large Servo/Butterfly Valve Adapter Shaft			Stock
5-20-000430	Large Servo/Butterfly Valve Mounting Bracket			Stock
2-45-000399	Current Monitor Relay			Stock
Miscpart	Potentiometers-Servo (61-6969)			Stock
Seimens Linkageless Modulation				
2-35-001016	TAK Air Servo Adapter			
2-35-001014	TAK Gas Servo Adapter			
2-35-001018	TAK Oil Servo Adapter			
2-40-000429	Plug Set			
2-40-000430	Display Cable			
2-40-000431	120V Transformer Power Supply			
2-40-000432	Bus Cable End Clip			
2-40-000433	Air Servo Motor			
2-40-000434	Gas Servo Motor			
2-40-000435	Conduit Adapter			
2-40-000437	Display Module AZL			
2-40-000447	Bus Cable			
2-40-000449	120V Controller LMV51			
2-40-000465	Flame Detector Self Check Vertical Mounting			
2-40-000466	Infrared Scanner Bracket Vertical Mounting			
2-45-001017	Black Nylon Cord Grip			
2-20-000422	Air Gate Shaft Adapter			
2-40-000458	220V Controller LMV51			
2-40-000457	220V Transformer			
2-40-000823	RTD 3-Wire 100 ohms			
2-40-000767	58.1 Shaft			
2-40-000768	33.9 Adapter			
5-10-003053	Gas Valve Mounting Bracket			
5-20-000455	Air Servo Mounting Bracket			
5-20-000456	End Mounting Bracket			

5-20-000426	80/320/400C End Mounting Bracket			
5-10-004786	Gussett for Brackets			
2-30-000804	Scanner Bracket Side View NEMA4			
2-40-000436	Flame Detector Side View NEMA4			
FT-0080C				
5-20-00427	Linkageless Air Gate			
5-10-001792	Air Gate Mounting Assembly			
5-20-000456	End Bracket (2 Required)			
2-20-000422	Air Gate Servo Adapter			
2-35-001016	Air Servo to Air Gate coupling			
5-20-000455	Air Gate Center Bracket			
FT-120C – 600C				
5-20-000423	Linkageless Air Gate			
5-20-000455	Air Gate Center Bracket			
5-20-000456	End Bracket (2 required)			
2-20-000422	Air Gate Servo Adapter			
2-35-001016	Air Servo to Air Gate Coupling			
5-10-001702	Air Gate Mounting Assembly			
5-10-001704	Air Gate Mounting Assembly (FT-320C-400C Only)			
FT-800C				
5-20-000428	Linkageless Air Gate			
4-20-000455	Air Gate Center Bracket			
2-20-000422	Air Gate Servo Adapter			
2-35-001016	Air Servo to Air Gate Coupling			
5-10-001802	Air Gate Mounting Assembly			
5-20-000457	End Bracket (2 required)			
FT-1000C – 1200C				
5-20-000428	Linkageless Air Gate			
7-21-000030	Air Gate Mounting Assembly			
5-20-000455	Air Gate Center Bracket			
2-20-000422	Air Gate Servo Adapter			
2-35-001016	Air Servo to Air Gate Coupling			
5-20-000435	End Bracket (2 required)			
O & M Manuals				
5-60-000120	Coil Model Thermal Fluid Heater Manual (C Model)	5.5	2.5	5 days
5-60-000122	Vertical Tubeless Thermal Fluid Heater Manual (A Model)			5 days
5-60-000123	Electric Thermal Fluid Heater Manual (N Model)			5 days
5-60-000121	Unfired Steam Generator Manual			5 days
PANEL BOX COMPONENTS **Air Switch**				
2-30-000260	1910-5 Air Switch (replaces #2-30-119 1823-2) Filter	1.46	.66	Stock
2-30-000270	1910-0 Air Switch (replaces #2-30-230 1823-1) Fan	1.46	.66	Stock

Ignition Transformer				
2-40-000082	6kv 120V/60hz Ignition Transformer	8.62	3.92	Stock
2-40-000084	6kv 110V/50hz Ignition Transformer	8.62	3.92	Stock
2-40-000086	10kv 120V/60hz Ignition Transformer	8.62	3.92	Stock
2-40-000088	10kv 110V/50hz Ignition Transformer	8.62	3.92	Stock
Lights/Switches/Button/Relays				
2-40-000131	General Purpose Relay (Ice Cube) 700HA32A1 120V-AB	.8		Stock
2-40-000135	General Purpose Relay (Ice Cube) 700HA32A2 220V-AB	.8		Stock
2-40-000096	Base for Ice Cube Relay		.1	Stock
2-40-000843	4 Pole Relay 120V-AB			
2-40-000842	4 Pole Relay Bast			Stock
2-40-000993	PS5-RA24 power supply	.4	.2	Stock
2-45-000050	Fuel Selector Switch	.34	.15	Stock
2-45-000091	SPST Switch-mod lock	.05	.02	Stock
2-45-000212	3 Position Switch-SqD	.14	.06	Stock
2-45-000300	NO Contacts for switch	.04	.02	Stock
2-45-000269	NC Contacts for switch	.04	.02	Stock
2-40-000791	Push Button Start SqD-green	.1	.05	Stock
2-40-000793	Push Button Stop SqD-red	.1	.05	Stock
2-45-000412	Green Light SqD-120V	.08	.03	Stock
2-45-000411	Red Light SqD-120V	.08	.03	Stock
2-40-000841	700HR Time Delay Relay for Circulating Pump	.85	.34	Stock
2-40-000134	Time Delay Relay Base			Stock
2-45-000309	Primary/Stand-by Switch –2pos	.14	.06	Stock
2-40-000151	Time Delay 10 sec adjustable			
2-45-000203	Bulb S&S	.02	.01	*
2-45-000205	Green Lens only S&S	.02	.01	*
2-45-000206	Red Lens only S&S	.02	.01	*
				***Consult Factory for Lead Time**
Motor Contactors – 3 phase/120V coil – Siemens				
2-40-000878	3RT1015-1AK6 Contactor-7 amp	.8	.36	Stock
2-40-000567	3RT1016-1AK6 Contactor-9 amp	.8	.36	Stock
2-40-000642	3RT1017-1AK6 Contactor-12 amp	.8	.36	Stock
2-40-000643	3RT1025-2QB0 Contactor-17 amp	.8	.36	Stock
2-40-000644	3RT1026-1AK6 Contactor-25 amp	.8	.36	Stock
2-40-000646	3RT1035-1AK6 Contactor40 amp	.8	.36	Stock
2-40-000825	3RT1036-1AK6 Contactor-50 amp	.8	.36	Stock
2-40-000647	3RT1044-1AK6 Contactor-65 amp	.8	.36	Stock
2-40-000645	3RT1033-1AK6 Contactor-28 amp			Stock
2-40-000631	3RT1046-1AK6 Contactor-95 amp			Stock
2-40-000637	3RT1046-1AK6 Contactor			Stock
2-40-000879	3RH1921-1LA11 Aux Contactor			Stock

2-40-000648	3BR1015-2PB0 Overload-1.5-6 amp	.45	.2	Stock
2-40-000566	3BR1015-2NB0 Overload-.4-1.6 amp	.45	.2	Stock
2-40-000573	3BR1015-2SB0 Overload-3-12 amp	.45	.2	Stock
2-40-000651	3BR1025-2QB0 Overload-6-25 amp	.45	.2	Stock
2-40-000716	3BR1035-2UB0 Overload-13-50 amp	.45	.2	Stock
2-40-000656	3BR1045-2EB0 Overload-23-75 amp	.45	.2	Stock
2-40-000822	3BR1045-2EB0 Overload-25-100 amp			Stock
Panel Box Air Conditioner & Parts				
2-40-000997	Panel Box Air Conditioner	49.6	22.6	1 week
2-45-000468	5 Minute Time Delay Relay for A/C	.5	.3	Stock
2-45-000469	Relay Base for 2-45-000468	.2	.1	Stock
Stepdown Transformer				
2-40-000441	.75KVA Stepdown Transformer-480/120-50/60hz	12	5.46	1 week
2-40-000443	1.5KVA Stepdown Transformer-480/120	12	5.46	1 week
2-40-000445	1KVA Stepdown Transformer-480/120-50/60hz	12	5.46	Stock
2-40-000440	1KVA Stepdown Transformer-208/120			Stock
Pressure Gauges & Accessories				
2-30-000529	0-100 PSI Panel Pressure Gauge-heater outlet	.44	.2	Stock
2-30-000530	0-200 PSI Panel Pressure Gauge-heater inlet	.44	.2	Stock
2-30-000531	30-0-60 PSI Panel Pressure Gauge-pump suction	.38	.17	Stock
2-30-000342	0-200 PSI Liquid Filled Gauge	.56	.25	Stock
2-30-000343	0-400 PSI Liquid Filled Gauge	.56	.25	Stock
5-21-000274	Single Gauge Panel	.5	.3	Stock
5-21-000273	Dual Gauge Panel	.9	.4	Stock
5-21-000272	Triple Gauge Panel	.8	.4	Stock
2-40-001003	Stack Thermometer 9” Probe ½” NPT			
PUMPS **Allweiler Un-mounted Pumps**				
2-30-001680	NTT-32-160 w/Mechanical Seal			*
2-30-001041	NTT-32-200 w/Mechanical Seal			*
2-30-001681	NTT-40-160 w/Mechanical Seal			*
2-30-001020	NTT-40-200 w/Mechanical Seal			*
2-30-001021	NTT-50-160 w/Mechanical Seal			*
2-30-001684	NTT-50-200 w/Mechanical Seal			*
2-30-001022	NTT-50-250 w/Mechanical Seal			*
2-30-001685	NTT-65-160 w/Mechanical Seal			*
2-30-001036	NTT-65-200 w/Mechanical Seal			*
2-30-001035	NTT-65-250 w/Mechanical Seal			*
2-30-001034	NTT-80-160 w/Mechanical Seal			*
2-30-001031	NTT-80-200 w/Mechanical Seal			*
2-30-001033	NTT-80-250 w/Mechanical Seal			*
2-30-001032	NTT-100-200 w/Mechanical Seal			*

2-30-001040	NTT-100-250 w/Mechanical Seal			*
				***Long Lead Time-check with factory for delivery & impeller trim size**
Allweiler Full Size Impellers				
2-30-001051	NTT 32/160 Impeller 170mm	4.8	2.18	*
2-30-001120	NTT 40/160 Impeller 170 mm	4.98	2.26	*
2-30-001122	NTT 65/160 Impeller 170 mm	4.62	2.1	*
2-30-001123	NTT 80/160 Impeller 180 mm			*
2-30-001126	NTT 40/200 Impeller 205 mm	6.62	3.01	*
				***Long Lead Time-check with factory for delivery & impeller trim size**
ALLWEILER SPARE PARTS LIST Common Parts For: NTT-25-200;32-1 60;4200;4250;50-1 60; 50-200; 32-200; 50-250; 65-1 60; and 80-160, 65-200				
4-30-000106	Seal Kit	1.58	.72	Stock
4-30-000126	Rebuild Kit –Includes seal kit	3.12	1.42	Stock
2-30-001030	400.1 Casing Gasket-206 x 217.5 x .5 mm	.01	.0	Stock
2-30-001043	400.2 Gasket 257 x 269 x .5	.01	.0	Stock
2-30-001044	400.13 Gasket –72.5 x 88 x .5 mm	.01	.0	Stock
2-30-001045	321.4 & 321.3 Ball Bearing	.4	.18	Stock
2-30-001048	461.1 Set of Packing	.1	.05	Stock
2-30-001049	433.2 Mechanical Seal	.26	.12	Stock
2-30-001050	210.1 Shaft	4.46	2.03	Stock
2-30-001055	Complete 360 Bearing Frame	30.52	13.87	Stock
2-60-000153	EP #2 Grease	10.14	4.61	Stock
Common Parts For: NTT-65-250; 80-200; 80-250; 100-200; 100-250; and 125-250				
2-30-001029	400.2 Casing Gasket	.01	.0	Stock
2-30-001205	400.8 Gasket	.01	.0	Stock
2-30-001203	461.1 Set of Packing	.01	.0	Stock
2-30-001200	433.2 Mechanical Seal	.4	.18	Stock
2-30-001038	210.1 Shaft	3.0	1.36	Stock
2-30-001204	321.3 @ 321.4 Ball Bearing	1.42	.65	Stock
2-30-001058	Complete 470 Bearing Frame	53.84	24.47	Stock
2-60-000153	EP #2 Grease	10.14	4.61	Stock
Dean's – Un-mounted Pump-includes impeller (truck ship only – call for impeller trim size)				
2-30-002000	RA3000 1-1/2x3x8-1/2	260.0	118.0	Stock
2-30-002002	RA3000 2x3x8-1/2	316.0	126.4	Stock
2-30-002004	RA3000 3x4x8-1/2	344.0	156.0	Stock
2-30-002006	RA3000 4x6x8-1/2	390.0	177.0	Stock
Miscpart	RA3000 1.5x3x10			Stock
5-20-000400	Small Pump Guard			Stock
5-20-000402	Large Pump Guard			Stock
2-30-002218	#4 Impeller Key	.02	.01	Stock
2-30-002219	#12 Impeller Bolt	.04	.02	Stock
2-30-002220	#12A Impeller Washer	.14	.07	Stock

2-30-002221	#13 Mech Seal Gland	1.8	.9	Stock
2-30-002222	#25A Thrust Bearing	1.5	.7	Stock
2-30-002223	#28 Bearing End Cover	5.7	2.6	Stock
2-30-002224	#29 Pump Shaft	9.5	4.4	Stock
2-30-002225	#31 Thrust Bearing Locknut	.3	.2	Stock
2-30-002226	#31A Thrust Bearing Washer	.1	.05	Stock
2-30-002227	#75 Snap Ring	.02	.01	Stock
2-30-002228	#76 Grease Seat – front	.1	.05	Stock
2-30-002229	#76A Grease Seat – rear	.1	.05	Stock
2-30-002230	#77B Bearing End Cover Gasket			Stock
2-30-002231	#95 A/B Mech Seal	.5	.23	Stock
2-30-002232	#180 Radial Bearing Cartridge	3.8	.18	Stock
2-30-002233	#325 Seal Gland Gasket			Stock
2-30-002257	Seal Gland			1 week
2-30-002258	Lip Seal			1 week
2-30-002259	Gland Gasket			1 week
2-30-002256	Collar & Set Screws			1 week
2-30-002252	#6A Casing Ring 1x3x8 ½ & 1 1/2x3x8 ½			Consult factory
2-30-002253	#6A Casing Ring 2x3x8 ½			Consult factory
2-30-002254	#6A Casing Ring 3x4x8 ½			Consult factory
2-30-002255	#6A Casing Ring 4x6x8 ½			Consult factory
2-30-002234	#325A Seal Gland Gasket			Stock
2-30-002242	#365 Mech Seal Retainer	.2	.1	Stock
2-30-002251	#3 Impeller 1x3x8 ½			1 week
2-30-002235	#3 Impeller 1-1/2x3x8-1/2	8.7	4.0	Stock
2-30-002236	#3 Impeller 2x3x8-1/2	10.3	4.7	Stock
2-30-002237	#3 Impeller 3x4x8-1/2	11.1	5.1	Stock
2-30-002238	#3 Impeller 4x6x8-1/2	12.6	5.8	Stock
Miscpart	#3 Impeller 1.5x3x10			Stock
2-30-002239	#77 Casing Gasket	.04	.02	Stock
2-30-002240	6322595 Grease	.2	.1	Stock
8-00-000046	Shaft Sleeve Guide	1.0	.05	Stock
8-00-000047	Carbon Sleeve Removal Tool	1.6	.8	Stock
Dean's – kits				
4-30-000130	Start Up kit for Deans RA3000 Series Pumps			Stock
4-30-000140	1 Year Service Kit for Deans RA3000 1.5x3x8.5			Stock
4-30-000141	1 Year Service Kit for Deans RA3000 2x3x8.5			Stock
4-30-000142	1 Year Service Kit for Deans RA3000 3x4x8.5			Stock
4-30-000143	1 Year Service Kit for Deans RA3000 4x6x8.5			Stock
4-30-000150	2 Year Service Kit for Deans RA3000 1.5x3x8.5			Stock

4-30-000151	2 Year Service Kit for Deans RA3000 2x3x8.5			Stock
4-30-000152	2 Year Service Kit for Deans RA3000 3x4x8.5			Stock
4-30-000153	2 Year Service Kit for Deans RA3000 4x6x8.5			Stock
SIHI Un-mounted Pumps – includes impeller (call for impeller trim size)				
2-30-001000	ZTN 3216 w/mech seal	58.0	26.36	Consult factory
2-30-001002	ZTN 3220 w/mech seal	84.0	38.18	Consult factory
2-30-001004	ZTN 4016 w/mech seal	73.0	33.18	Consult factory
2-30-001006	ZTN 4020 w/mech seal	84.0	38.18	Consult factory
2-30-001007	ZTN 5013 w/mech seal	90.0	40.91	Consult factory
2-30-001008	ZTN 5016 w/mech seal	90.0	40.91	Consult factory
2-30-001010	ZTN 5020 w/mech seal	95.0	43.18	Consult factory
2-30-001012	ZTN 6516 w/mech seal	92.0	41.82	Consult factory
2-30-001014	ZTN 6520 w/mech seal	89.0	40.45	Consult factory
2-30-001016	ZTN 8016 w/mech seal	107.0	48.64	Consult factory
2-30-001018	ZTN 8020 w/mech seal	115.0	52.27	Consult factory
2-30-001019	ZTN 10020 w/mech seal	152.0	69.09	Consult factory
SIHI Impellers				
2-30-000589	8020-30 Impeller 210 mm	8.08	3.67	Consult factory
2-30-000590	5016-30 Impeller 170 mm	3.56	1.62	Consult factory
2-30-000591	3220-30 & 4020 Impeller 210 mm	5.52	2.51	Consult factory
2-30-000693	5020-30 Impeller 210 mm	6.14	2.79	Consult factory
2-30-000694	4016-30 Impeller 170 mm	3.94	1.79	Consult factory
Miscpart	10020 Impeller			Consult factory
Pump serial numbers must be given to factory to verify availability & pricing **Common parts for the following models: 3213, 3216, 3220, 4013, 4016, 4020, 5013, 5016, 5020, 6513, 6516, 6520 and 8016**				
4-30-000108	Mech seal kit (3213 to 8016)	1.7	.8	Stock
4-30-000110	Pump repair kit w/ mech seal (3213 to 8016)	2.0	1.0	Stock
4-30-000100	Radial seal kit (3213 to 8016)	1.34	.61	Stock
4-30-000120	Pump rebuild kit w/rad seals (3213 to 8016)	2.32	1.05	Stock
2-30-001013	Item 500-Mechanical Seal	2.0	1.1	Stock
2-30-000580	Item 341-Sleeve Bearing	.44	.2	Stock
2-30-000583	Item 200-Shaft (includes # 256, 257, 260, 286, 292)	2.94	1.34	Stock
2-30-000585	Item 426-Rad Seal –7 required	.1	.05	Stock
2-30-000451	Item 140-Gasket	.01	0.0	Stock
2-30-000588	Item 81' –'O' Ring	.01	0.0	Stock

2-30-000594	Item 221-Ball Bearing Cover	.5	.23	Stock
2-30-000597	Item 230-Ball Bearing	.5	.23	Stock
2-30-000598	Item 292-Lockwasher	.01	0.0	Stock
2-20-000190	Item 266-Spacer	.01	0.0	Stock
2-12-000067	Item 80-13 Series Casing Gasket	.12	.05	Stock
2-12-000098	Item 80-16 Series Casing Gasket	.18	.08	Stock
2-12-000099	Item 80-20 Series Casing Gasket			Stock
2-60-000153	EP#2 Grease	10.14	4.61	Stock
Common parts for the 8020 and 10020 models				
4-30-000112	Seal Kit w/mech seal	1.7	.8	Stock
4-30-000113	Pump Repair Kit w/mech seal	4.1	1.9	Stock
2-30-001015	Item 500-Mechanical Seal	.4	.2	Stock
4-30-000102	8020 Seal Kit w/radial seals	1.38	.63	Stock
4-30-000122	8020 Rebuild Kit w/radial seals	3.8	1.73	Stock
2-30-000451	Item 140-Gasket	.1	0.0	Stock
2-30-000581	Item 230-Ball Bearing	.98	.45	Stock
2-30-000593	Item 221-Bearing Cover	.1	.05	Stock
2-30-000582	Item 200-Shaft	7.5	3.41	Stock
2-30-000584	Item 426-Rad Seal-7 required	.1	.05	Stock
2-30-000592	Item 241-Sleeve Bearing	.66	.3	Stock
2-12-000099	Item 80-Casing Gasket	.0		Stock
2-12-000116	Item 80-Gasing Gasket for ZTN 10020	.02	.01	Stock
2-30-000599	Item 81-'O' Ring	.0		Stock
2-60-000153	EP#2 Grease	10.14	4.61	Stock
Pump/motor coupling parts				
2-30-000707	E4 24mm Rexnord Hub	1.8	.82	Stock
2-30-000705	E4 1-1/8" Rexnord Hub	1.45	.66	Stock
2-30-000706	E4 1-3/8" Rexnord Hub	1.22	.55	Stock
2-30-000710	E4 1-5/8" Rexnord Hub	.96	.44	Stock
2-30-000708	E4 Elastomer Element	1.36	.62	Stock
2-30-000704	E5 24 mm Rexnord Hub	2.84	1.29	Stock
2-30-001072	E5 32 mm Rexnord Hub	2.4	1.09	Stock
2-30-000712	E5 1-1/8" Rexnord Hub	2.52	1.15	Stock
2-30-000703	E5 1-3/8" Rexnord Hub	2.5	1.14	Stock
2-30-000702	E5 1-5/8" Rexnord Hub	2.14	.97	Stock
2-30-000713	E5 1-7/8" Rexnord Hub	1.64	.75	Stock
2-30-000714	E5 Elastomer Element	2.14	.97	Stock
2-30-000716	E10 24 mm Rexnord Hub	4.08	1.85	Stock
2-30-001073	E10 32 mm Rexnord Hub	5.0	2.27	Stock
2-30-000718	E10 1-5/8" Rexnord Hub	3.4	1.55	Stock
2-30-000717	E10 1-7/8" Rexnord Hub	3.04	1.38	Stock
2-30-000711	E10 2-1/8" Rexnord Hub	3.5	1.59	Stock

2-30-000715	E10 Elastomer Element	2.86	1.3	Stock
2-30-000752	E20 1-1/8" Rexnord Hub			Stock
2-30-000821	E20 32 mm Rexnord Hub	7.86	3.57	Stock
2-30-000823	E20 1-7/8" Rexnord Hub	7.86	3.57	Stock
2-30-000824	E20 2-1/8" Rexnord Hub	7.86	3.57	Stock
2-30-000822	E20 Elastomer Element	2.86	1.3	Stock
Pump bases				
5-30-005000	12"x40" Base			Stock
5-30-005002	15"x48" Base			Stock
5-30-005004	18"x48" Base			Stock
SAFETY RELIEF VALVES **Thermal fluid safety valves**				
2-30-000544	Kunkle Safety Valve ¾" 100 psi-920	3.92	1.78	Stock
2-30-000545	Safety Valve 1" 100 psi-920	5.72	2.6	Stock
2-30-000546	Safety Valve 1-1/4" 100 psi-920	8.6	3.91	Stock
2-30-000547	Safety Valve 1-1/2" 100 psi-920	15.04	6.84	Stock
2-30-000548	Safety Valve 2" 100 psi-920			Stock
Thermal fluid safety valve (flanged)				
2-30-000609	Kunkle safety valve ¾" 100 psi-920-300# flanged	11.3	5.2	Stock
2-30-000610	Kunkle safety valve 1" 100 psi-920-300# flanged	14.6	6.7	Stock
2-30-000611	Kunkle safety valve 1-1/4" 100 psi-920-300# flanged	23.5	10.7	Stock
2-30-000612	Kunkle safety valve 1-1/2" 100 psi-920-300# flanged	34.0	15.5	Stock
2-30-000613	Kunkle safety valve 2" 100 psi-920-300# flanged Above used on heater #3117C & Up (2001)	45.0	20.5	Stock
Kunkle N2 safety valves – expansion tank				
2-30-000637	1" SRV 15 PSI			
2-30-000636	¾" SRV 15 PSI			
2-30-000639	1 ½" SRV 15 PSI			
2-30-000638	1 ¼" SRV 15 PSI			
SKID COMPONENTS **Worchester Valves**				
2-30-000534	¼" Threaded Ball Valve	1.54	.07	Consult factory
2-30-000536	¾" Ball Valve-Two Way	1.98	.9	Consult factory
2-30-000537	1" Ball Valve-Two Way	3.82	1.74	Consult factory
2-30-000538	1-1/4" Ball Valve-Two Way	5.1	2.32	Consult factory
2-30-000539	1-1/2" Ball Valve-Two Way	7.46	3.39	Consult factory
2-30-000540	2" Ball Valve-Two Way	10.1	4.59	Consult factory
2-30-000897	½" Ball Valve w/Actuator	7.08	3.22	Consult factory
2-30-000896	1" Ball Valve w/Actuator	14.0	6.45	Consult factory
2-30-000899	1-1/2" 3-Way Diverting Valve w/Actuator	22.14	10.06	Consult factory

2-30-000898	2” 3-Way Diverting Valve w/Actuator	25.84	11.75	Consult factory
2-30-001300	1-1/4” Valve Repair Kit	.16	.07	Consult factory
2-30-001301	1-12” Valve Repair Kit	.2	.09	Consult factory
2-30-001303	1039 Actuator Repair Kit	.18	.08	Consult factory
2-30-001304	2039 Actuator Repair Kit	.1	.08	Consult factory
2-30-001305	Series 1039 Actuator (1” and smaller)	.06	.05	Consult factory
2-30-001313	1-1/4” S Ring	.02	.03	Consult factory
2-30-001314	1-1/2” S Ring	.02	.01	Consult factory
2-30-001315	2” S Ring		.01	Consult factory
Dezurik Valves				
2-30-000885	1.5” Dezurik Valve w/EI-O-Matic Actuator and Positioner			Consult factory
2-30-000820	2” Dezurik Valve w/EI-O-Matic Actuator and Positioner			Consult factory
2-30-000886	3” Dezurik Valve w/EI-O-Matic Actuator and Positioner			Consult factory
2-30-000882	3” Dezurik Valve Repair Kit			Consult factory
2-30-000880	2” Dezurik Valve Repair Kit			Consult factory
2-30-000883	1.5” Dezurik Valve Repair Kit	.2	.1	Consult factory
2-30-001261	ES10 Actuator Rebuild Kit	.2	.1	Consult factory
2-30-001260	ES20 Actuator Rebuild Kit	.16	.07	Consult factory
2-30-001276	1” Valve Actuator ES10-6			Consult factory
SteamPac Components				
2-40-000420	Fulton Pump Relay –120V	.5	.23	Stock
2-40-000422	Base for Fulton Pump Relay (8 pin)	.25	.11	Stock
2-40-000403	IDIDO Relay	2.0	.91	Stock
2-40-000202	Motor Starter R4243 – 30 Amp	.52	.24	Stock
2-40-000421	120V Water Level Relay			Stock
2-40-000423	Base for 120V Water Level Relay (11 pin)			Stock
2-40-000229	Pressuretrol L404A1396	2.0	.91	Stock
2-12-000004	Handhole Gasket	.04	.02	Stock
2-12-000007	5/8”x9-1/4” Gauge Glass	.2	.09	Stock
2-12-000019	5/8” Rubber Gasket	.004	0.0	Stock
2-12-000020	5/8” Brass Gasket	.002	0.0	Stock
2-30-000149	½” Water Gauge Valve w/ ball checks	1.5	.68	Stock
2-30-000047	½” Tri-cock	.42	.19	Stock
2-20-000017	Low Water Cutoff Probe-17-1/8” – cut to any length	.5	.23	Stock
2-20-000010	Low Water Probe	.5	.23	Stock
2-20-000012	High Water Probe	.5	.23	Stock

2-30-000029	½" Float Valve	.72	.33	Stock
2-30-000028	¾" Float Valve	.76	.35	Stock
2-30-000124	4 ½" Float Ball only	.6	.27	Stock
2-12-000534	½" Float Valve Disc	.01	0	Stock
2-12-000535	¾" Float Valve Disc	.01	0	Stock
2-30-000332	300# Steam Gauge	.5	.23	Stock
Strainer Parts				
2-30-000870	60 Mesh Strainer Basket-2" Keckley	.4	.18	Stock
2-30-000871	60 Mesh Strainer Basket-2-1/2" Keckley	.38	.17	Stock
2-30-000872	60 Mesh Strainer Basket-3" Keckley	.66	.3	Stock
2-30-000873	60 Mesh Strainer Basket-4" Keckley	.75	.34	Stock
2-30-000847	60 Mesh Strainer Basket-6" Keckley	.75	.34	Stock
2-30-000829	60 Mesh Strainer Basket-8" Keckley	.8	.37	Stock
2-12-000120	Gasket for 2" Keckley Strainer	.04	.02	Stock
2-12-000121	Gasket for 2-1/2" Keckley Strainer	.04	.02	Stock
2-12-000122	Gasket for 3" Keckley Strainer	.04	.02	Stock
2-12-000123	Gasket for 4" Keckley Strainer	.14	.06	Stock
2-30-000878	Gasket for 6" Keckley Strainer	.14	.06	Stock
2-30-000830	Gasket for 8" Keckley Strainer	.14	.06	Stock
2-30-000627	Strainer –4" Keckley 150# Flanged	62.2	28.3	Stock
2-30-000874	Strainer –5" Keckley 150# Flanged			Stock
2-30-000875	Strainer –6" Keckley 150# Flanged	68.5	34.3	Stock
2-30-000828	Strainer –8" Keckley 150# Flanged	999.0	454.0	Stock
2-30-000808	Strainer –2 ½" Titan			
2-30-000809	Strainer –3" Titan			
2-30-000810	Strainer –4" Titan			
2-12-000135	Gasket for 2 ½" Titan Strainer			
2-12-000136	Gasket for 3" Titan Strainer			
2-12-000137	Gasket for 4" Titan Strainer			
Notes: SIHI & Allweiler pump flanges use 150# - 4 bolt, Deans pump flanges use 300#				

Standard Warranty for Fulton Thermal Fluid Heaters

Warranty Valid for Models FT-A, FT-C, FT-S, FT-N, FT-HC

One (1) Year (12 Month) Material and Workmanship Warranty
The pressure vessel is covered against defective material or workmanship for a period of one (1) year from the date of shipment from the factory. Fulton will repair or replace F.O.B. factory any part of the equipment, as defined above, provided this equipment has been installed, operated and maintained by the buyer in accordance with approved practices and recommendations made by Fulton. The commissioning agency must also successfully complete and return the equipment Installation and Operation Checklists to Fulton's Quality Assurance department. This warranty covers any failure caused defective material or workmanship.

Parts Warranty
Fulton will repair or replace F.O.B. factory any part of the equipment of our manufacture that is found to be defective in workmanship or material within one (1) year of shipment from the factory provided this equipment has been installed, operated and maintained by the buyer in accordance with approved practices and recommendations made by both Fulton and the component manufacturers and the commissioning agency has successfully completed and returned the equipment Installation and Operation Checklists to Fulton's Quality Assurance department.

General
Fulton shall be notified in writing as soon as any defect becomes apparent. This warranty does not include freight, handling or labor charges of any kind.

These warranties are contingent upon the proper sizing, installation, operation and maintenance of the boiler and peripheral components and equipment. Warranties valid only if installed, operated, and maintained as outlined in the Fulton Installation and Operation Manual.

No Sales Manager or other representative of Fulton other than the Quality Manager or an officer of the company has warranty authority. Fulton will not pay any charges unless they were pre-approved, in writing, by the Fulton Quality Manager.

This warranty is exclusive and in lieu of all other warranties, expressed or implied, including but not limited to the implied warranties of merchantability and fitness for a particular purpose. Fulton shall in no event be liable for any consequential or incidental damages arising in any way, including but not limited to any loss of profits or business, even if the Fulton Companies has been advised of the possibility of such damages. Fulton's liability shall never exceed the amount paid for the original equipment found to be defective.

To activate the warranty for this product, the appropriate commissioning sheets must be completed and returned to the Fulton Quality Assurance department for review and approval.

Fulton

9/10/09

Section 6

Section 6 – Product Specs & Data

Fulton Fuel Fired Coil Design Thermal Fluid Heat Transfer Systems

1. General Description

a) Contractor shall furnish and install a_____ fired _____BTU/Hr. thermal fluid heat transfer system. The system shall be "Fulton" as manufactured by Fulton Thermal Corporation, Pulaski, New York.

b) The system shall be a complete package including a vertical coil design type heater; combination expansion deaerator thermal buffer tank to allow for expansion of thermal fluid during heat up to operating temperature and to prevent oxidation of the thermal fluid during operation, even when tank is vented to atmosphere; for operating temperatures up to 650°F complete with instrumentation and controls as specified in Section 3. Flanged inlet and outlet shall be located at front end of the unit.

2. Heater Size & Operating Temperature

a) The heater net input shall not exceed _____ BTU/Hr. while producing a minimum of _____ BTU/Hr. output as measured at the thermal fluid outlet. The heater shall be supplied complete with control panel and all required safety devices for a maximum operating temperature of _____°F (standard 650°F max). It shall have a flow rate of _____GPM and a motor voltage of _____ with a control voltage of _____.

3. Heater Design

a) The heater shall be of a vertical, helical coil self venting design, and the pressure vessel coil construction shall be carbon steel ASME SA106B, Schedule 40 or equal, with a design pressure of 200 PSI standard at 700°F. Heater will be per ASME Code Section I stamped at 150 PSIG MWP trimmed at 100 PSI unless otherwise specified. Test pressure will be per ASME Code Section I. Minimal refractory lining shall be supplied in heater combustion chamber to avoid thermal inertia and overheating of the thermal fluid should a pump or power failure occur. IT shall be completely factory piped, wired, and tested. Thermal efficiency shall be 85% or higher on fuel LHV.

b) The shell, coil and burner are surrounded by the preheater jacket. This jacket is steel welded construction with an integral floor plate, bolted top cover to facilitate coil removal, access panels for air chamber inspection and has an aluminum inner air baffle. This preheater obviates the requirement for insulation of the

heater and simultaneously boosts thermal efficiency by preheating incoming combustion air.

c) The following instrumentation/controls/safety devices shall be supplied as a minimum requirement:

1. High temperature safety switch interlock at heater outlet shutdown and alarm signal at terminal strip-Yokogawa
2. Heater operation interlock with circulation pump.
3. Low differential pressure switch to shut down the pump and heater due to a low flow condition - U.E.
4. Thermal fluid temperature control –Siemens
5. High System Pressure Switch for Complete Shutdown – Danfoss or Honeywell
6. Low System Pressure Switch for Complete Shutdown – Danfoss or Honeywell
7. Expansion Tank Low Level Switch for Shutdown - Square D
8. Heater Outlet Pressure Gauge - Ashcroft
9. Heater Inlet Pressure Gauge - Ashcroft
10. Pump Supply (Vacuum) Gauge - Ashcroft
11. Flame safety relay – Siemens
12. Magnetic starters for burner and pump motors
13. Three Position Selector Switch: off/pump on/heater on
14. Four Indicating Lights:
    1. Pressure & Flow
    2. Heat Demand
    3. Main Flame
    4. Alarm
15. ASME Certified Safety Relief Valve -Kunkle Model 920
16. Non-fused disconnect
17. Single source power connection

4. Burner

a) The burner shall be manufactured and matched to the heater by the heater manufacturer to fully assure single-source system responsibility. The burner shall be forced draft and shall be an integral part of the heater, but designed for easy removal and cleaning of the burner. Burner control method shall be On/Off, 3:1 modulation. Burner control shall be completely automatic, including flame supervision, fluid flow monitoring, and heater cycling.

5. Combination Expansion/Deaerator Thermal Buffer Tank Size

a) The combination expansion/deaerator thermal buffer tank shall have _____gallon capacity and be supplied complete with liquid level switch. It shall be suitable for a maximum total system fluid content of _____ gallons, including heater and expansion/deaerator tank capacities (based on a _____% expansion rate of the hot oil – to be verified by the client).

6. Combination Expansion/Deaerator Thermal Buffer Tank Design

a) The combination expansion/deaerator thermal buffer tank will be constructed of carbon steel. It shall be supplied with expansion tank liquid level switch and 300# ANSI flanged connections. The tank may be built to ASME Code Section VIII Division I upon request.

7. Thermal Fluid Circulating Pump Size

a) The thermal fluid circulating pump shall be air cooled with mechanical seal design for 650^{o}F maximum operating temperature, _____ GPM at _____ PSI, _____ HP Motor, _____ RPM motor, complete with motor starter, _____ voltage. Water cooled pumps will be supplied upon request or for operating temperatures above 650^{o} F.

8. Thermal Fluid Circulating Pump Design

a) The thermal fluid circulating pump shall be of centrifugal design, with a mechanical seal air cooled for temperatures up to 650°F or water cooled for operating temperatures above 650°F and shall be supplied complete with motor starter for proper motor HP, voltage and cycles.

9. Tests

a) Shall include a hydrostatic test of the pressure vessel in the presence of an inspector having a National Board Commission. He shall certify a Data Report which shall be delivered with the heater as evidence of ASME Code compliance. In addition to ASME symbol, the heater shall bear a National Board Registration Number.

b) Full electrical checks will be performed including testing of all controls and circuitry.

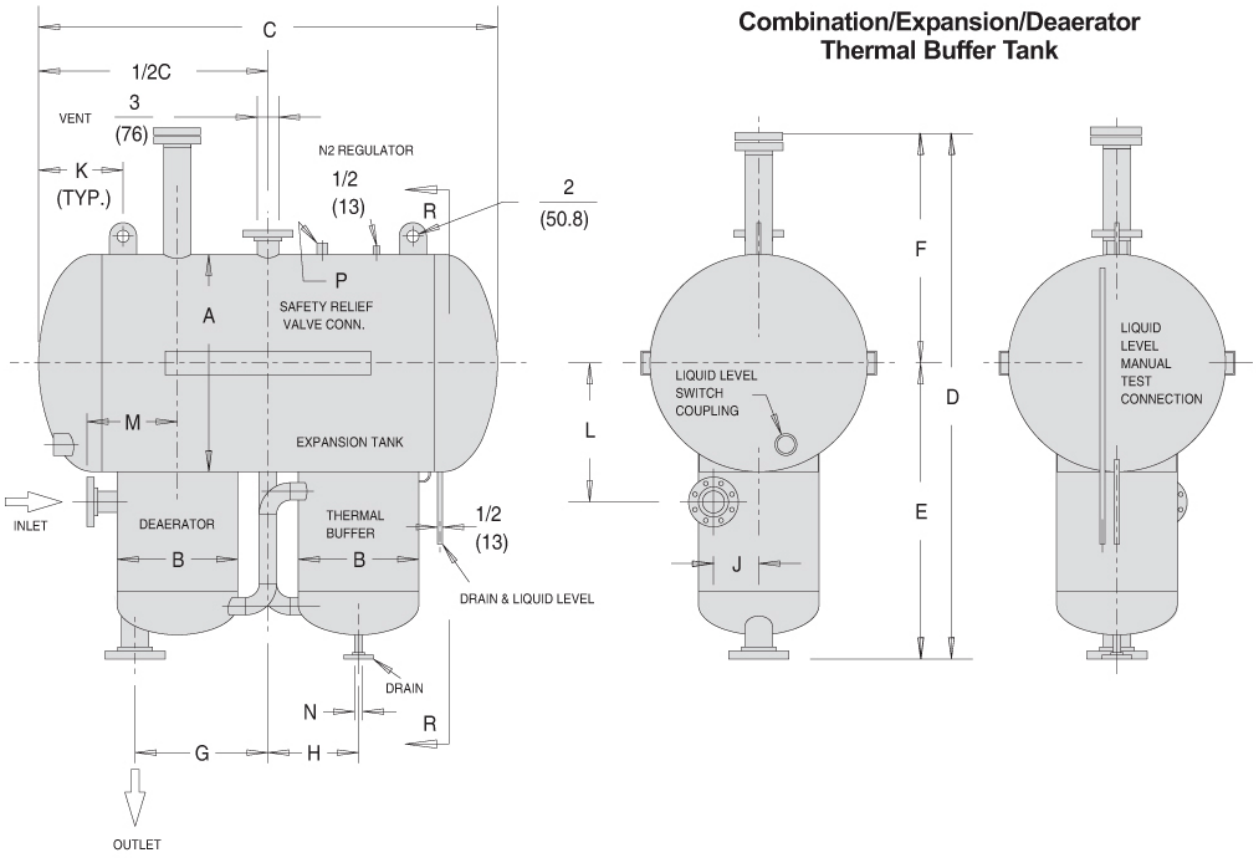
c) Test fire with combustion check.

10. Operating Manual

a) Instructions for installation, operation, and maintenance of the heat transfer system shall be contained in a manual provided with each unit.

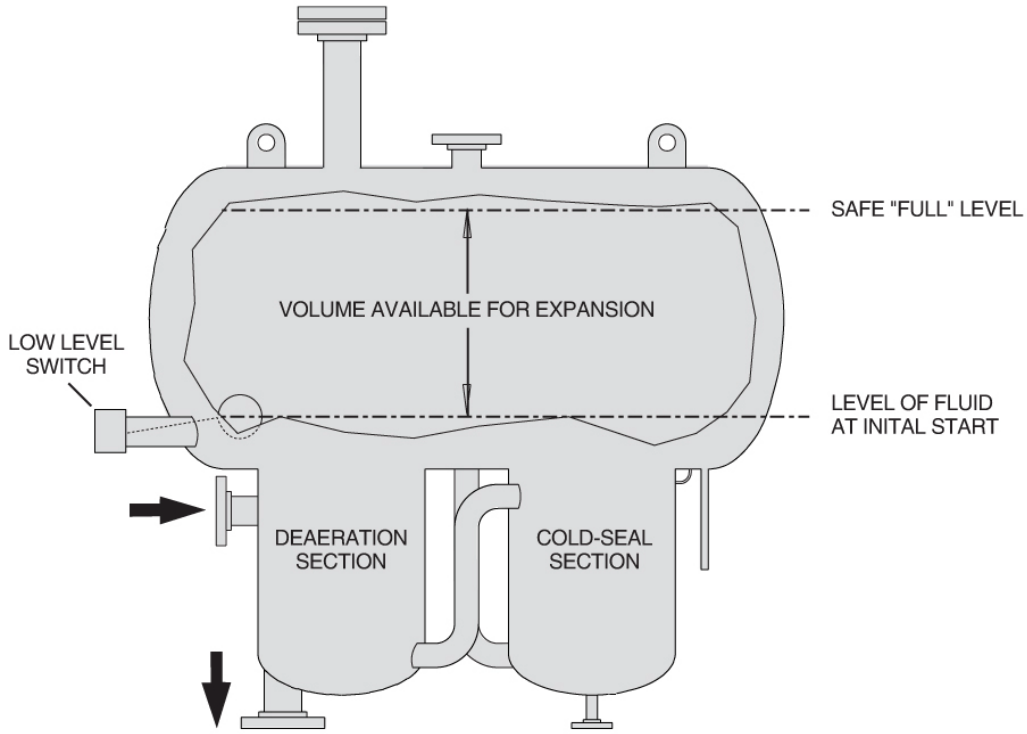
b) A complete wiring diagram, corresponding to the equipment supplied, shall be part of the manual and one shall also be affixed to the inside of the heater's panel box.

Dimensions and Sizing Instructions of the Fulton Combination Expansion/Deaerator/Thermal Buffer Tank Models FT-200-L to FT-5000-L



MODEL	A	B	C	D	E	F	G (Ref)	H	J (Ref)	K	L	M	N	P	CAP.	Dry Wt.	Max Full Wt.
FT-0200-L	20 (510)	12¾ (325)	54 (1370)	60⅝ (1540)	34 (865)	26⅝ (676)	16 1/16 (424)	12 (305)	4½ (115)	4¼ (108)	15 (380)	12 15/16 (329)	¾ (20)	¾ (20)	52 (200)	636 (289)	1314 (596)
FT-0500-L	26 (660)	16 (405)	74 (1880)	66⅝ (1692)	37 (940)	29⅝ (752)	19¾ (502)	14 (355)	6 (150)	11½ (290)	18 (460)	14 15/16 (379)	¾ (20)	¾ (20)	132 (500)	970 (440)	2450 (1111)
FT-1000-L	36 (915)	20 (510)	76 (1930)	87⅝ (2226)	49 (1245)	38⅝ (981)	22¼ (565)	15 (380)	7 1/16 (202)	14 (355)	24 (610)	14 15/16 (379)	1 (25)	1 (25)	264 (1000)	1350 (612)	4380 (1987)
FT-1500-L	36 (915)	20 (510)	106 (2690)	87 (2210)	49 (1245)	38⅝ (981)	24¾ (629)	17½ (445)	8 (203)	14 (355)	24 (610)	14 15/16 (379)	1 (25)	1¼ (32)	397 (1500)	1710 (776)	5875 (2667)
FT-2000-L	42 (1070)	22 (560)	106 (2690)	107⅝ (2734)	62½ (1590)	45⅛ (1146)	31 1/16 (792)	24 (610)	8½ (216)	15½ (394)	28 (710)	14 15/16 (379)	1 (25)	1½ (38)	528 (2000)	2550 (1134)	8230 (3733)
FT-3000-L	42 (1070)	26 (660)	140 (3556)	115⅛ (2924)	70 (1778)	45⅛ (1146)	33 3/16 (843)	24 (610)	9 15/16 (252)	15½ (394)	28 (710)	18 15/16 (481	1 (25)	1½ (38)	793 (3000)	3200 (1451)	11,610 (5265)
FT-5000-L	60 (1524)	26 (660)	130⅜ (3312)	132⅛ (3356)	77½ (1969)	54⅝ (1387)	32 1/16 (818)	24 (610)	9⅜ (238)	20⅝ (524)	37 (940)	18 15/16 (481)	1 (25)	1½ (38)	1321 (5000)	5300 (1637)	17,370 (7895)

Inlet and outlet dimensions vary with installation. All dimension are approximate. Specifications subject to change without notice.
Dimensions given in inches and (MM)
Capacities given in gallons and (LITERS)
Weights given in pounds and (KG)



Developed specifically for thermal fluid system use, the Fulton Combination/Deaerator/Expansion/Thermal Buffer Tank is a patented design. The unique combination of the operation of these three vessels in one results in numerous advantages including: pipework simplification, protection of thermal fluid from oxidation, ease of installation, and continuous deaeration of fluid, avoiding pump cavitation.

Expansion Section:

The expansion section is vital to the thermal fluid system. From ambient to operating temperature, the thermal fluid in the system will typically expand in the range of 30%, and a vessel capable of handling this expansion is mandatory. Additional expansion section features include a liquid level switch and manual fluid levels test connections. In the event of system fluid loss, the level in the expansion section of the combination tank will drop, and the liquid level switch will shut the unit down. Manual low and high fluid level test connections are always provided.

Deaerator Section:

At start up the primary purpose of the deaerator section is to remove all volatiles from the system to avoid pump cavitation. The deaerator section also allows oxygen to be vented from the system on a continuous basis during operation to avoid oxidation of the thermal fluid, and removes other volatile particles generated by the fluid itself during system operation.

Thermal Buffer Section:

A system of interconnecting pipework in the thermal buffer tank section prevents the movement of any oil, that has not cooled sufficiently, into the expansion section. This avoids contact of very high thermal fluid temperature with oxygen contained in the atmosphere.

Sizing the Tank for the System:

Expansion tank capacity is the total volume of the tank. It is necessary to have some air space available at the tope of the tank to avoid spillage or overflow.

At initial fill (for system volume calculations) the deaerator and cold seal sections must be filled completely, and the expansion section must be filled to a level of 4" to "make" the low level switch.

The volume between the initial fill level and the safe "full" level is the amount available for expansion. That volume is used to decide which tank is suitable for the system expansion.

Model	Capacity (Gallons)	Initial Fill (Gallons)	Available for Expansion (Gallons)	Max System Volume
FT-100-L	35	9	25	100
FT-200-L	52	25	46	184
FT-1000-L	264	80	232	1000
FT-1500-L	397	90	380	1400
FT-2000-L	528	145	444	1700
FT-3000-L	793	215	717	2600
FT-5000-L	1310	300	1168	4600

Example: A System contains 175 gallons, including the heater, but not the tank. You select the FT-200-L, so you add 25 gallons to 175. You must look up the expansion rate for the thermal fluid. (Assume it's 25%). 200 gal. x 1.25=250 gal. 250-200=50 gal. expansion. The FT-200-L has only 46 gal. available for expansion, so the correct selection is FT-500-L.

Specifications-Coil Design Thermal Fluid Heater

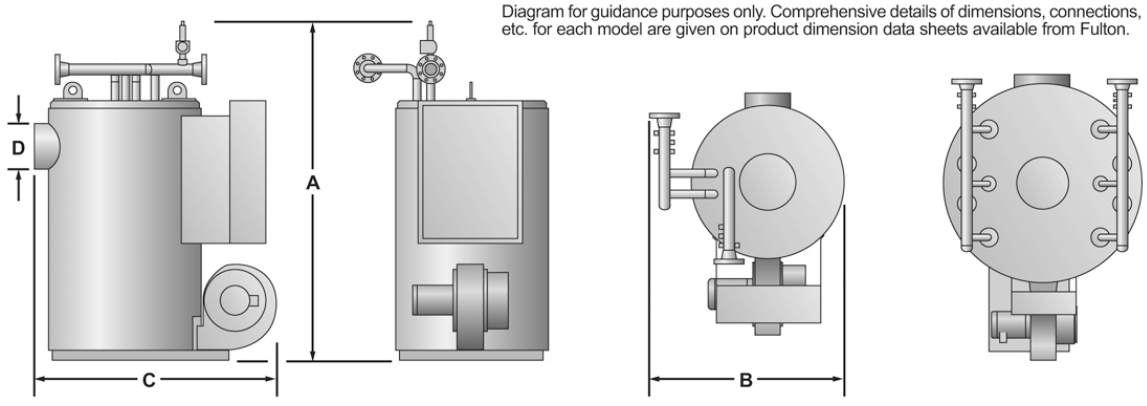
Model FT-C	0080	0120	0160	0240	0320	0400	0600	0800	1000	1200	1400
Heat Output											
1000 BTU/HR	800	1,200	1,600	2,400	3,200	4,000	6,000	8,000	10,000	12,000	14,000
1000 KCAL/HR	200	300	400	600	800	1,000	1,500	2,000	2,500	3,000	3,500
Thermal Fluid Content											
GAL	10	21	19	31	68	76	132	171	290	383	460
LITERS	38	80	72	116	258	288	498	648	1,097	1,448	1,741
Recommended Flow Rate											
GPM	50	75	100	150	250	250	375	500	615	730	800
M3/HR	11.4	17	22.7	34	56.8	56.8	85.2	113.6	139	167	182
Typical Circulating Pump Motor											
HP	10	10	15	15	20	20	30	40	50	50	60
KW	7.5	7.5	11.2	11.2	14.9	14.9	22.5	29.5	37.3	37.3	45
Typical Burner Motor											
HP	1.5	3	3	3	5	5	7.5	15	15	20	20
KW	1.1	2.2	2.2	2.2	3.7	3.7	5.6	11.2	11.2	15	15
Fuel Consumption @ Full Output No.2 Oil											
GPH	7.1	10.7	14.3	21.4	28	35.3	53	69.7	87.1	104.5	122
LITER/HR	27	40.6	54.1	81	108.8	136	201	263.7	329.6	395.5	461.5
Natural Gas											
FT3/HR	998	1,498	1,998	2,999	4,000	4,997	7,498	9,997	12,496	14,998	17,500
M3/HR	38.3	42.4	56.5	84.9	113.2	141.5	212.3	283	353.8	424.6	495.5

- Voltage 3 Phase for Burner and Pump - Each unit has an incorporated stepdown transformer.
- Fuel up to No. 6 Oil Available for Large Units.
- Efficiency up to 80% Minimum Based on High Heating Value of the Fuel (No. 2 Oil @ 140,000 BTU/GHHV; Natural Gas @ 1000 BTU/ft3HHV.
- Modulation 3 to 1 Turn Down Ratio. Optional on FT-0080, 0120, and 0160-Standard on all others.
- Circulating pump motor sizes based on standard pressure (55 PSIG) and viscosity 1 cs, specific gravity 0.7, with 25-37 PSID available head for installation.

Dimensions-Coil Design Thermal Fluid Heater

Model FT-C	0080	0120	0160	0240	0320	0400	0600	0800	1000	1200	1400
Heater Inlet/Outlet Connections											
IN	1.25	5	2	2.51	3	3	4	4	6	6	6
MM	32	38	51	64	76.3	76	102	102	152	152	152
(A) Overall Height											
IN	73.7	80.7	80.6	89.7	100.6	112.4	143.6	143	146.5	146.4	163.1
MM	1,872	2,050	2,046	2,278	2,556	2,856	3,648	3,632	3,721	3,718	4,144
(B) Overall Width											
IN	31.6	34.4	45.9	50.1	49.3	49.3	63.4	70.5	95	108.4	108.4
MM	803	873	1,165	1,273	1,252	1,252	1,611	1,791	2,413	2,753	2,753
(C) Overall Depth											
IN	46.2	60.6	60.6	66.6	80.6	80.6	88.1	107.75	135.1	152.9	152.9
MM	1,173	1,540	1,540	1,691	2,046	2,046	2,237	2,736	3,432	3,882	3,882
(D) Flue Outlet Diameter											
IN	10	10	10	12	14	14	18	20	20	22	22
MM	254	254	254	305	356	356	457	508	508	559	559
Recommended Vertical Stack Diameter											
IN	10	12	12	14	18	18	22	24	24	26	26
MM	254	304	304	356	457	457	558	609	609	661	661
Approximate Dry Weight											
LB	1,500	2,100	2,550	3,400	5,300	5,300	8,250	11,450	19,250	21,700	23,000
KG	700	950	1,150	1,550	2,400	2,400	3.750	5,200	8,750	9,850	10,455

Diagram for guidance purposes only. Comprehensive details of dimensions, connections, etc. for each model are given on product dimension data sheets available from Fulton.



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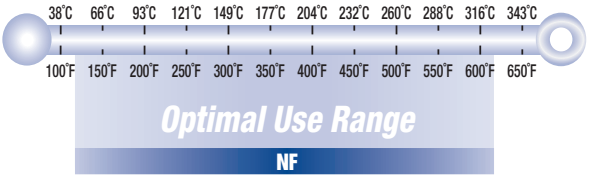
Paratherm-NF®

Heat Transfer Fluid



Food Grade ***Low Viscosity for Easy Start Up*** **Operation to 600°F** ENGINEERING BULLETIN NF 809

The Paratherm **NF**® Heat Transfer Fluid is a food grade, mineral-oil based heat transfer fluid designed for extended trouble-free service in closed-loop liquid-phase systems up to 600°F in fuel-fired heaters and 630°F in electric immersion heaters.

Applications include:

- Chemical reactors
- Food processing
- Portable electric temperature control units
- Electric heaters

Typical Properties*

Product Name	Paratherm NF
Chemical Name	Hydrotreated Mineral Oil
Appearance	Water White Liquid
Odor	Odorless
Maximum Recommended Film Temperature	650ºF/343ºC
Maximum Recommended OperatingTemperature - Fired Heaters	600ºF/316ºC
Maximum Recommended Operating Temperature - All Others	630ºF/332ºC
Minimum Operating Temperature 20 cPs (20 mPa-s)	96ºF/36ºC
Minimum Start-up Temperature 300 cPs (300 mPa-s)	23ºF/-5ºC
Viscosity at 60ºF/15.5ºC cSt (mm^2/sec)	64
Density at 60ºF/15.5ºC lb/gal (kg/m^3)	7.4 (886)
Flash Point Cleveland Open Cup (D92)	340ºF/171ºC
Flash Point Pensky-Martens Closed Cup (D93)	315ºF/157ºC
Vapor Pressure @ maximum operating temperature (600ºF/316ºC) psia (kPa)	2.0 (13.8)
Average Volume Expansion, %/100˚F (100°C)	5.5 (9.9)
Average Molecular Weight	340
Dielectric Breakdown Voltage D1816-04 (kV, 0.1" gap)	34.37
Dielectric Constant (1 KHz) D924-04	2.183
Dissipation Factor (1 KHz) D924-04	0.000003
Volume Resistivity at 100V (Ω-cm) D257-07	$3.40X10^{14}$
Heat of Combustion (approximate) BTU/lb (kJ/kg)	20,000 (46,300)
Heat of Vaporization (approximate) BTU/lb (kJ/kg)	91 (210)
Pour point D97	<-40ºF/-40ºC

** These are typical laboratory values, and are not guaranteed for all samples.*

Food grade means less maintenance

The food grade level of quality is not only important for food processing, it also makes Paratherm **NF** Heat Transfer Fluid one of the lowest maintenance fluids on the market. Impurities that naturally occur in crude oil (such as asphaltenes and sulfur compounds) tend to break down first in the heater and, if severely overheated, can form coke deposits on the heater surfaces. The extensive refining process that makes Paratherm **NF** food grade removes these impurities so degradation-induced maintenance is reduced.

Low viscosity promotes fast startups

Liquid-phase systems should be brought up to temperature slowly until the fluid is in fully turbulent flow. This prevents localized fluid overheating. Once viscosity decreases enough that turbulent flow is achieved, the outlet temperature can be increased as fast as the equipment can handle. The lower the temperature when that transition occurs, the faster the system will reach operating temperature. Paratherm **NF** has the lowest viscosity range of any mineral-oil based fluid.

High heat transfer coefficients extend fluid life

In heat transfer fluids, the most important advantage of a high heat transfer coefficient is that it reduces the heater surface temperature required to achieve set-point temperature. Lower temperature means less thermal degradation which means longer life. Paratherm **NF** has the highest heat transfer coefficient of any mineral oil based fluid.

Fluid storage

Drums should be stored inside to prevent water from getting into the heat transfer fluid. If sealed drums must be left outdoors, they should be stored on their sides. While unopened totes are weatherproof, they should not be stacked if left outdoors. If the fluid is to be stored outside below its minimum pumpable temperature, the containers should be moved indoors to warm up before charging the fluid into the system.

Replacing existing fluid

In many cases, changing fluid involves a straightforward drain and fill. There are very few fluids that are so incompatible that 10-15% residue will affect the new Paratherm. If you have any questions, contact us.

Charging new systems

Unless required for product quality reasons, new systems do not need to be cleaned before Paratherm is charged. The amount of chemical coatings, oils, and other manufacturing residues are usually not enough to affect the fluid life. All that is necessary is to install a Y-strainer with a minimum 60 mesh screen up stream of the pump to catch any metal or welding residue. The screen can be removed once the system has been cycled twice through its operating temperature.

Fluid analysis

The fluid in new systems should be tested within 9 to 12 months of start-up. New fluid in existing systems should be tested within the first month of operation to establish a base line for future testing.

Paratherm Corporation
HEAT TRANSFER FLUIDS

4 Portland Road,
West Conshohocken PA 19428 USA
Phone: 610-941-4900
Fax: 610-941-9191
800-222-3611
E-mail: info@paratherm.com
Web: www.paratherm.com

Paratherm NF® Heat Transfer Fluid

Physical Properties

		Viscosity			Density			Thermal Conductivity	Specific Heat	Vapor Pressure	
˚F	˚C	cSt	cPs	lb/ft-hr	lb/ft³	lb/gal	g/cc	BTU/(hr-ft-˚F)	BTU/lb-˚F	mm Hg	psia
0	-18	1095	995	2408	56.8	7.6	0.909	0.062	0.39		
25	-4	295	265	641	56.2	7.5	0.900	0.062	0.41		
50	10	93	83	201	55.6	7.4	0.890	0.061	0.42		
75	24	36	32	77	55.0	7.4	0.881	0.061	0.44		
100	38	18	16	39	54.5	7.3	0.872	0.060	0.46		
125	52	11	9.4	23	53.9	7.2	0.863	0.060	0.48		
150	66	7.0	6.0	15	53.3	7.1	0.854	0.059	0.49		
175	79	5.0	4.2	10	52.7	7.1	0.844	0.059	0.51		
200	93	3.9	3.2	7.8	52.2	7.0	0.835	0.058	0.53	1.5	
225	107	3.1	2.6	6.2	51.6	6.9	0.826	0.058	0.55	2.4	
250	121	2.7	2.2	5.3	51.0	6.8	0.817	0.058	0.56	3.6	
275	135	2.4	1.9	4.6	50.5	6.7	0.808	0.057	0.58	5.2	0.10
300	149	2.0	1.6	3.8	49.9	6.7	0.799	0.057	0.60	7.3	0.14
325	163	1.7	1.4	3.3	49.3	6.6	0.789	0.056	0.62	9.9	0.19
350	177	1.5	1.2	2.8	48.7	6.5	0.780	0.056	0.63	13	0.26
375	191	1.2	0.92	2.2	48.2	6.4	0.771	0.055	0.65	17	0.33
400	204	1.04	0.79	1.9	47.6	6.4	0.762	0.055	0.67	22	0.43
425	218	0.83	0.63	1.5	47.0	6.3	0.753	0.055	0.69	28	0.54
450	232	0.71	0.53	1.3	46.4	6.2	0.744	0.054	0.70	35	0.67
475	246	0.59	0.43	1.0	45.9	6.1	0.734	0.054	0.72	43	0.83
500	260	0.49	0.35	0.85	45.3	6.1	0.725	0.053	0.74	52	1.0
525	274	0.41	0.29	0.70	44.7	6.0	0.716	0.053	0.76	63	1.2
550	288	0.34	0.24	0.58	44.1	5.9	0.707	0.053	0.77	76	1.5
575	302	0.27	0.19	0.46	43.6	5.8	0.698	0.052	0.79	90	1.7
600	316	0.23	0.16	0.38	43.0	5.7	0.689	0.052	0.81	106	2.0
625	329	0.19	0.13	0.32	42.4	5.7	0.679	0.052	0.83	124	2.4
650	343	0.16	0.11	0.27	41.9	5.6	0.670	0.051	0.84	144	2.8

Note: The information and recommendations in this literature are made in good faith and are believed to be correct as of the below date. You, the user or specifier, should independently determine the suitability and fitness of Paratherm heat transfer fluids for use in your specific application. We warrant that the fluids conform to the specifications in Paratherm literature. Because we have no control over the fluid's end use or the conditions under which it will be used, we make no other warranties—expressed or implied, including the warranties of merchantability or fitness for a particular use or purpose (recommendations in this bulletin are not intended nor should be construed as approval to infringe on any existing patent). The user's exclusive remedy, and Paratherm's sole liability is limited to refund of the purchase price or replacement of any product proven to be otherwise than as warranted. Paratherm Corporation will not be liable for incidental or consequential damages of any kind.

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Fulton FT 1200-C Thermal Heating Unit Spare Parts List

FT-1200-C with Siemens LMV Programmer

The following is a basic recommended spare parts list for a Fulton Thermal Model **FT-1200-C**, **Gas Fired**, **Modulated**, with **Infrared Scanner**.

Part #	**Description**	**Qty.**
2-40-437	AZL Display Module	1
2-40-449	Siemens LMV 51	1
2-40-434	Gas Butterfly Servo	1
2-40-433	Air Gate Servo	1
2-40-465	Infrared Scanner	1
2-12-250	Burner Tile Refractory	1
2-40-862	Temperature limit	1
2-45-381	3 Amp FNQ fuse	2
2-45-365	8 Amp KTKR fuse	1
2-45-263	35 Amp LPJ fuse	3
2-45-270	125 Amp LPJ fuse	3
2-40-441	.75KVA Stepdown Transformer	1
2-40-082	6KV Ignition Transformer	1

Fulton FT 1200 C Air Cooled Pump Spare Parts List

Recommended Spare Parts for RA 3000 3 x 4 x 8 ½ Air Cooled Pump

P/N	Description	Qty
2-30-2004	RA 3000 3 x 4 x 8 ½	1
2-30-2221	Mechanical Seal Gland (#13)	1
2-30-2227	Snap Ring (#75)	1
2-30-2228	Grease Seal – front (#76)	1
2-30-2229	Grease Seal – rear (#76A)	1
2-30-2230	Bearing End Cover Gasket (#77B)	1
2-30-2231	Mechanical Seal (#95 A/B)	1
2-30-2232	Radial Bearing Cartridge	1
2-30-2233	Seal Gland Gasket (#325)	1
2-30-2234	Seal Gland Gasket (#325A)	1
2-30-2237	Impeller (#3) (trim to 7 1/2”)	1
2-30-2239	Casing Gasket (#77)	2
2-30-2240	Grease (6322595)	1

Fulton FT 1200 C Pump Performance Data

Therma-Flite

MET PRO CORPORATION

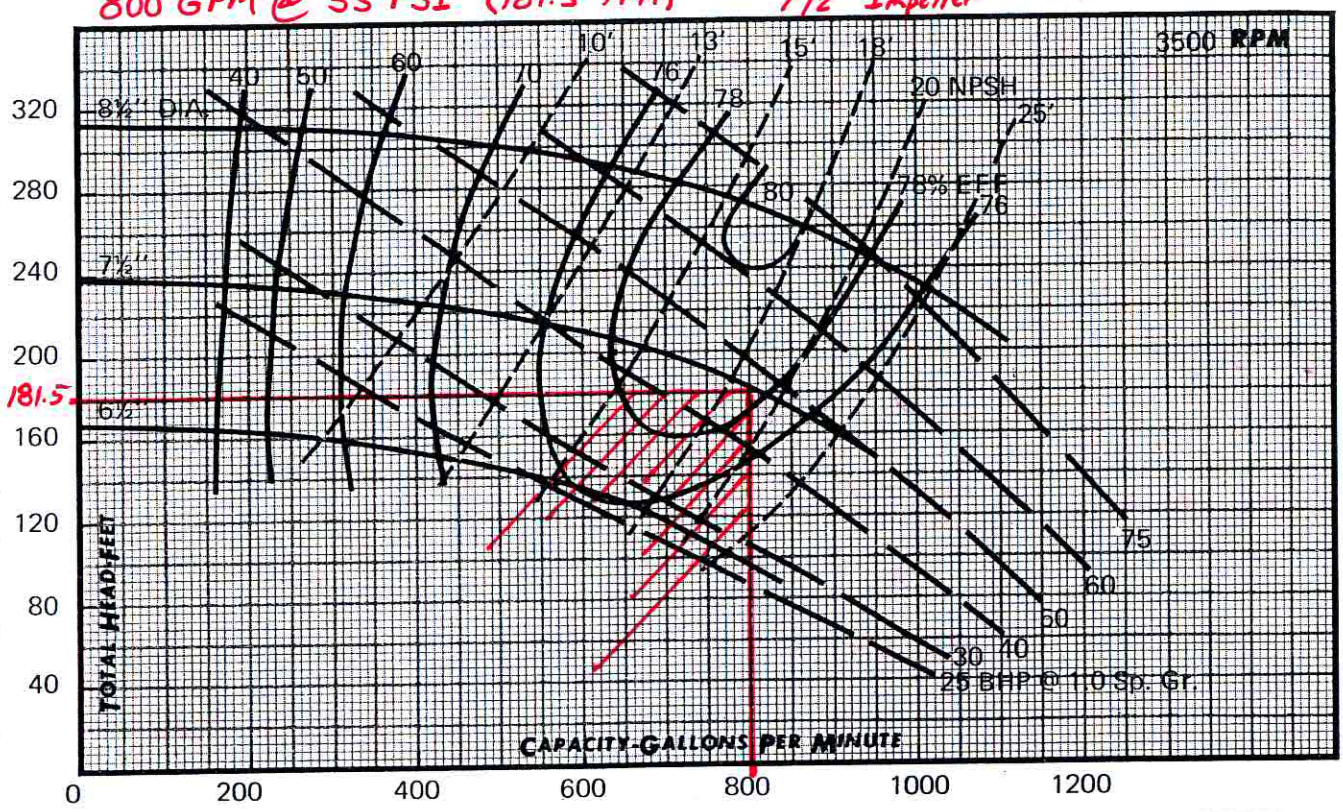
Dean Pump Division

P.O. BOX 68172, INDIANAPOLIS, IN 46268-0172, (317) 293-2930, FAX: (317) 297-7028

CENTRIFUGAL PUMP PERFORMANCE DATA: CURVE R 4085-A1
PUMP SIZE: 4" X 6" X 8½"
PUMP TYPE: R 434, RA 3146, R 5144

800 GPM @ 55 PSI (181.5 TFH) 7½" Impeller

4" DISCHARGE X 6" SUCTION

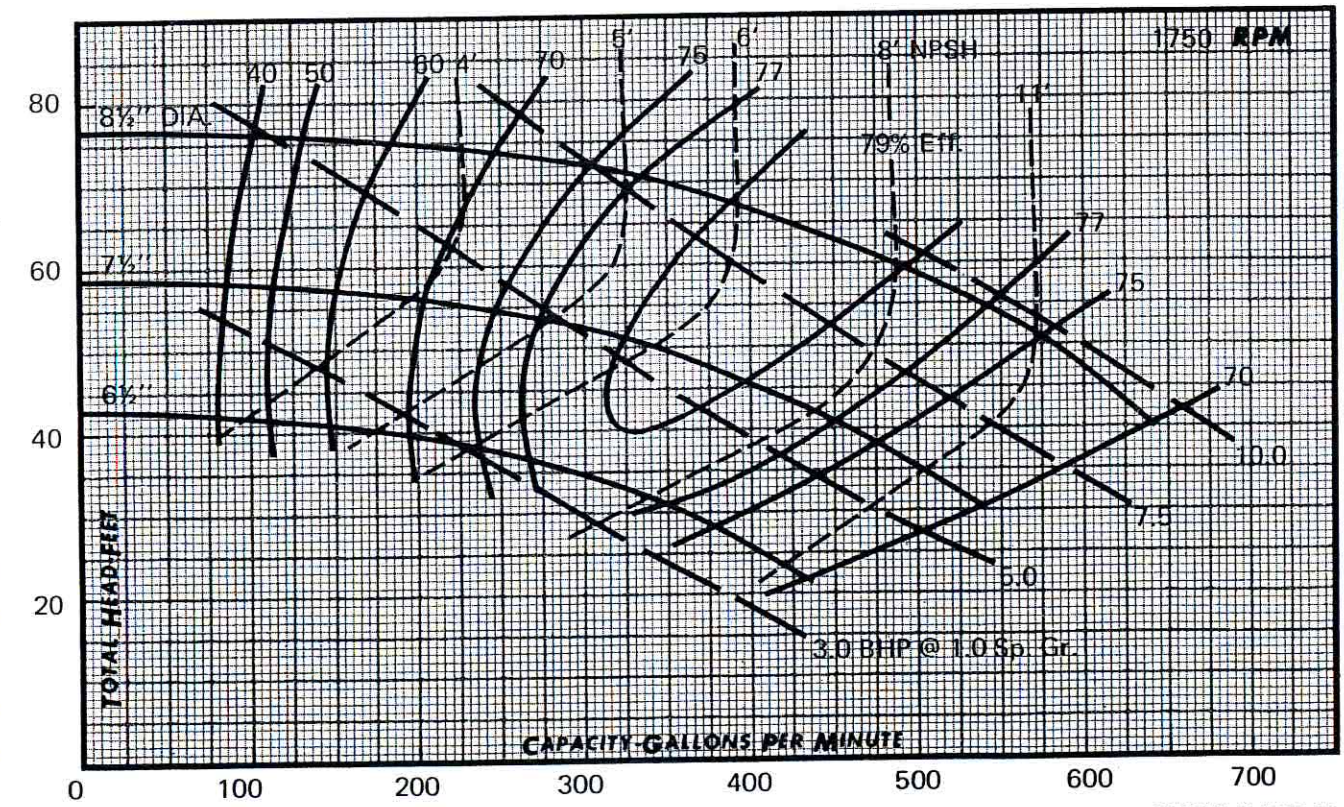


60 H.P. Motor

CUSTOMER _____

CUSTOMER'S ORDER No. _____ ITEM No. _____

DEAN PUMP SERIAL No. _____ FACTORY ORDER No. _____



CURVE R 4085-A1

PUMP PERFORMANCE: This curve, based on extensive tests, defines the average performance of this pump for liquids having a viscosity of 70 SSU or less. Actual performance of individual units may differ slightly from the performance indicated on this curve. Pump applications made from the data contained herein are subject to confirmation and acceptance by our Engineering Department at our Indianapolis Office.

$$\text{Hydrolic H.P.} = \frac{(\text{PSI})\ 55 \times (\text{GPM})\ 800 \times 2.31}{3960} = 25.6$$

$$\text{Corrected Hydrolic H.P.} = \frac{25.66}{.6} = 42.77$$

$$\text{Motor Break H.P.} = \frac{42.77}{.78} = 54.84$$

Pump Eff.

60 H.P. Motor

Fulton FT 1200 C Blower Performance Data

The New York Blower Company

Fan-to-Size
Fan Selection Data

Project:	
Location:	
Contact:	

Fan Design

Product:	Pressure Blower	Arrangement:	9
Size/Model:	2310S	Drive type:	Belt
Wheel Type:	Steel		
Wheel Material:	Mild Steel		
Wheel Width:	100.0 %	Wheel Diameter:	100.0 %

Operating Conditions

Volume Flow Rate:	3,500 CFM	Fan Speed:	3264 rpm
Fan Static Pressure:	25.0 in wg	Fan Input Power:	20.9 bhp
Outlet Velocity:	6422 ft/min	VP/SP ratio:	0.0757
Altitude (above mean sea level):	0 ft	Operating Temperature:	262 Deg F
Operating Inlet Airstream Density:	0.0551 lb/ft3		
Static Efficiency:	65.96%	Mechanical Efficiency:	70.96%
Maximum Operating Temperature:	262 Deg F	Maximum Safe Operating Speed:	3800 rpm

Operating cost is $3,415.02 for 2080 hours with a 90% efficient motor when energy unit cost per kW-hr is 0.095

Standard Conditions

Volume Flow Rate:	3,500 CFM	Fan Speed:	3264 rpm
Fan Static Pressure:	34.0 in wg	Fan Input Power:	28.4 bhp
Density at Mean Sea Level :	0.0750 lb/ft3	Max. Safe Speed at 70 Deg F:	3800 rpm

Sound Power Level Ratings Levels expressed in dB (power levels reference 10^(-12) watts)

Center Frequency (Hz):	**63**	**125**	**250**	**500**	**1000**	**2000**	**4000**	**8000**	
Octave Bands:	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**Overall**
Total Fan Power Levels*:	97.2	100.2	102.6	99.9	97.2	95.4	90.9	86.7	107.3
Inlet Power Levels**:	94.2	97.2	99.6	96.9	94.2	92.4	87.9	83.7	104.3
Outlet Power Levels**:	94.2	97.2	99.6	96.9	94.2	92.4	87.9	83.7	104.3

*As corrected for point of operation (location on fan curve)
**Unsilenced Inlet and Outlet power ratings are 3 dB lower than total fan power levels under the assumption that "half" of the sound power can be attributed to each opening. Silenced power ratings include this 3 dB reduction as well as the silencer attenuation.

Estimated Sound Pressure Levels Expressed in dB (pressure levels reference $2x10^{-7}$ microbar)

Directivity/Reflection Factor (Q) is 1, spherical radiation; Distance is 5 ft.; A-weighting is in use.

The estimated sound pressure level outside the fan due to an open inlet OR outlet is 85.4 dBA at 5.0 feet. The estimated sound pressure level outside the fan when BOTH inlet and outlet are ducted is 73.5 dBA at 5.0 feet (Housing Radiated Noise).

Your Representative:
R J Wondrack Company
300 Stoutenger Street
East Syracuse, NY 13057
Phone: (315) 437-4440
Fax: (315) 437-9783
E-Mail: chris.clarkson@wondrack.com

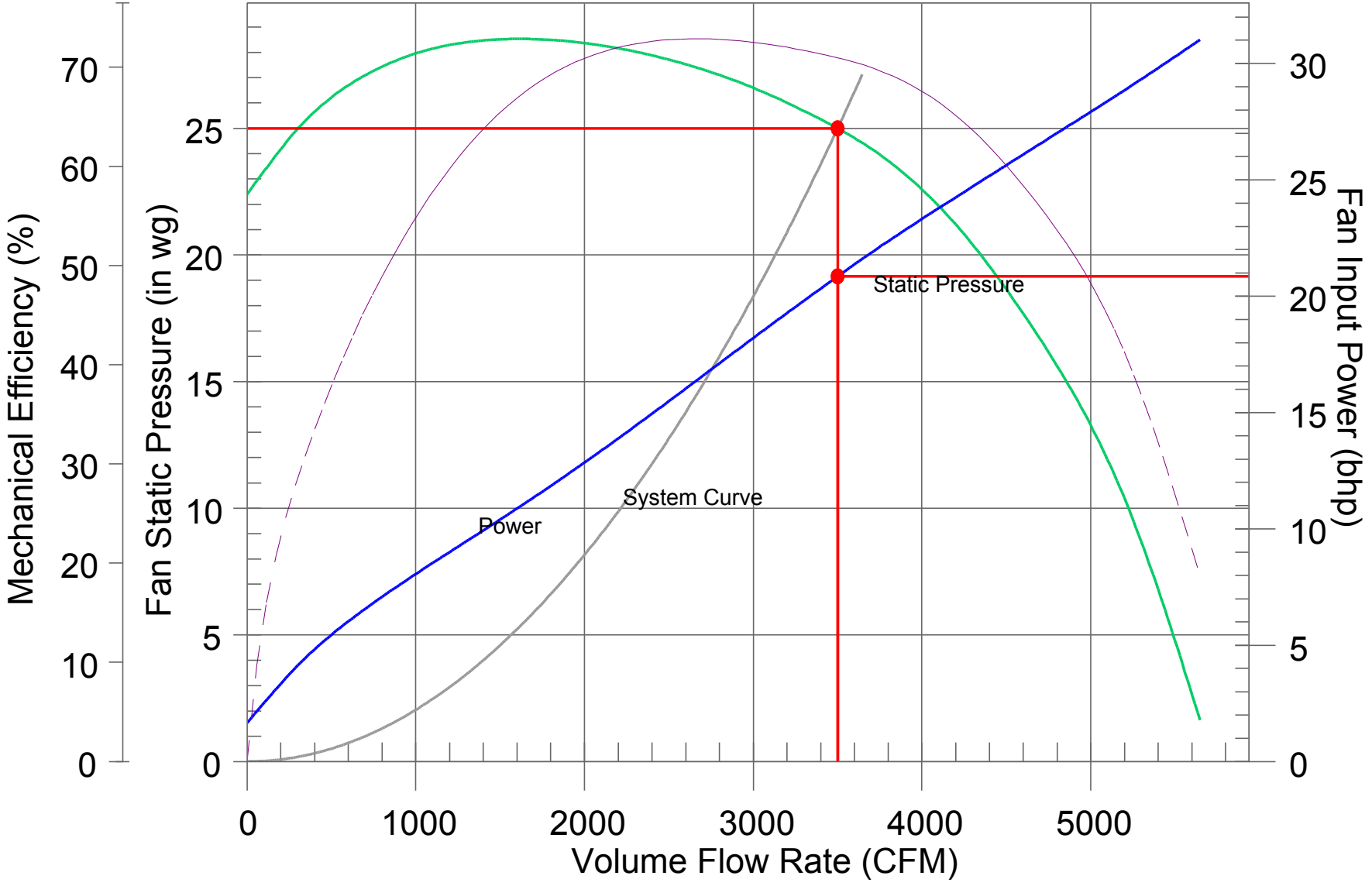
The New York Blower Company

Fan-to-Size

Pressure Blower
2310 Steel
Arr.: 9

Volume Flow Rate: 3,500 CFM
Fan Static Press.: 25.0 in wg
Speed: 3264 rpm
Power: 20.9 bhp

Temp.: 262 Deg F
Altitude: 0 ft
Density: 0.0551 lb/ft3
Outlet Velocity: 6422 ft/min



Customer:
Fulton Companies
Therma-Flite

[v1.77.30-R -- October 2007] Date Printed: 4/4/2010
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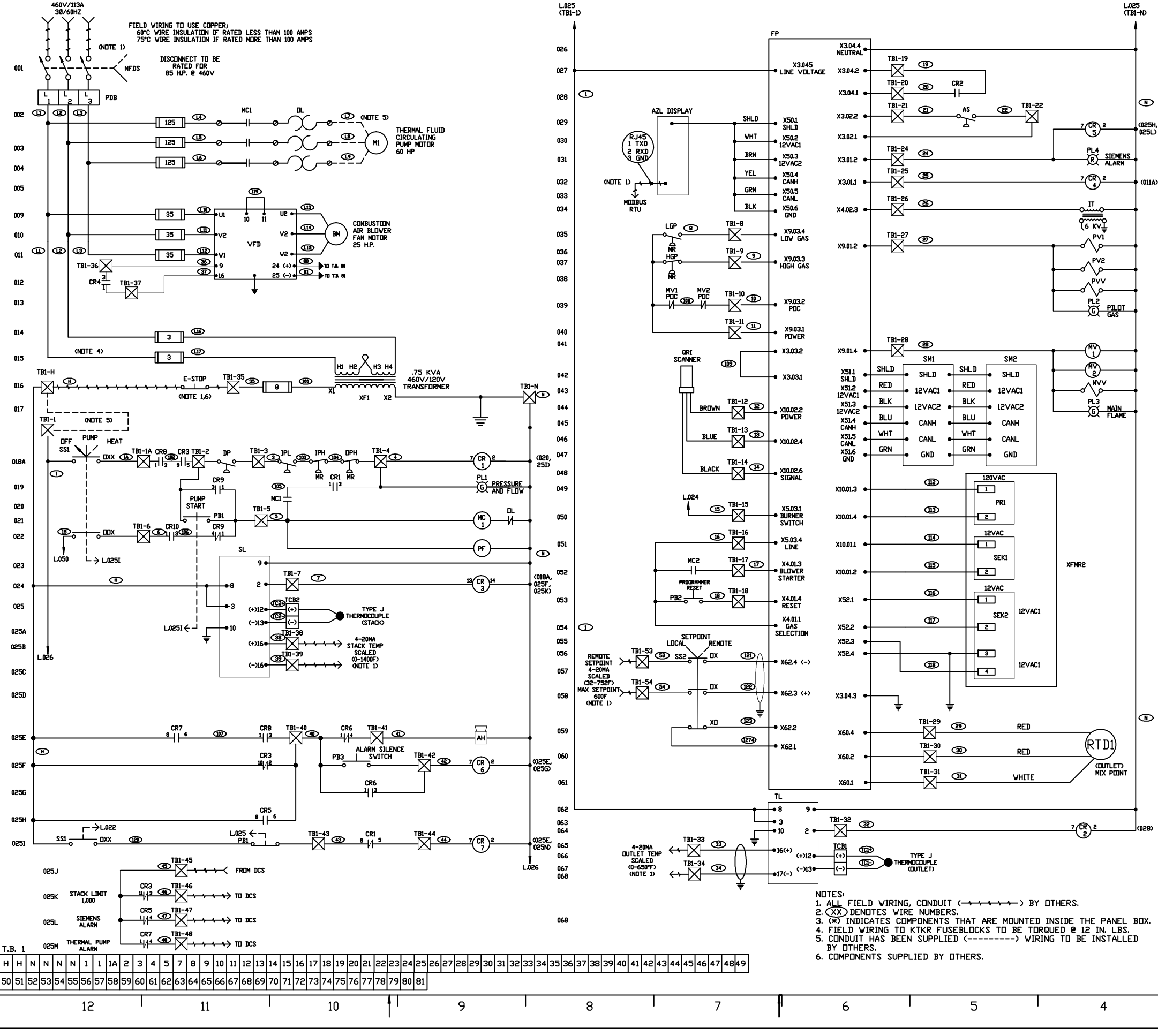
Your Sales Representative:
R J Wondrack Company
Phone: (315) 437-4440

Fulton FT 1200C Electrical Schematic Drawing T53DR-1834 Sheet 1 of 2



BILL OF MATERIALS

ITEM	COMPONENT P/N	DESCRIPTION	DEV ID	UOM
1#	2-40-000096	8-PIN RELAY BASE	-	9 EA.
2#	2-40-000131	ICE CUBE CONTROL RELAYS	CR1,2,4-10	9 EA.
3#	2-40-000430	SIEMENS DISPLAY CABLE	-	1 EA.
4#	2-45-000244	3 POLE CLASS J FUSEBLOCK, 60A	-	1 EA.
5	2-40-000837	RTD 6" SPRING LOADED	RTD1	1 EA.
6#	2-40-000437	AZL DISPLAY MODULE	DM	1 EA.
7#	2-40-000449	SIEMENS LMV 51	FP	1 EA.
8	2-40-000465	INFRARED SCANNER	-	1 EA.
9	2-40-000434	GAS BUTTERFLY SERVO SQM45	SM1	1 EA.
10	2-30-000529	GAUGE 0-100 PSI	-	1 EA.
11	2-30-000530	GAUGE 0-200 PSI	-	1 EA.
12#	2-40-000429	PLUG SET	-	1 EA.
13	5-21-000273	GAUGE PANEL PLATE	-	1 EA.
14	2-40-000082	6KV IGNITION TRANSFORMER	IT	1 EA.
15	----------	MAIN GAS VALVE	MV1,2	2 EA.
16	----------	MAIN VALVE PROOF OF CLOSURE	POC1,2	2 EA.
17	----------	PILOT GAS VALVE	PV1,2	2 EA.
18#	2-45-000412	GREEN PILOT LIGHT	PL1-3	3 EA.
19#	2-45-000212	3-POS SELECTOR SWITCH	SS1	1 EA.
20#	2-40-000791	PUMP START PUSHBUTTON	PB1	1 EA.
21#	2-45-000411	RED PILOT LIGHT	PL4	1 EA.
22	2-40-000637	CIRCULATION PUMP MOTOR CONTACTOR	MC1	1 EA.
23	2-40-000656	CIRCULATION PUMP MOTOR OVERLOAD	OL	1 EA.
24	2-40-003040	HIGH INLET/OUTLET PRESSURE SWITCH	DPH,IPH	2 EA.
25	----------	LIQUID LEVEL SWITCH	LLS	1 EA.
26	2-40-003041	LOW INLET PRESSURE SWITCH	IPL	1 EA.
27	2-30-000454	DIFFERENTIAL PRESSURE SWITCH	DP	1 EA.
28#	2-40-000879	AUX CONTACT BLOCK	-	1 EA.
29	----------	HIGH/LOW GAS PRESSURE SWITCH	LPG,HPG	1 EA.
30#	2-40-000862	TEMPERATURE LIMIT	TL,SL	2 EA.
31#	2-40-000466	SCANNER MOUNTING BRACKET	-	1 EA.
32	2-40-000802	TYPE J THERMOCOUPLE 2"	-	1 EA.
33	2-40-000441	480V/120V STEPDOWN XFORMER .75KVA	XF1	1 EA.
34	----------	GAUGE 30" HG-0-60-PSI	-	1 EA.
35#	2-30-000270	AIR SWITCH	AS	1 EA.
36#	PD#	PANEL BOX 42X36X8	-	1 EA.
37#	2-45-000371	KTKR FUSE BLOCK	-	3 EA.
38	2-40-000658	WEATHER PROOF BOX	-	1 EA.
39#	2-45-000365	8 AMP KTKR FUSE	-	1 EA.
40#	2-45-000263	LPJ 35 AMP FUSES	-	3 EA.
41#	2-40-000431	SIEMENS POWER SUPPLY	XFMR2	1 EA.
42	2-40-000433	AIR GATE SERVO SQM48	SM2	1 EA.
43#	2-40-000880	TYPE J THERMOCOUPLE BLOCK	TCB 1,2	2 EA.
44#	2-40-000881	BLOCK END CAP	-	2 EA.
45#	2-40-000795	BLACK PUSH BUTTON	PB2,3	2 EA.
46#	2-45-000000	POWER DISTRIBUTION BLOCK	PDB	1 EA.
47#	PD#	NON-FUSED DISCONNECT	NFDS	1 EA.
48#	PD#	DISCONNECT HANDLE	-	1 EA.
49#	2-40-000657	ALARM HORN	AH	1 EA.
50#	2-45-000270	LPJ 125 AMP FUSES	-	3 EA.
51#	2-45-000272	3 POLE CLASS J FUSE BLOCK 200A	-	1 EA.
52#	2-45-000381	3 AMP FNQ FUSE	-	2 EA.
53	2-40-000801	TYPE J THERMOCOUPLE "4"	-	1 EA.
54	----------	MAIN VENT VALVE	MVV	1 EA.
55	----------	PILOT VENT VALVE	PVV	1 EA.
56#	2-45-000309	2 POS. SELECTOR SWITCH	SS2	1 EA.
57#	2-40-000843	4 POLE RELAY	CR3	1 EA.
58#	2-40-000842	RELAY BASE	-	1 EA.
59#	2-45-001040	24VDC POWER SUPPLY	PS	1 EA.
60#	2-45-001047	INTERGRATED CONTROL	IC	1 EA.
61	2-40-000819	RTD 4"	RTD2	1 EA.
62#	2-45-000395	PANEL BOX FAN	PF	1 EA.
63#	PD#	PANEL LOUVERS	-	2 EA.

REV.	DESCRIPTION	B.O.M. REVIEW	SHOP REVIEW	CHECKED	APPROVAL
-	INITIAL RELEASE	N / A	N / A	G.W. 20-APR-10	L.N.L. 20-APR-10

REVISIONS

The item shown in this drawing may be covered by one or more patents of The Fulton Companies.

This design and drawing are proprietary and are the exclusive property of The Fulton Companies. The corporation does not permit their use except with prior written consent.

DWN BY T.M.C. 16-APR-10
SCALE NONE SHEET NO. 1 / 2
UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN INCHES
TOLERANCE ON
FRACTIONS ± 1/4
TWO PLACE DECIMALS ± .01
THREE PLACE DECIMALS ± .005
ANGLES ± 2 DEG.
SURFACE FINISH 250 MICROINCHES

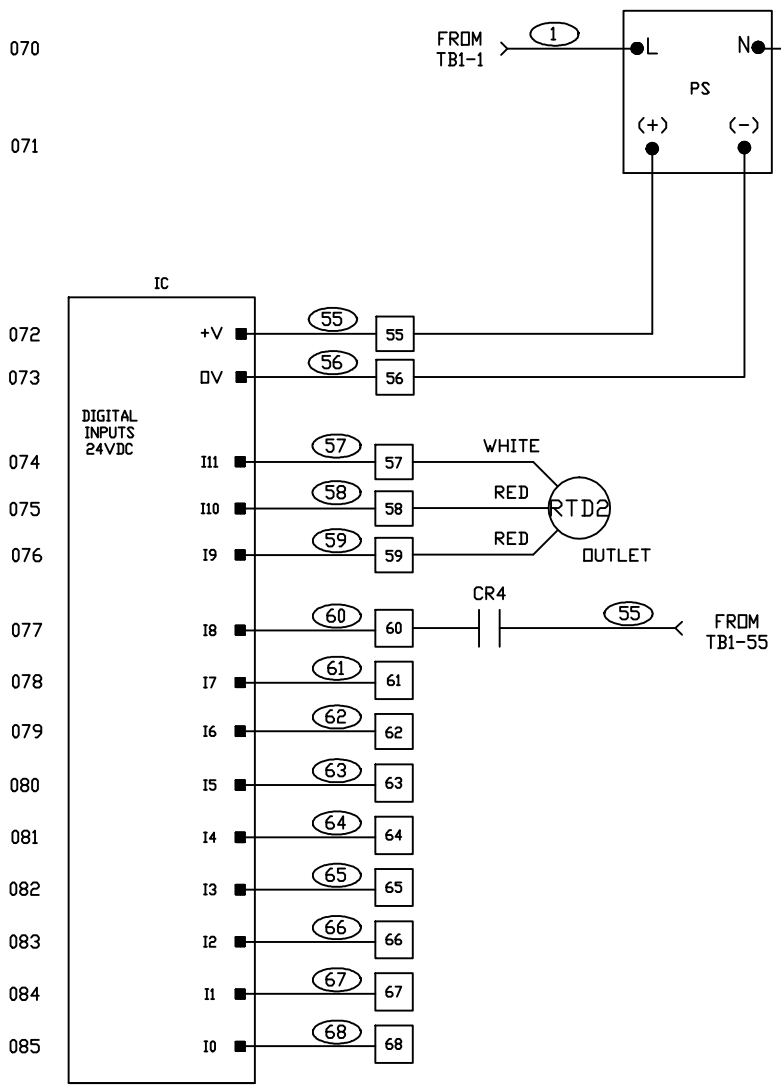
Fulton Thermal Corp. 972 Centerville Road Pulaski, New York, USA 13142

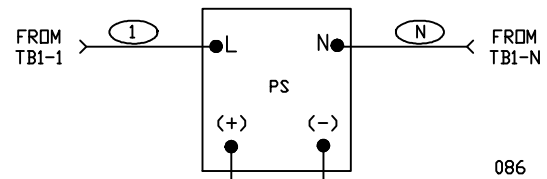
FT-1200-C
ELECTRICAL SCHEMATIC
NFPA 85, GAS FIRED, NEMA 1 PANEL
THERMAL FLUID HEATER

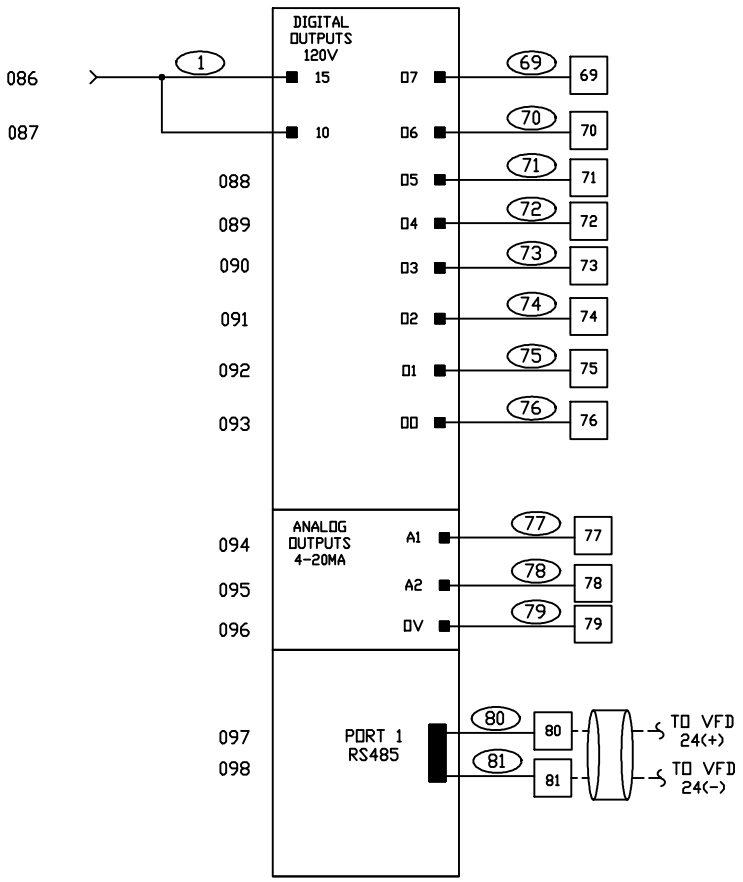
SHEET SIZE D DWG NO. T53DR-1834 REV. -

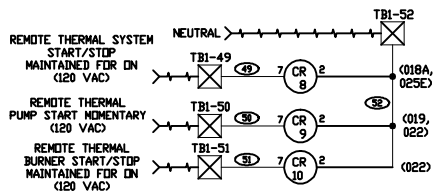
BGMU Submittal Package, Part 1 of 2, 05/03/2010, Page 438 of 635

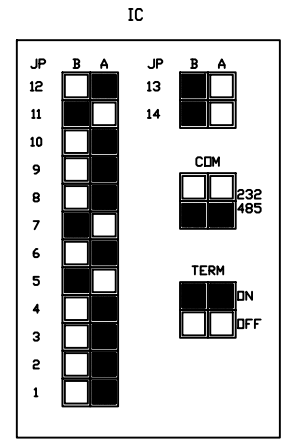
Fulton FT 1200C Electrical Schematic Drawing T53DR-1834 Sheet 2 of 2











NOTES:
1. ALL FIELD WIRING, CONDUIT (—•—•—•—•—) BY OTHERS.
2. (XX) DENOTES WIRE NUMBERS.
3. (W) INDICATES COMPONENTS THAT ARE MOUNTED INSIDE THE PANEL BOX.
4. FIELD WIRING TO KTKR FUSEBLOCKS TO BE TORQUED @ 12 IN. LBS.
5. CONDUIT HAS BEEN SUPPLIED (---------) WIRING TO BE INSTALLED BY OTHERS.
6. COMPONENTS SUPPLIED BY OTHERS.

REV.	DESCRIPTION	B.D.M. REVIEW:	SHOP REVIEW:	CHECKED	APPROVAL:
-	INITIAL RELEASE	N/A	N/A	G.W. 20-APR-10	L.N.I. 20-APR-10

REVISIONS

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DWG BY: T.M.C. 16 APR 2010
SCALE: NONE SHEET NO: 2 / 2
UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN INCHES
TOLERANCE ON:
FRACTIONS ± 1/4
TWO PLACE DECIMALS ± .01
THREE PLACE DECIMALS ± .005
ANGLES ± 2 DEG.
SURFACE FINISH 250 MICROINCHES

Fulton Thermal Corp.
972 Centerville Road
Pulaski, New York, USA 13142

Fulton

FT-1200-C
ELECTRICAL SCHEMATIC
NFPA 85, GAS FIRED, NEMA 1 PANEL
THERMAL FLUID HEATER

SHEET SIZE: D DWG NO: T53DR-1834 REV: -

REV.
SIZE D

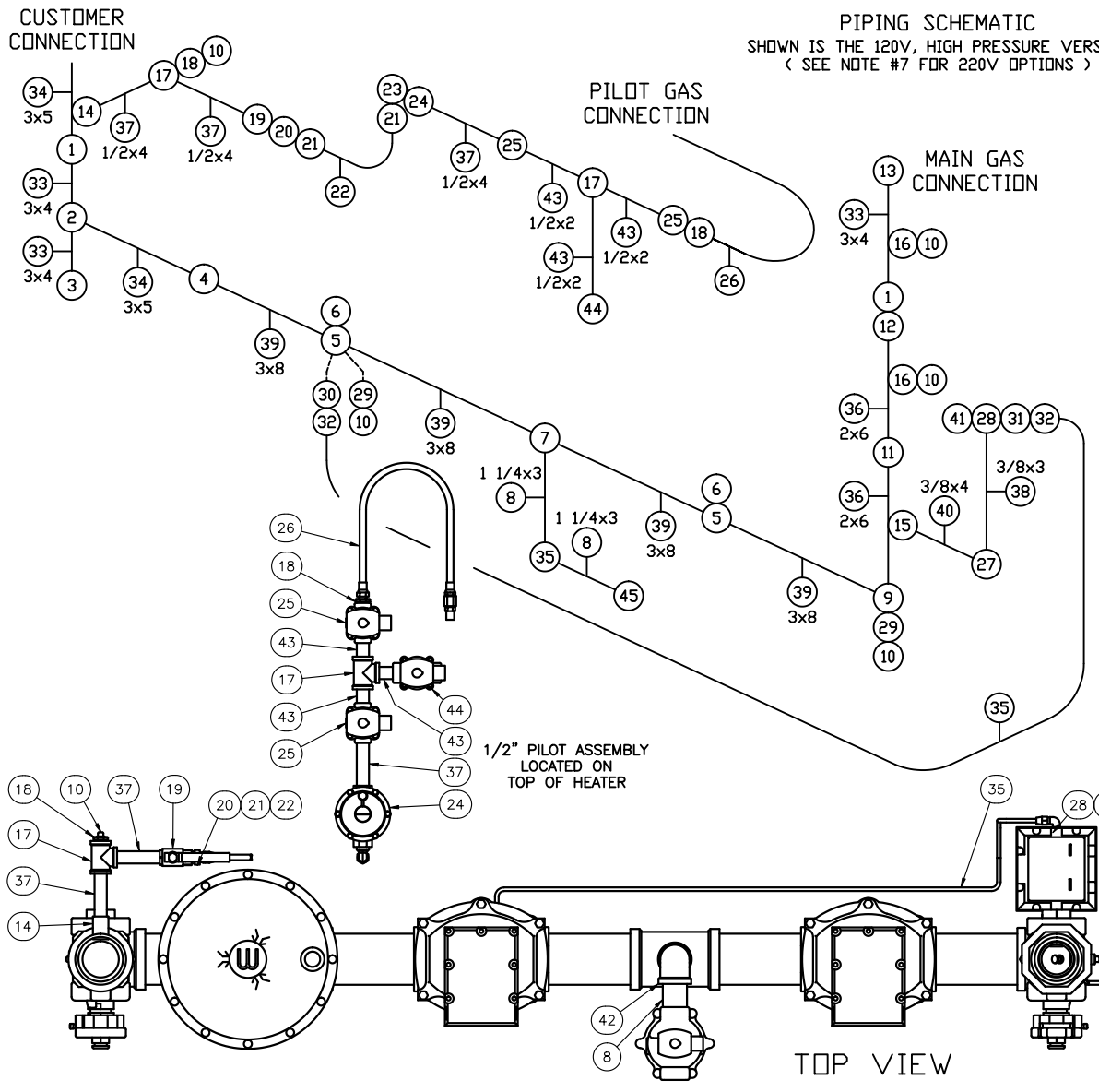
BGMU Submittal Package, Part 1 of 2, 05/03/2010, Page 440 of 635

Fulton Drawing No.: 7-54-120006, Fulton FT 1200 C Gas Train

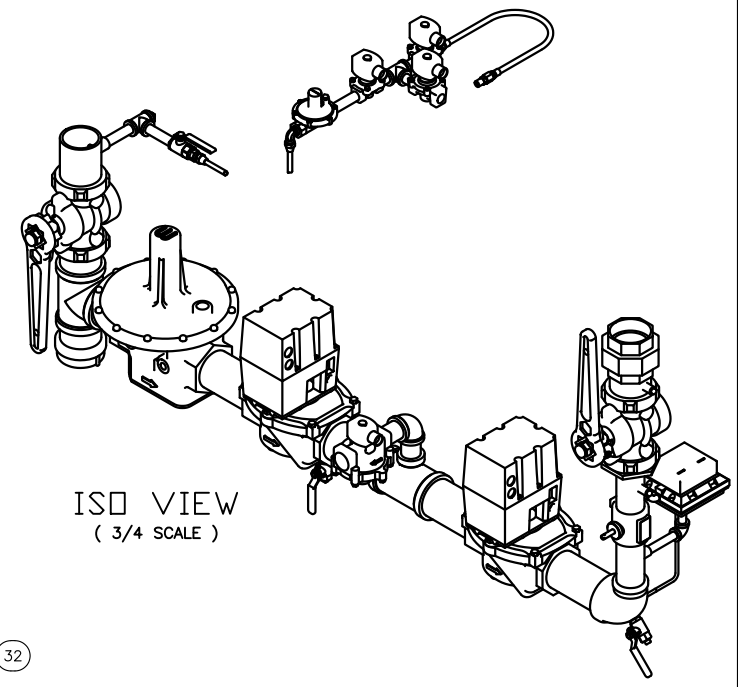
REVISIONS					
LTR	DESCRIPTION	CHECKED / DATE	SHOP REVIEW / DATE	BOM REVIEW / DATE	APPROVAL / DATE

PIPING SCHEMATIC

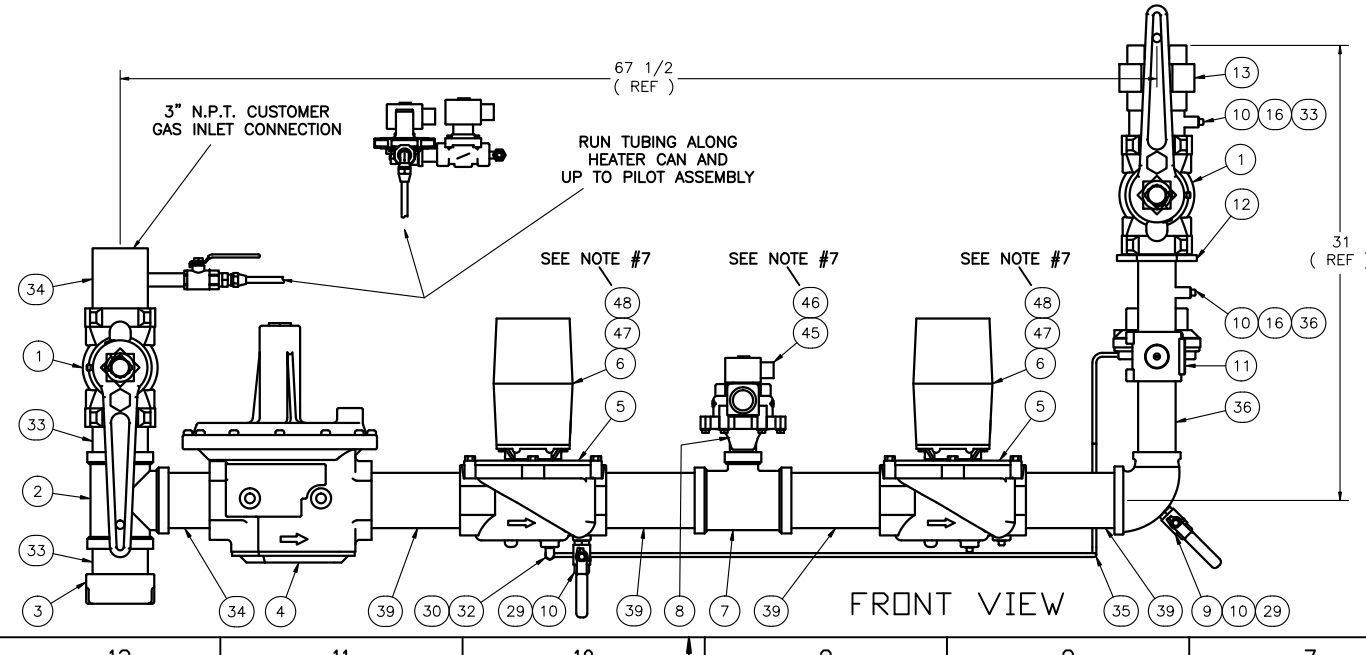
SHOWN IS THE 120V, HIGH PRESSURE VERSION
(SEE NOTE #7 FOR 220V OPTIONS)



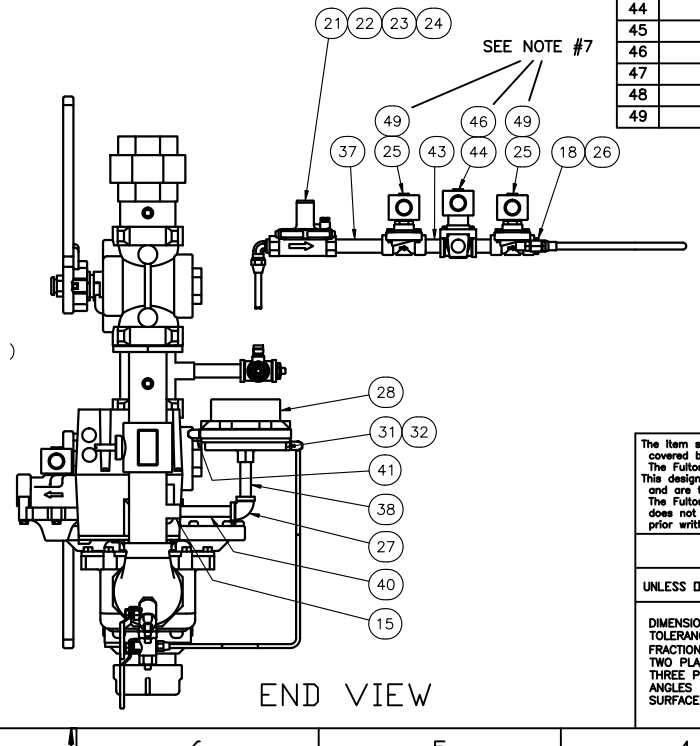
TOP VIEW



ISO VIEW
(3/4 SCALE)



FRONT VIEW



END VIEW

B.O.M.				
ITEM	PART NUMBER	DESCRIPTION	QTY	U.O.M.
1	2-30-000005	3" LUBRICATED PLUG COCK	2	EA.
2	2-35-000244	3" N.P.T. TEE	1	EA.
3	2-35-000298	3" N.P.T. CAP	1	EA.
4	2-30-000680	3" GAS PRESSURE REGULATOR 210G (10 PSI MAX)	1	EA.
5	2-40-000255	3" INDUSTRIAL GAS VALVE V5055C	2	EA.
6	2-40-000220	FLUID POWER ACTUATOR W/ POC 120V V4055D-1043	2	EA.
7	2-35-000218	3" x 3" x 1 1/4" N.P.T. REDUCING TEE	1	EA.
8	2-35-000141	1 1/4" x 3" N.P.T. STD NIPPLE	2	EA.
9	2-35-000463	3" x 2" N.P.T. REDUCING ELBOW (TAPPED 1/4" AT ASSEMBLY)	1	EA.
10	2-35-000306	1/4" N.P.T. F.S. PLUG	5	EA.
11	2-30-000511	2" ECLIPSE MODULATING GAS BUTTERFLY VALVE	1	EA.
12	2-35-000254	3" x 2" N.P.T. REDUCING BUSHING	1	EA.
13	2-35-000066	3" N.P.T. UNION	1	EA.
14	2-35-000220	1/2" N.P.T. SCH-40 COUPLING	1	EA.
15	2-35-000219	3/8" N.P.T. SCH-40 COUPLING	1	EA.
16	2-35-000210	1/4" N.P.T. SCH-40 COUPLING	2	EA.
17	2-35-000213	1/2" N.P.T. TEE	2	EA.
18	2-35-000262	BUSHING 1/2" N.P.T. x 1/4" N.P.T. 002-2825 BLK HEX ASTM A197	2	EA.
19	2-30-000111	1/2" N.P.T. UL GAS BALL VALVE	1	EA.
20	2-35-000314	WEATHERHEAD FITTING 48x6x8	1	EA.
21	2-35-000515	3/8" BRASS FLARE NUT	2	EA.
22	2-11-000003	3/8" COPPER TUBING	5	FT.
23	2-35-000315	WEATHERHEAD FITTING 49x6x8 90°	1	EA.
24	2-30-000677	1/2" PILOT GAS PRESSURE REGULATOR (10 PSI MAX)	1	EA.
25	2-30-000298	1/2" AUTOMATIC PILOT GAS VALVE	2	EA.
26	2-30-000566	FLEX HOSE 24"	1	EA.
27	2-35-000227	3/8" N.P.T. ELBOW	1	EA.
28	2-40-000539	HIGH/LOW GAS PRESSURE SWITCH (6-24"L, 10-50"H)	1	EA.
29	2-30-000398	1/4" N.P.T. BALL VALVE M/FM	2	EA.
30	2-35-000001	1/4" N.P.T. x 1/4" FLARE 90°	1	EA.
31	2-35-000002	1/8" N.P.T. x 1/4" FLARE 90°	1	EA.
32	2-35-000007	1/4" BRASS FLARE NUT	2	EA.
33	2-35-000055	3" x 4" LG. NIPPLE STD BLK	3	EA.
34	2-35-000056	3" x 5" LG. NIPPLE STD BLK	2	EA.
35	2-11-000002	1/4" COPPER TUBING	5	FT.
36	2-35-000160	2" x 6" LG. NIPPLE STD BLK	2	EA.
37	2-35-000091	1/2" x 4" LG. NIPPLE	3	EA.
38	2-35-000106	3/8" x 3" LG. STD BLK	1	EA.
39	2-35-000058	3" x 8" LG. NIPPLE STD BLK	4	EA.
40	2-35-000186	3/8" x 4" LG. STD BLK	1	EA.
41	2-35-000494	1/8" N.P.T. x 1/4" COMPRESSION FITTING 90°	1	EA.
42	2-35-000272	1 1/4" N.P.T. ELBOW	1	EA.
43	2-35-000087	1/2" X 2" NIPPLE	3	EA.
44	PO#	1/2" N.P.T. VENT VALVE BODY	1	EA.
45	2-30-000402	1 1/4" VENT VALVE ASSEMBLY	1	EA.
46	2-30-000156	220V COIL FOR VENT VALVE	2	EA.
47	2-40-000210	FLUID POWER ACTUATOR 220V V4055A	2	EA
48	2-40-000832	VALVE CLOSED INDICATION SWITCH	2	EA.
49	2-30-000294	220V COIL FOR ASCO PILOT VALVE	2	EA.

NOTES:
1. NIPPLE LENGTH MAY VARY DEPENDING ON THE LENGTH OF INDIVIDUAL THREAD ENGAGEMENT.
2. NO CLOSE NIPPLES ARE USED ON GAS CONNECTIONS. ALL PIPE FITTINGS, UNLESS OTHERWISE NOTED, ARE N.P.T. SCHEDULE 40 CONFORMING TO ASTM A733-89 OR EQUIVALENT.
3. ALL COMPONENTS VENTED TO THE ATMOSPHERE WILL HAVE SEPARATE VENT LINES BY OTHERS AND ARE TO BE RED TAGGED FOR CUSTOMER NOTIFICATION AT FINAL ASSEMBLY.
4. ALL DIMENSIONS ARE IN INCHES AND ARE FOR REFERENCE ONLY. DUE TO FABRICATION VARIANCES DIMENSIONS MAY CHANGE.
5. ENGINEERING MAY APPROVE SUBSTITUTION OF DEPICTED COMPONENTS WITH AN EQUIVALENT APPROVED COMPONENT DUE TO CODE, AREA OF INSTALLATION, CUSTOMER REQUIREMENTS AND / OR AVAILABILITY OF PARTS AT THE TIME OF ASSEMBLY.
6. ALL MANUAL SHUT-OFF VALVES SHALL BE BALL OR LUBRICATED PLUG TYPE; W/ STOPS. ALL MANUALLY OPERATED VALVES SHALL BE THE LEVER HANDLED TYPE AND SHALL BE PERMANENTLY ATTACHED TO THE VALVES.
7. FOR 220V APPLICATIONS USE ITEMS 47 & 48 IN PLACE OF ITEM 6, USE ITEM 46 WITH ITEMS 44 & 45 AND USE ITEM 49 WITH ITEM 25 IN PLACE OF 120V COIL.

The item shown in this drawing may be covered by one or more patents of The Fulton Companies. This design and drawing are proprietary and are the exclusive property of The Fulton Companies. The corporation does not permit their use except with prior written concent.

UNLESS OTHERWISE SPECIFIED:

DIMENSIONS ARE IN INCHES
TOLERANCE ON:
FRACTIONS ± 1/4
TWO PLACE DECIMALS ± .01
THREE PLACE DECIMALS ± .005
ANGLES ± 2 DEG.
SURFACE FINISH 250 MICROINCHES

DWG BY:	B.M.P.	DATE: 15 OCT 2003
B.O.M. REVIEW		DATE:
SHOP REVIEW		DATE:
CHECKED		DATE:
APPROVED		DATE:
SCALE:	3 / 16	
SHEET NO.:	1 OF 1	

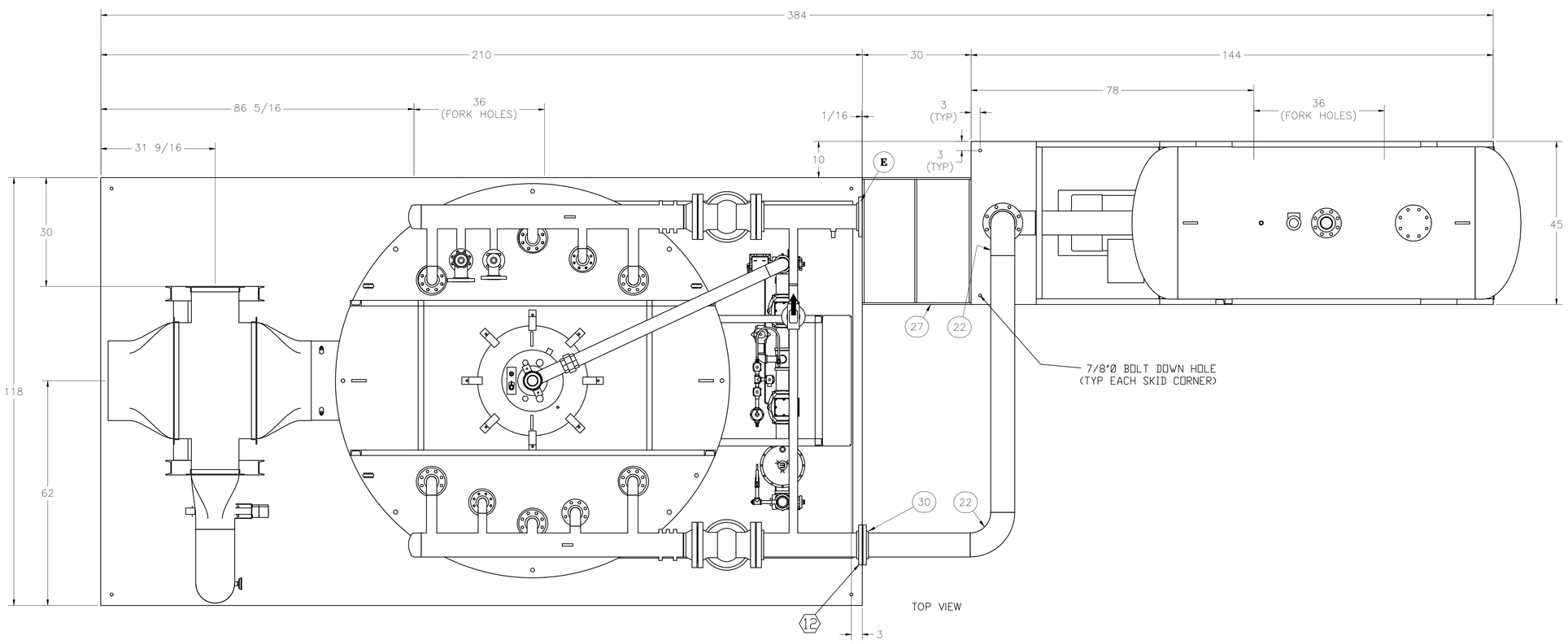
Fulton Thermal Corp.
972 Centerville road
Pulaski, New York, USA 13142

3" GAS TRAIN FOR FT-1200-C & FT-1400-C NFPA 85, NEMA 1 MODULATED

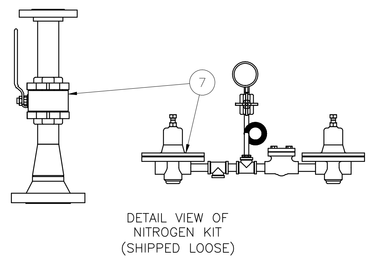
SIZE D | DWG. NO. 7-54-120006 | REV. -

BGMU Submittal Package, Part 1 of 2, 05/03/2010, Page 442 of 635

Fulton FT 1200 C BGMU Room Layout



Parts List				
ITEM	PART NUMBER	DESCRIPTION	QTY	U.O.M.
1		1/4" HR PLATE	45	S.F.
2	2-10-000216	4" x 6" TUBE STEEL	30	FT.
3	T91DR-0565	FT-1200-C HEATER SKID	1	EA.
4	9-FT-2000-L	FT-2000-L COMBINATION 528 GAL. COLD SEAL EXPANSION & DEAERATOR TANKS	1	EA.
5	T40DR-0491	FT-2000-L D.A. TANK STANDARD SUPPORT FRAME	1	EA.
6	7-30-002022	4 x 6 x 8 1/2 DEAN PUMP W/ 60 HP MOTOR	1	EA.
7	4-30-000210	2-WAY NITROGEN BLANKET KIT	1	EA.
8	2-30-000639	1 1/2" N.P.T. INLET 2 1/2" N.P.T. OUTLET SAFETY RELIEF VALVE	1	EA.
9	2-30-000891	VELAN 6" 150# GATE VALVE	1	EA.
10	2-30-001070	6" X 24" 150# FLANGED FLEX CONNECTION SA105	2	EA.
11	2-30-000733	6" 150# VELAN GLOBE VALVE	1	EA.
12	2-30-000869	3/4" S.W. GATE VALVE	2	EA.
13	2-30-004054	6" 150# STRAINER SURE FLOW	1	EA.
14	2-12-000804	6" STRAINER GASKET SURE FLOW	1	EA.
15	5-10-004703	TANK FRAME MOUNTING PLATE	4	EA.
16	5-10-004702	9" x 9" x 1/4" STEEL GUSSET PLATE	8	EA.
17	2-30-000453	1/4" N.P.T. CARBON STEEL NEEDLE VALVE 60-101-01	1	EA.
18	2-35-000390	1/4" N.P.T. SMLS STEEL SIPHON XH 350# SA-106B	1	EA.
19	2-35-000883	WINTERS .25 NPT PRESSURE INDICATOR 30-0-60	1	EA.
20	2-35-000178	1/4" F.S. N.P.T. COUPLING	1	EA.
21	2-35-000189	3/4" x 3" N.P.T. SCHED 80 T.O.E.	2	EA.
22	2-35-000551	6" WELD ELBOW SCH 40	5	EA.
23	2-35-001094	3/4" SOCKET WELD ELBOW	1	EA.
24	2-35-000285	3/4" THREADED CAP	2	EA.
25	2-35-000471	6" x 4" WELD REDUCER	1	EA.
26	2-35-000461	1 1/2 " x 3/4" WELD REDUCER	1	EA.
27	1-10-000101	2" x 1/2" FLATSTOCK	14	FT.
28	2-10-000100	4" x 5.4# CHANNEL	78	FT.
29	2-10-000147	6" PIPE	21	FT.
30	2-35-000553	6" 150# R.F. S.O. FLANGE	5	EA.
31	2-35-000580	6" 150# R.F. W.N. FLANGE	4	EA.
32	2-35-000458	4 300# R.F. W.N. FLANGE	1	EA.
33	2-35-000557	6 300# R.F. W.N. FLANGE	1	EA.
34	2-35-000555	6" 300# R.F. S.O. FLANGE	1	EA.
35	2-12-000417	4" 300# GASKET	1	EA.
36	2-12-000421	6" 300# GASKET	2	EA.
37	2-12-000420	6" 150# GASKET	10	EA.
38	2-35-000343	3/4" x 4 1/2" BOLT	24	EA.
39	2-22-000068	3/4" LOCK WASHER	120	EA.
40	2-35-000346	3/4" HEX NUT	120	EA.
41	2-35-000352	3/4" x 4" BOLT	8	EA.
42	2-35-000342	3/4" x 3 1/2" BOLT	80	EA.



DETAIL VIEW OF NITROGEN KIT (SHIPPED LOOSE)

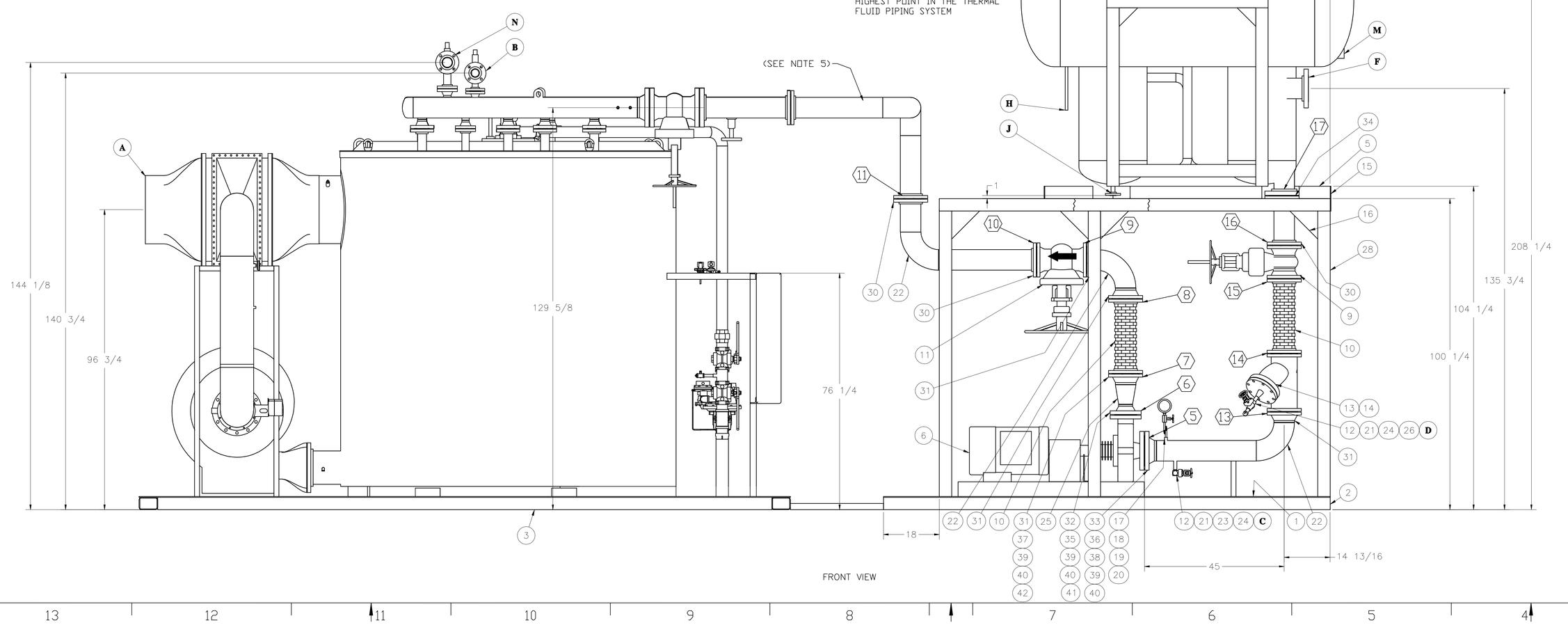
NOTES:
1. PORTIONS OF THE PIPING AND COMPONENTS WILL BE DISASSEMBLED FOR SHIPPING.
2. D.A. TANK IS SHIPPED SEPARATELY.
3. THE SUPPORT STRUCTURE MAY BE CROSS BRACED OR OTHERWISE ENHANCED BEYOND WHAT IS SHOWN, AS REQUIRED.
4. FORK HOLES ARE LOCATED ON RIGHT SIDE OF SKIDS. HEATER SKID CONSTRUCTION FOR FT-0600-C THRU FT-1200-C, PLACE ONE RUNNER ON HEATER CENTERLINE & ONE ON OUTSIDE EDGE OF EACH FORK HOLE. PLACE ALL OTHER RUNNERS MAX. 24" ON CENTER
5. ADDITIONAL FIELD SUPPORTS MAY BE REQUIRED.
6. PLEASE REFER TO THE O&M MANUAL FOR ADDITIONAL INFORMATION REGARDING CLEARANCES AND INSTALLATION INSTRUCTIONS.

(X) — DENOTES FLANGE CONNECTION NUMBER- USE NUMBERS STAMPED ON MATCHING FLANGES TO AID REASSEMBLY.

ESTIMATED DRY WEIGHT 48,941 LBS

ESTIMATED FLUID VOLUME 752 GAL.

THE FOLLOWING ARE MAJOR CUSTOMER CONNECTIONS:
- **A** - 22"Ø FLUE CONNECTION 26'0 RECOMMENDED VERTICAL STACK DIAMETER
- **B** - 2 1/2" 150# FLANGED SAFETY RELIEF VALVE OUTLET
- **C** - 3/4" N.P.T. DRAIN AND FILL CONNECTION (CAPPED)
- **D** - 3/4" N.P.T. STRAINER DRAIN (CAPPED)
- **E** - 6" 150# SUPPLY
- **F** - 6" 300# RETURN
- **G** - 3" 300# VENT
- **H** - 1/2" N.P.T. MANUAL HIGH/LOW LEVEL CHECK PIPES
- **J** - 1" 300# DRAIN
- **K** - 2 1/2" N.P.T. SAFETY RELIEF VALVE OUTLET
- **L** - 1/2" N.P.T. NITROGEN CONN.
- **M** - 2 1/2" N.P.T. LIQUID LEVEL SWITCH
- **N** - 3" 150# FLANGED SAFETY RELIEF VALVE OUTLET



REV.	DESCRIPTION	CHECKED	MECH. ENG.	ELEC. ENG.	APPROVAL
-	INITIAL RELEASE	A.C. 04/20/2010	M.R. 04/20/2010	L.N.L. 04/20/2010	G.W. 04/20/2010

REVISIONS

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DWG BY: T. CORSON — DATE: 16 APR 2010

SCALE: 1 / 16 — SHEET NO. 1 / 1

UNLESS OTHERWISE SPECIFIED:

DIMENSIONS ARE IN INCHES
TOLERANCE ON
FRACTIONS ± 1/4
TWO PLACE DECIMALS ± .01
THREE PLACE DECIMALS ± .005
ANGLES ± 2 DEG.
SURFACE FINISH 250 MICRORINCHES

Fulton Thermal Corp.
972 Centerville Road
Pulaski, New York, USA 13142

FT-1200-C THERMAL FLUID HEATER WITH FT-2000-L D.A. TANK, DEAN'S 4 x 6 x 8 1/2" PUMP 60 H.P. MOTOR AND SPACER BRACING

SHEET SIZE E — DWG NO. T99DR-1530 — REV. -

BOM Submittal Package, Part 1 of 2, 05/03/2010, Page 44 of 105

H. Condenser/Scrubber

- Performance Specification: BioScru Scrubber / Condenser BSD-7430

1-877-BIO-SLDS
P 707-747-5949
F 707-747-5951

TFL5412 PERFORMANCE SPECIFICATION

BSD-7430 BIOSCRU SCRUBBER / CONDENSER

Capacity:

Condensing Capacity:	10,000 lb/hr

Nozzles:

Gas Inlet Nozzle:	20”
Clean Gas:	ANSI 4” 150# Flange
Liquid Inlet:	ANSI 4” 150# Flange
Liquid Drain:	ANSI 10” 150# Flange

1st Stage Nozzle:

SS Solid Cone 15 deg

Spraying Systems Co.: 2 ½” HH-30 SS 301100 – 122GPM @50PSI

2nd Stage Nozzle:

SS Solid Cone 15 deg

Spraying Systems Co.: 3” H-15 SS 152500 – 278 GPM @50PSI

Material of Construction:

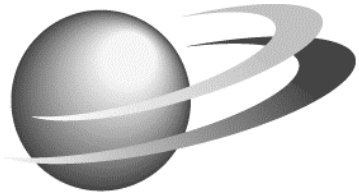
Scrubber Condenser:	316 Stainless Steel

Manufacture:

Designed and Manufactured by Therma-Flite, Inc.

I. Bio-Filter

- BIOREM SK450 Operation & Maintenance Manual
- BIOREM SK450 Process & Instrumentation Diagram Drawing Set
- BIOREM SK450 New York Blower Performance Data
- BIOREM SK450 Electrical Drawings,
    - Control System Electrical Wiring Diagram BIOREM Dwg. No.: SK250_450-E-001 S 1 of 4
    - Control System Electrical Wiring Diagram BIOREM Dwg. No.: SK250_450-E-001 S 2 of 4
    - Control System Electrical Wiring Diagram, BIOREM Dwg. No.: SK250_450-E-001 S 3 of 4
    - Control Panel Layout Diagram, BIOREM Dwg. No.: SK250_450-E-001 S 4 of 4
- BIOREM SK450 General Arrangement Drawings
    - BIOREM Dwg. No.: SK450-GA-000 S 1 of 7
    - BIOREM Dwg. No.: SK450-GA-000 S 2 of 7
    - BIOREM Dwg. No.: SK450-GA-000 S 3 of 7



BIOREM

OPERATION & MAINTENANCE MANUAL

O&M Manual Volume I of II

BIOREM® Biofilter
AIR POLLUTION CONTROL SYSTEM

Revision 0

Prepared for:
SK-450 Series

Prepared by:
BIOREM®
7496 Wellington Road 34, RR#3
Guelph, Ontario
N1H 6H9

LIST OF EFFECTIVE PAGES

INSERT THE LATEST CHANGED PAGES IN THE APPROPRIATE SECTIONS AND DISPOSE OF ANY SUPERSEDED PAGES.

The portion of the test affected by the latest change is indicated by a vertical black line in the margin of the page. Changes to illustrations are indicated by a similar vertical block line.

O&M Document Change Log

Revision or Change	Description
Rev. 0	Issued for approval

Manuals

There are two binders which comprise the BIOREM® Operation & Maintenance Manuals submitted on this project. The binders are Operation & Maintenance Manual (O&M Volume I of II), and Vendor Data (O&M Volume II of II). BIOREM® has separated the package into two binders to assist in the reading and understanding of the system. The first binder, volume I, contains information on the systems operating, monitoring and general maintenance requirements. Specific, detailed information on the systems components is found in volume II, Vendor Data.

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CAUTION!

READ AND ADHERE TO THE FOLLOWING PRECAUTIONS

1. This manual must be read and understood in its entirety before operating the system.

2. If operating specifications within this manual are not strictly followed, the media warranty will be null and void.

3. If the system needs to be shutdown for an extended period of time, care should be taken to ensure the system does not freeze.

4. The Customer is fully responsible for the effect of additional contaminates on the system which were not identified for the design that are introduced in the air stream. Performance guarantees and the media warranty will be null and void.

5. During any maintenance or repairs over the media, ensure that foreign debris including glues and solvents are not permitted to fall into the media bed. The inclusion of such debris may impact the performance of the system. Performance guarantees and the media warranty may be null and void.

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OPERATIONAL PRECAUTIONS

OBSERVE ALL IMPORTANT, CAUTION, WARNING AND DANGER NOTICES, DEFINED AS:

Important warnings refer to hazards or unsafe methods or practices that can result in product damage, equipment damage and/or performance deterioration.

Cautions refer to hazards or unsafe methods or practices that can result in product damage, equipment damage and/or personal injury.

Warnings refer to hazards or unsafe methods or practices that can result in product damage, equipment damage, severe personal injury and/or death.

TYPOGRAPHICAL CONVENTIONS

In addition to the cautions and warnings previously listed, the following typographical conventions are used in this manual:

- **Italics are used for emphasis.**
- **Notes are indicated and used as follows:**

Notes are used to highlight information that helps with the use of the system.

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1. Introduction

This manual describes the Biofilter Air Pollution Control System installed at the customer facility and provides details of the correct operation, monitoring and maintenance of the system. All operators and supervisors working with the system should read the manual completely and understand how the entire system is designed to operate. Operation of the system outside the limits described in this manual may impair the system performance and invalidate portions of the warranty.

By following the procedures in this manual, all operators will be able to successfully start-up and operate the Biofilter system. BIOREM® can also provide advice on training or additional training courses on request.

With the commissioning of this system, a long-term partnership has been formed. The BIOREM® Service Department is committed to providing the right supporting services at the correct time to ensure successful operation of the system.

1.1 Technical Support

Questions about this manual or the operation of the system may be directed to the Service Department.

SERVICE HQ
BIOREM®
7496 Wellington Road 34, RR#3
Guelph, Ontario
N1H 6H9
Tel: 1-519-767-9100
1 (800) 353-2087
Fax: 1-519-767-1824

US REGIONAL OFFICE
BIOREM®
100 Rawson Rd., Suite 230
Victor, NY
14564

Web Site: www.Biorem.biz
Email: service@Biorem.biz

1.1.1 Technical Support

For technical support, clients can call 1-800-353-2087 and follow the directions provided to reach the service department.

When possible try to make calls of a non-urgent nature between 8:30 am and 5:00 pm in the Eastern Time Zone of North America.

1.2 Services

BIOREM® delivers a comprehensive range of services to meet your needs. Please call our Service Department for details and pricing of the following services:

- Process data monitoring
- Site visits including media audits
- Training programs
- OEM parts
- System upgrades
- Calibration
- Preventative maintenance planning
- Commissioning

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1.2.1 Site Visits

The staff and service professionals will deliver substantial value in a planned service visit covering key operating aspects such as media assessments, instrument calibration, preventative maintenance planning, process monitoring and where applicable PLC code modifications. Ask us to develop a service plan for you.

1.2.2 Training

Training is offered at the time of system commissioning. Customized training packages are available where, for example, operator turnover has led to a need for comprehensive training of new staff.

During regularly scheduled site visits, the Field Service Representative can provide operators with on site, informal training to cover areas of concern, to explain operations, processes, maintenance or troubleshooting activities, and to enhance general operator ability and confidence. Training on the entire system is not provided during these site visits.

Additional training is available and invoiced based on the type of training and hours required. Training rates and packages are subject to change, as a result please contact the service department for the current rates.

1.3 Theory of Operations

1.3.1 Biofiltration

Biofiltration is a pollution control technique which uses microorganisms to capture and biologically degrade process pollutants. The microorganisms live in a thin layer of moisture, the “biofilm”, which surrounds the filter media.

During the biofiltration process, the polluted air stream slowly moves through the biofilter media bed. The contaminated air is diffused in the biofilter and adsorbed onto the biofilm. Here the microorganisms, including bacteria and fungi, metabolize the air contaminates producing energy and metabolic byproducts in the form of carbon dioxide and water.

This biological degradation process occurs by oxidation, and can be written as follows:

$$\textbf{Organic Pollutant} + O_2 \rightarrow CO_2 + H_2O + \textbf{Heat} + \textbf{Biomass}$$

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2. Safety

2.1 Overview

Safety is a team effort. Every individual on site must make a conscious effort to work safely. Safety must be kept on the front of operators' minds when working on this or any air pollution control system. Safety documentation on the equipment in this system can be found in this manual. Safety concerning the BIOREM® supplied components can be found in the Vendor Data in the Engineering Submittal. Material Safety Data Sheets (MSDS) can be found in **APPENDIX B** of this manual. Any additional MSDS can be added to **APPENDIX B** as required.

2.2 Cleanliness

An air pollution control system poses a number of potential health hazards if good housekeeping practices and attention to warnings are not followed. Immunization protects against infection, but common sense is required when performing maintenance activities. Do not expose cuts or open sores to non-potable irrigation water and operating media. Ensure hands are washed with antibacterial soap on a regular basis, especially prior to eating.

2.3 Electrical Safety

Power is supplied to the control panel when the power switch is in the ON position. When in the OFF position, some components inside the control panel are live and service should not occur unless the power supply from the central control panel is disconnected. A proper lock-out procedure should be used.

!
IMPORTANT!

Installation and servicing of the electrical panel and electrical devices are only to be performed by qualified authorized personnel.

2.4 Chemical Safety

Some chemicals are formed as a by-product of some of the pollution removal processes. The chemicals are commonly found in the waste streams of the system. Appropriate caution and safety equipment must be used when handling these waste streams.

2.4.1 Sulfuric Acid

Sulfuric acid (H_2SO_4) forms as a byproduct on systems which are removing SO_2 from the polluted air stream. The concentration of sulfuric acid is typically low in the system, less than 1% of humidification and irrigation water. The following list outlines some important considerations when handling this chemical:

- Never drink the waste water stream from the system – severe and permanent damage may result.
- Will burn skin upon contact.
- Will burn eyes upon contact.

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Completely drain any line which contains recirculation water and/or system waste water prior to servicing any valves, instrumentation or rotating equipment.

2.5 Noise Hazards

Exposure to sounds greater than 85 dB for extended periods of time is harmful to human hearing. Wear hearing protection in designated areas.

2.6 Pinch Hazards

Do not operate any supplied equipment without the shields or guards in place over the drive belts, shafts and/or couplings. Exposed rotating parts can catch clothing, fingers, tools, or long hair causing severe personal injury.

2.7 Thermal Hazards

Exposed hot surfaces can create potential burn/ignition hazards. Fans compress air causing heat to be generated. This heat can bring the temperature of the fan surface to a level which may cause skin to burn.

On systems where heaters are installed to prevent freezing, the surface of the container can become warm to the touch. The heater should never be removed and/or handled when the elements are on. Always allow sufficient time for the elements to cool before handling the heater.

2.8 Personal Protective Equipment (PPE)

The use of PPE is mandatory on many sites. PPE includes but is not limited to the following:

- **Head Protection** – Hard hats should be worn at all times when overhead construction is being done. This includes work on the media which may require the removal of lids/hatches.

- **Eye Protection** – Safety glasses with side shields should be worn at all times while around the air pollution control system.

- **Face Protection** – A full face shield should be worn when handling chemicals or waste water solutions.

- **Hand Protection** – Protective gloves are to be worn when near pinch hazards. Chemical resistant gloves are to be worn when handling any chemicals or unknown waste solutions.

- **Foot Protection** – Safety boots with steel toes and steel shank should be worn at all times.

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- **Hearing Protection** – Hearing protection is to be utilized when working on or near any of the fans. Either disposable ear plugs or the headset style are acceptable.

- **Fall Protection** – An approved safety harness should be used in accordance with local codes. Typical codes require a harness to be used when the risk of falling more than 10 feet is possible. The harness safety line should not allow the person to fall more than 5 feet before arresting the fall.

Covers of the tanks containing the media are not designed to be walked on. Any servicing or inspections should be done from the side of the tank. Proper procedures are to be followed when accessing any media cell.

2.9 Confined Space Entry

Confined space is defined as a space in which, because of construction, location, contents or work activity therein, the accumulation of hazardous of toxic gas, vapor, dust, fumes, or the creation of an oxygen-deficient atmosphere may occur. In addition, a confined space:

- Is not intended for continuous worker occupancy.
- Has a limited or restricted entry and exit as a result of design, structure, and location.
- May contain or produce dangerous accumulations of gases, vapors, mists, dust, fumes, fog, lack of enrichment of oxygen, and biological agents.

Before beginning any work the following equipment must be inventoried and tested. Any item not passing inspection or calibration must be replaced or repaired before any work is started.

- Gas detector
- Tripod
- Body harness and safety line
- Easily accessible cell phone (or similar device) for emergency calls
- List of local emergency numbers for the site
- Portable ventilator and generator (when required)
- A suitable breathing apparatus
- Protective clothing (when required)
- Ladder (when required)
- Flashlight and alarm horn (when required)
- Manhole opener (when required)

The above list of required equipment may vary according to local regulations and is to be used as a guide only. Consult documentation on local regulations and site requirements if available.

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3. Biotrickling & Biofilter System Overview

The biofiltration system extracts and collects foul air for subsequent treatment through the biotrickling system and then through the biofilter prior to atmospheric discharge. The system can be divided into four main functional systems; Biotrickling System, Biofilter System, Media Irrigation System and Process Air Handling System, which are described below.

The treatment in the biotrickling filter relies on the transfer of pollutants from the gas phase onto an aqueous bio-film immobilized on a packed bed which is then degraded into common elements by microbiological organisms. Degradation rates are maintained by continuous recirculation of a liquid over the immobilized bacteria, which allows for pH control, addition of nutrients and removal of inhibitory compounds. Odorous compounds in the air then entering the biofilter are solubilized into the moisture layer surrounding the individual media particles or are adsorbed directly to their surface. Bacteria present within this moisture film utilize the compounds as substrate. The compounds are biologically oxidized to CO_2, H_2O and some inorganic salts and clean air is discharged to the atmosphere.

It is critical that the filter creates an optimal environment to enhance microbial development. Maintaining proper air temperature, pH, moisture and nutrient levels are essential for favorable biofilter performance and removal efficiency.

3.1 Air Flow Volume

A relatively steady air volume to both the biotrickler and biofilter is required during operation. Large increases in airflow volume will dramatically decrease the residence time, possibly exceeding the adsorption and degradation capabilities of the biofilter system. Excessive airflow can create voids in the filter material, allowing raw gas to pass through the system without sufficient processing time. Insufficient airflow may potentially generate anaerobic conditions. Air volume to the system is controlled by adjusting the control damper on the outlet of the exhaust fan.

3.2 Media Bed Temperature

Ideally, the biofilter media temperature should remain relatively constant with a typical range existing between 65^{o}F and 85^{o}F.

3.3 Media Pressure Differential

Pressure drop across either of the medias in the biotrickling filter or biofilter provides an indication of operating conditions. As biomass starts to accumulate the pressure differential across the media will increase and therefore it is an important troubleshooting parameter to record.

3.4 Media pH

3.4.1 Biotrickling Media pH

The pH level within the biotrickling sump is an important parameter; a low pH environment is ideal for the bacteria to grow and degrade the contaminants. The biotrickling filter should be maintained between 1 and 3 during system operation. The

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pH is regulated through a continuously purge process and can be adjusted based on inlet air H_2S concentration. Certain process conditions may allow for the sump to be at a pH outside of the optimal range.

Recirculation liquid found in the sump and lines is corrosive. Use proper protective clothing in handling the sulfuric acid leachate.

3.4.2 Biofilter Media pH

The pH of the biofilter media should be maintained between 5.0 and 9.0 during system operation. Core samples should be taken quarterly at various depths and locations of the filter bed for media analysis. Certain process conditions may allow for the media to be at a pH outside of the optimal range.

3.5 Nutrient Addition (Optional)

3.5.1 Biotrickling Filter

Within a biotrickling filter it is important to add a sufficient supply of nutrients to the recirculation liquid to maintain the bacteria population. Typically nutrients contain levels of nitrogen, phosphates and carbon sources. If nutrient levels drop below 20% of the typical concentrations, nutrient addition may be required. Nutrient sources can either come directly from the plant effluent or can be added as part of a patented nutrient mixture provided by BIOREM®.

Nutrients are essential for removal performance. If plant effluent is not available as make-up water then nutrients must be injected into the system.

3.5.2 Biofilter

Inoculation and nutrification processes are intended to give a burst of microbial activity to the biofilter bed in order to increase the speed at which the microbes acclimatize. If nutrient levels drop below 20% of the typical concentrations, nutrient addition may be required.

3.6 Media Irrigation System

A media irrigation system is incorporated into both the biotrickler and biofilter designs to provide the media with supplements and/or moisture. The moisture is added to the systems by means of an internal irrigation manifold located within the vessels.

3.6.1 Biotrickling Filter

The water is continuously recirculated within the biotrickling filter (biotrickler) for water conservation. Recirculated water is continuously bled from the system to maintain pH between 1 and 3, and to assist in preventing the accumulation of solids and other contaminates in the water. A small quantity of make-up water is required to account for evaporation and the water which is continuously bled.

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A controlled recirculation rate is required during operation of the biotrickling filter to ensure the proper amounts of nutrients are delivered to the bacteria and degraded wastes are removed. The delivery of too much liquid can lead to the biomass being stripped from the media and higher back pressure, while insufficient liquid distribution can cause dry areas on the packing resulting in a lower bacteria population that would lead to less odoriferous air being treated. Controlling the recirculation rate is also important to ensure that the spray nozzles can deliver the proper spray pattern to completely cover the surface of the packing. Recirculation rates are dependent on the volume of air being treated and the diameter of the vessel. The liquid flow rate is controlled via the diaphragm valve on the recirculation line located within the water box.

The spraying system must be in operation at all times when air is being moved through the biotrickling filter. In order to maintain continued optimal destruction of the odorous compounds, the relative humidity of the exhaust air must be greater than 98% at all times.

Protection from extreme high and low temperatures is required. The exhaust air temperature may need to be adjusted before biotrickler filter entry. The ideal wet bulb temperature of the biotrickling filter inlet air is required within the range of 55°F to 100°F.

In order to facilitate the removal of inhibitory compounds a volume of the sump will be purged from the system. The liquid purge rate will be dependent on the amount of pollutants (H_2S) in the inlet air stream and the volumetric air flow rate.

3.6.2 Biofilter

The irrigation process within the biofilter is controlled by a programmed timing sequence actuating a solenoid valve located on a potable/plant effluent water supply line. Frequency, duration and start times are adjustable. If applicable, programming instructions are provided in the equipment catalogue.

Provision for hand operated override has been incorporated into the design and is located on the solenoid valve. A visual inspection of the media bed for dry areas or over saturated areas will aid in determining an optimal irrigation sequence for the system. The amount of water required for media irrigation is typically dependent on inlet air stream characteristics and media volume.

3.7 Process Air Handling System

Odorous air from the existing facility is extracted using an exhaust fan. Maintaining a constant negative pressure upstream of the fan will ensure that all of the foul air from the facility is routed through the Biotrickler & Biofilter system for treatment. Information on the exhaust fan can be found in the equipment catalogue. A relatively steady air volume to the system is required during operation.

Sudden increases in air flow will decrease the residence time. This increase will have a detrimental impact on the systems ability to absorb and degrade the pollutants. Gradual increases in air flow over a period of time will have minimum impact on the systems ability to absorb and degrade the pollutants, provided the maximum air flow of the system is not exceeded. Air flows exceeding the design conditions may result in the

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creation of voids in the media, allowing the passage of polluted air through the media with minimal to no absorption and degradation.

Decreases in air flow may have a negative impact on the systems ability to absorb and degrade the pollutants. If insufficient air flow is provided to the system the distribution of the air in the media bed will be impacted and allow for the system to generate anaerobic conditions.

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4. System Operations

4.1 Process Requirements

4.1.1 Inlet & Outlet Air Properties

The biofiltration system shall be designed to remove odorous constituents from the process air stream under the following operating conditions:

Table 1: Process Parameters

4.1.2 Biotrickling Filter Irrigation

The water flow rate required for humidification within the biotrickling filter is 11.1 GPM.

4.1.3 Biofilter Irrigation

The water flow rate required for media irrigation is 0.7 GPM at a minimum pressure of 40 PSI up to a maximum of 100 PSI. Irrigation occurs for 35 min every 2 days; for a total of approximately 23 G of water each irrigation cycle.

4.1.4 Media

Table 2: Design Parameters

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4.2 Process Control Philosophy

4.2.1 Automation & Manual Operation

Consult the control narrative provided in **APPENDIX E** for a full description of valve positions and status of rotating equipment.

4.3 Shutdown Requirements

The system is designed to operate continuously with shutdown requirements for routine maintenance and media sampling only. Continuous operation as a process corresponds to continuous air flow, humidification and irrigation as discussed in this manual.

The system is designed for continuous operation. Operating the system intermittently will impact the performance.

4.3.1 Short Term Shutdown

When the system is to be shutdown for scheduled maintenance, equipment replacement or media sampling, follow the steps outlined below. Refer to the manufacturers' IOM manual for complete instructions. It is the responsibility of the customer that all plant approved safety procedures are followed. Shutdown should not exceed 24 hours.

1. On the control panel, place all hand switches in the OFF position.
2. If applicable, ensure all fans and pumps have come to a complete stop and are disconnected prior to any inspection or maintenance.
3. When working on the process air lines or applicable instrumentation, valves, or mechanical equipment (i.e. fans, pitot tubes, air temperature gauge, dampers, etc.) isolate the process air by closing off inlet air supply.
4. When working on water lines or applicable instrumentation, valves or mechanical equipment (i.e. recirculation pumps, flow switches, diaphragm valves, pressure gauges, etc.) relieve any pressure from process water lines by closing off water supply and draining the lines.
5. On the control panel, turn the main disconnect switch to OFF position.
6. Where applicable, follow proper Confined Space Entry procedures when working on the system.
7. Where applicable, follow proper Lock Out and Tag Out procedures when working on the system or system components.

Completely drain any line which contains recirculation water and/or system waste water prior to servicing any valves, instrumentation or rotating equipment.

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4.3.2 Long Term Shutdown

Follow the steps below for the system shutdown more than 24 hours duration. Refer to the manufacturers' IOM manual for complete instructions. It is the responsibility of the customer that all plant approved safety procedures are followed.

1. On the control panel, place all hand switches in the OFF position.
2. Isolate the process air by closing off inlet air supply. If not applicable, ensure proper ventilation in the working space.
3. Relieve any pressure from process water lines by closing off water supply and draining the lines.
4. Open Y-strainers and all manual drain valves.
5. Drain all chambers, scrubbers, tanks and sumps.
6. In the water box, open and drain all valves.
7. Drain all water lines. Ensure all p-traps are drained and blown out (using compressed air if required).
8. Make sure that all valves remain open.
9. On the control panel, turn the main disconnect switch to OFF position.
10. Confirm power is shut off. Lock Out and Tag Out the control panel.
11. On the systems equipped with pumps and fans, all pumps and fans should be completely drained. Refer to the manufacturer's IOM manual for complete storage instructions. Loosen and remove fan belts as required.
12. Motor shafts and fan shafts are to be manually rotated every month. Refer to manufacturer's IOM manual for long term storage instructions.
13. On the systems equipped with pH probe, probe must be removed and kept wetted. Refer to manufacturer's IOM manual for long term storage instructions.

Irrigation liquid found in the sump and lines is corrosive. Use proper protective clothing in handling the sulfuric acid leachate.

4.3.3 Restart of the system.

To re-start the system after short term shutdown, follow the steps outlined below.

1. Remove all locks and tags.
2. Ensure that all valves positioned for maintenance are returned to their normal operating position.
3. Open main water supply valve.
4. Restore power to the control panel by turning on the main disconnect.
5. Place all hand switches into AUTO ensuring the fan hand switch is the last switch to be placed in AUTO.
6. The system will run in automatic once the fan HOA is placed in AUTO.

To start the system again after long term shutdown follow the steps outlined below. Refer to the manufacturers' IOM manual for complete instructions. It is the responsibility of the customer all plant approved safety procedures.

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1. Check all instruments are functional.
2. Zero all magnehelic gauges by adjusting screw on the face of the gauges. This should be done with all airlines disconnected.
3. If applicable, reinstall and calibrate all instrumentation – refer to manufacturers' IOM manual for complete instructions.
4. Ensure all air lines are free of debris and moisture.
5. Remove all locks and tags.
6. Ensure all water lines are connected.
7. Close Y-strainers and all Normally Closed valves. Refer to P&ID diagrams in **APPENDIX D** to indicate the location of all Normally Closed valves. Ensure all appropriate valves are open to allow for water flow.
8. Open water supply.
9. Restore power to the control panel by turning on the main disconnect.
10. Check and set instrumentation to proper operational set points. Refer to Table 10: As-Installed Setpoints for start-up systems parameters.
11. Flush water lines with once through water. On the systems equipped with pumps, do not run pumps until all lines are flushed.
12. On the Biotrickling systems, turn on recirculation pump by placing the hand switch in HAND and inspect for leaks.
13. Ensure the media irrigation coverage is even by activating the irrigation and visual inspecting coverage. On a Biotrickling Filter, this is accomplished by turning ON the recirculation pump. On a Biofilter system, this is accomplished by manually OPENING irrigation solenoid valve.
14. Re-wet media for about 10 minutes.
15. Refill all tanks to operating levels.
16. Open air inlet.
17. If applicable, reinstall fan belts and verify belt tension per manufacturer's recommendations.

NOTE

Fan belts are to be re-tensioned after 2 weeks of operation.

18. Place all hand switches into AUTO ensuring that the fan hand switch is the last to be placed in AUTO.
19. Restart fan by placing the hand switch in AUTO.
20. Make sure pumps run without issue.
21. Measure and record the process parameters. Verify they are within the acceptable operating range as indicated in **APPENDIX H - Observation and Monitoring Datasheet**.

When system restarted, biofilter bacteria should re-establish again within few days of operation.

Any questions or comments should be directed to BIOREM Technologies Inc.

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5. Performance Monitoring

In order to maintain maximum removal efficiency throughout the lifetime of the media, a comprehensive monitoring program should be initiated. The program consists of several components, these are; media monitoring, observations and sampling (sampling is part of the BIOSERVE program only), and preventative maintenance of the equipment. For more information on BIOSERVE see the corresponding appendices at the back of this volume.

5.1 Log Sheets for Manually Collecting Data

In order to respond to performance issues, media warranty and equipment warranty issues it is necessary to have an accurate account of the operating parameters of the system. The operating parameters will assist in determining the root cause of the problem and assist in expediting the resolution.

To assist in facilitating the task of monitoring the system an observation and monitoring datasheet has been provided. The document contains typical parameters that require logging and the frequency at which these parameters are to be recorded. *It is the responsibility of the operations staff at the facility to ensure the records are up-to-date.* For a sample log sheet see the corresponding appendices at the back of this volume.

5.2 Set Point Log Sheet

Prior to commissioning the set point values are recorded on the P&ID's as indicated. During operation there may be a need to adjust these values to compensate for seasonal variations. Set points may also require adjustment based on operations best practices and optimization of the system over a period of time.

A set point log sheet is used to record changes made so that operations staff and BIOREM® service staff are aware of when changes were made and why. A list of as-installed set points is provided in see the corresponding appendices at the back of this volume. It is recommended that a separate log book maintained.

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6. Media

6.1 Installation

The media is installed through the top of the system. Installation is completed during the construction/installation of the media cells.

Media installation is completed mechanically using front end loaders and/or conveyor belts. After the media is installed in a cell it is leveled by manually raking the surface.

Media is to be installed using a method which provides the least amount of media surface abrasion. Excessive abrasion may impact the performance of the media.

6.2 Removal

Media removal is accomplished by the use of a vacuum system. Several vacuum trucks may be required to remove the media.

Prior to media removal, the cell in which the media is to be removed must be decommissioned and all devices locked out.

6.3 Sampling

Media samples should be taken at various depths to permit a proper analysis of the media. Samples should be taken at the top of the media bed, the middle and the bottom. If the bottom cannot be reached safely, a sample from the lowest possible safe depth should be taken. A minimum of two samples per location is required.

Sampling of the biofilter media ensures all parameters are normal to provide maximum pollutant removal efficiency. Some of the parameters which BIOREM® typically analyses are: media moisture, pH, and total microbial counts.

6.3.1 Preparation

Prior to taking any media samples the following items are to be acquired:

- Cooler large enough to fit ice packs and all necessary samples
  - Multiple coolers may be required on large systems
- Ice packs
  - Must be blue gel packs or plastic ice blocks
- Clean shovel
  - The cleanliness of the shovel may impact the analysis which is done on the media
- Sample bags (one per sample taken)
  - Large enough to hold 2 cups (i.e. small zip-lock freezer bag)
  - Must be zip-top and unused
  - Glass jars or other breakable materials are not acceptable

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- Two to five gallon bucket filled with potable water
- Latex or nitrile gloves
- Copy of the necessary *sampling documentation*
  - Media Sampling Sheet
  - Observation and Monitoring Data Sheets
- Fine point permanent marker to label samples

6.3.2 Sampling

Samples should be taken at several locations within the media cell on large systems to ensure adequate representation of the entire bed. Samples are not to be taken unless six (6) hours have elapsed since the last irrigation cycle. The locations of the samples are shown on the MEDIA SAMPLE SHEET found in the corresponding appendices section.

Prior to taking any samples the equipment providing polluted air and water for irrigation must be turned off and properly locked out.

Always wear the appropriate PPE and follow local safety regulations when taking the media samples. Confined space requirements or fall hazards may be present.

The following steps should be followed when taking media sampled:

1. Rinse shovel with potable water.
2. Dig to required depth, at locations indicated on the MEDIA SAMPLE SHEET.
3. Record visual observations of the media sample.
4. Retrieve the sample (approximately ¼ gallon) by hand and place it in the appropriately labeled sample bag.
5. Rinse the shovel in the potable water.
6. Continue steps 2 through 5 for all sample locations and depths.
7. Immediately place samples into a cooler with the ice packs. Samples shall remain in the cooler at approximately 4°C (39°F) until received at BIOREM®.

Keeping the media sample at a lower temperature and in the cooler ensures that they are protected from exposure to the elements. Direct sunlight, extreme cold or heat may impact the sample and yield false tests.

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8. Media samples are to be shipped with the completed MEDIA SAMPLING SHEET overnight to BIOREM® at the following address:

BIOREM®
ATTN: Service Department
7496 Wellington Road 34, RR#3
Guelph, Ontario
N1H 6H9
Tel: 1-519-767-9100
1 (800) 353-2087
Fax: 1-519-767-1824

Please notify BIOREM®'s service department when the media samples are shipped. Do not ship media samples on a Thursday or Friday, the beginning of the week is best. Samples will be processed immediately upon receipt. If you wish to confirm the type of analysis, or have any questions regarding media sampling, please contact BIOREM®'s Service Department at the number above.

Any expenses in acquiring the necessary equipment, taking media samples and shipping will be incurred by the customer. Shipped containers will not be returned.

A commercial invoice will be necessary for any shipments outside of CANADA.

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7. Preventative Maintenance

All routine maintenance for the system must be followed according to safety regulations and instructions specifies by the supplier of the equipment.

All relevant safety information in the Vendor Data and Section 2: Safety Information must be read before executing any safety work.

Section 6: Media must be read prior to taking or handling any media. Refer to the MSDS sheets in APPENDIX B material Safety Data Sheets for more details.

7.1 Vendor Data and Maintenance Procedures

Technical specifications of the mechanical and electrical items in the system, as well as specific detailed maintenance guidelines and procedures are provided in O&M Volume II – Vendor Data.

All routine maintenance must be completed according to the technical specifications of each system component, as described in O&M Volume II – Vendor Data. A summary of major preventative maintenance items in the system can be found in Table 3: Preventative Maintenance Schedule

BIOREM® has not independently verified the information contained in the Vendor Data and no representations or warranties of any kind, expressed or implied, are made by BIOREM® as to the quality, suitability, accuracy, timelines, or completeness of any material, information or data contained therein. BIOREM® does not accept liability for the consequences or any action taken on the basis of information contained in the Vendor Data.

Selection of the correct lubricant is subject to seasonal conditions, ambient temperatures, air movement, and air quality. The selection of lubricants should be made with caution and reference to the Vendor Data accounting for the operating conditions of the equipment.

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7.2 Rotating Equipment

7.2.1 Fans

The fans are designed to run continuously. Dates for lubrication and other maintenance requirements identified in the Vendor Data should be recorded in a maintenance log to ensure proper maintenance of the equipment.

When any maintenance is completed on a fan which requires the power source to be disconnected the rotation of the fan must be verified. Incorrect rotation can severely damage the equipment if started in the reverse direction and permitted to run. A certified electrician is required to perform this test.

7.2.2 Pumps

Dates for lubrication changes and other maintenance requirements identified in the Vendor Data should be recorded in a maintenance log to ensure proper maintenance of the equipment.

When any maintenance is completed on a pump which requires the power source to be disconnected the rotation of the pump must be verified. Incorrect rotation can severely damage the equipment if started in the reverse direction and permitted to run. A certified electrician is required to perform this test.

7.3 Media Biological Fouling

Biological fouling of the media may occur under certain process conditions. When conditions are right for fungi blooms the media may quickly become fouled. Fungi blooms are typically found on the surface of the media and within the first 1 to 2 feet of media

To determine if the media is fouled due to fungi blooms a visual inspection is required. There will also be a significant increase in the pressure drop across the system.

7.3.1 Media Tilling/Mixing

On systems where media biological fouling is present, tilling/mixing of the media may be necessary to restore the systems performance. Tilling/mixing is completed on the first 2 to 3 feet of media. Additional tilling/mixing below this level is normally not required.

7.3.2 Irrigation Monitoring

One of the conditions that may exist for fungi blooms to occur is over irrigation. As a result, when fungi blooms occur, it may be necessary to trim the irrigation on the media. This is done over several months and requires monitoring of the system to ensure that enough moisture is provided to the bed to ensure proper operations and performance while preventing or limiting the frequency of fungi blooms.

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7.4 Preventative Maintenance Equipment Schedule

The purpose of the operator's preventative maintenance schedule is to keep the equipment ready and operational and to detect any signs of equipment malfunction during operation and scheduled maintenance checks.

The tasks presented in Table 3: Preventative Maintenance Schedule are to be used as a guide for maintaining the equipment supplied for the BIOREM® system. For detailed equipment maintenance consult Volume II: Vendor Data. The following codes apply to the top of the columns in the table:

D – Daily Maintenance Check
W – Weekly Maintenance Check
M – Monthly Maintenance Check
Q – Quarterly Maintenance Check
S – Semi-Annual Maintenance Check
A – Annual Maintenance Check

Table 3: Preventative Maintenance Schedule

D	W	M	Q	S	A	TASK
Fill Out System Log Sheet						
						Complete log sheet.
General						
X						Security of components (loose fittings etc.)
X						Check for leaks on piping and system.
					X	Replace PLC battery every two (2) years. Consult electrical drawings. (required only if system is equipped with a PLC)
All Motors						
		X				Where possible remove fan cover and clean off any dust from the fan and airway. Use low pressure compressed air or dry cloth.
X						Inspect motor body for any corrosion.
Media						
	X					Visual inspection of media surface.
			X			Samples of media (with BIOSERVE package(s) only)
	X					Confirm even flow from all nozzles and spray pattern
Pressure Gauges						
			X			Confirm calibration.
	X					Clean gauge dial and drain drip leg.
Temperature Gauges						
			X			Confirm calibration.
	X					Clean gauge dial and drain drip leg.
Fan(s)						
		X				Lubricate as per Vendor Data Manual
		X				Drain fan body (if not Auto Drain, if Auto Drain confirm operation)
			X			Inspect belts and couplings for wear or damage.
			X			Inspect fan body for any corrosion or damage.
X						Check unit for vibration or noise during operation when running under stable conditions.

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D	W	M	Q	S	A	TASK
Pump(s)						
		X				Lubricate as per Vendor Data Manual
			X			Inspect pump body for any corrosion or damage.
X						Check unit for vibration or noise during operation when running under stable conditions.
Strainers & Filters						
		X				Visually confirm flow through strainer/filter if possible.
		X				Remove debris from strainer/filter.
Manual Valves						
					X	Actuate valve open/close.
					X	Check for leaks.
Automatic Valves						
		X				Actuate (from control panel) open/close.
		X				Check for leaks.
Water Flow Transmitters & Totalizers						
			X			Confirm calibration.
			X			Confirm flow through instrument.
			X			Inspect for debris in instrument which may impede flow.
			X			Clean display.
Pressure Transmitters						
			X			Confirm calibration.
			X			Inspect for debris in instrument which may impede flow.
			X			Clean display.
Air Flow Transmitters						
			X			Confirm calibration.
			X			Remove condensation from tubing between transmitter and pitot tubes.
			X			Inspect for debris in pitot tube.
			X			Clean display.
Level Switches						
			X			Ensure switch has clean path for movement.
Humidification Packing & Mist-Eliminator						
			X			Inspect for debris or particulate build-up.
			X			Confirm irrigation of packing.

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8. Troubleshooting

BIOREM®'s Field Service, Engineering and Process Teams have pooled their many years of experience in service and design on a wide variety of systems to compose this troubleshooting section. This section brings together the most frequently asked questions, issues and comments the BIOREM® team has received.

BIOREM® has prepared specific training to assist in the troubleshooting of your system. This training was provided during the commissioning to the operations staff. If additional training is required, please contact BIOREM® and ask to speak to someone in the Service Department.

The system contains lines that are under positive pressure other lines may be under negative pressure. Ensure that pressure in the line is relieved prior to commencing any maintenance.

8.1 Process Troubleshooting Guide

The following table provides details on common process questions, issues and concerns and how to address them.

Table 4: Process Troubleshooting Guide

Problem	Probable Cause	Actions
Media		
Media moisture outside of acceptable range*	1. Excessive irrigation cycle. 2. Solenoid valve stuck open. 3. Broken irrigation manifold. 4. Excessive water pressure. 5. Insufficient water pressure. 6. Irrigation nozzles plugged. 7. Solenoid valve fails to open. 8. Ball valve closed. 9. Y-strainer plugged / fouled. 10. Fan not operational. 11. Insufficient irrigation cycle. 12. Inadequate media coverage.	1. Consult BIOREM® service department. 2. Check valve operation – order re-build kit if necessary. 3. Check integrity of all PVC connections – replace if necessary. 4. Install pressure control valve to reduce the incoming pressure to a maximum to 80psi. 5. Ensure the water supply is at a minimum of 40psi. a. Verify the operation of the gauge. 6. Remove the nozzle clear the obstruction. 7. Ensure the H-O-A switch on the timer is set to the RUN position – ensure the timer has been properly programmed – test valve for operation. 8. Open ball valve. 9. Isolate Y-strainer – remove strainer screen – clean. 10. Inlet solenoid valve is interlocked with fan operation – ensure fan is running. 11. Consult BIOREM® service department. 12. Verify spray pattern – If low pressure or flow situation (on water supply line) is present, remedy. a. Adjust manifold to obtain the adequate coverage.

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Problem	Probable Cause	Actions
Media Continued…		
High back pressure / Erroneous pressure measurement	1. Media fouled 2. High media moisture content 3. Faulty gauge.	1. Consult BIOREM® service department. 2. Verify irrigation cycle is as designed. a. Consult BIOREM® service department. 3. Replace gauge.
Media Temperature outside of acceptable range*	1. Process temperature outside of range 2. Faulty gauge	1. If media temperature is above designed spec the system may require the addition of a cooling (dilution) air stream. a. Consult BIOREM® service department. 2. If media temperature is below designed spec the system may require the addition of heat via direct steam injection / recirculation of heated humidification water / heating coil / etc… a. Consult BIOREM® service department.
Unusual Media Appearance	1. Elevated inlet loading conditions (VOC/H_2S/TRS) 2. Biomass accumulation 3. Particles / foreign matter in inlet air stream 4. Irrigation water quality outside of specification	1. Monitor and record air stream characteristics. a. Consult BIOREM® service department. 2. Consult BIOREM® service department. 3. Ensure ductwork at balancing locations / pickup points does not entrain particles / foreign matter. a. Consult BIOREM® service department. 4. Ensure a quality of water to the biofilter system is clean and within spec. a. Consult BIOREM® service department.

8.2 Equipment Troubleshooting Guide

The following troubleshooting guide is intended for quick reference only. For detailed troubleshooting of system components, consult O&M Volume II Vendor Data.

If any of the problems identified in this section continue to occur or other difficulties arise, the operator should contact the BIOREM® Service Department. It will be necessary to send completed operating and service log sheets to determine the source of the issue.

IMPORTANT!

Consult all necessary safety documentation and follow the necessary safety requirements before proceeding with any maintenance.

Mechanical and Electrical maintenance should be done by qualified personnel. In the event that information between this manual and the information presented in the O&M Vendor Data is in conflict, supplied O&M Vendor Data should always take precedence. The operator is responsible for ensuring that the correct safety procedures are adhered to.

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Table 5: Equipment Troubleshooting Guide

Problem	Probable Cause	Actions
General		
Excessive moisture from exhaust stack	1. Drain lines plugged. 2. Air flow rate too high. 3. System not draining properly. 4. Excessive irrigation cycle.	1. Check drains for obstructions (including fan housing drain line) and clean / snake if necessary. 2. Ensure that the air flow rate is at the designed volume. If too high, reduce volume. 3. Ensure the drain lines are sized for the appropriate capacity and that the drain has been installed appropriately i.e. slope, line size, etc… 4. Consult BIOREM® service department.
Biofilter system will not drain properly	1. Ball valves on drain line(s) closed. 2. Trap / Drain line plugged. 3. Insufficient drain line capacity for drainage. 4. Excessive flow rate into biofilter. 5. P-Trap not installed properly.	1. Ensure ball valves are in the open position. 2. Flush / snake out trap and drain lines. 3. Increase drain line capacity. a. Ensure slope of the drain is sufficient to eliminate pooling. b. Sump pump may be required. 4. Reduce irrigation cycle. a. Ensure that flow rate to humidification and irrigation is within spec. 5. Ensure that P-trap is installed as per design drawings.

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Problem	Probable Cause	Actions
Fan		
Fan will not start	1. Starter fault (if applicable) 2. No power to control panel. 3. Breaker open or fuses blown 4. Electrical connections 5. System On-Off selector switch in the OFF position 6. Faulty fan motor 7. Main panel disconnect not engaged. 8. Fan impeller seized	1. Turn main panel disconnect ON 2. Verify main source disconnect is ON / Energized 3. Reset breaker / replace fuses a. Check for breaker / fuse sizing b. Check fan / motor spin freely 4. . Verify terminal and motor connections are secure 5. Place selector switch into the ON position 6. Megger motor. a. Consult BIOREM® service department 7. Check for ground fault 8. Check and grease bearings a. Ensure drain on fan housing is open. b. Remove any obstruction from fan wheel / shaft / etc…
No air Flow / Erroneous air flow measurement	1. Fan not running. 2. Broken / Seized fan impeller. 3. Fan belts broken / excessive wear. 4. Fan bearings. 5. Inlet air damper(s) closed 6. Blocked air supply duct. 7. Moisture in gauge. 8. Faulty gauge.	1. Start fan. 2. Replace / free impeller 3. Replace fan belt 4. Grease / repair replace bearings 5. Ensure that all dampers / pickup locations are open and balanced. 6. Determine source of blockage and remove. 7. Remove cover of gauge – drain – dry. 8. Replace gauge.
Excessive fan noise / vibration	1. Unbalanced impeller 2. Fan and motor not secured to base. 3. Fan and shaft bearings worn. 4. Fan drive belts worn. 5. Pulleys misaligned. 6. Fan housing bolts loose. 7. Moisture within fan housing. 8. Debris / build-up on impeller.	1. Check impeller for buildup on fan blades. a. Check for broken or chipped pieces. b. Clean and clear as required. 2. Ensure fan mounting is secure / tighten / install all bolts. 3. Replace worn bearings / grease if wear is not excessive. 4. Replace belts. 5. Align motor and fan pulleys. 6. Tighten all bolts / screws on fan housing and secure with lock washers. 7. Ensure drain plug at bottom of fan housing is removed and drain line is free from obstruction. 8. Observe impeller for buildup – clean if necessary.

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Problem	Probable Cause	Actions
Pump		
Pump will not start	1. Starter fault (if applicable) 2. No power to control panel. 3. Breaker open or fuses blown 4. Electrical connections 5. System On-Off selector switch in the OFF position 6. Faulty pump motor 7. Main panel disconnect not engaged. 8. Pump impeller seized	1. Turn main panel disconnect ON 2. Verify main source disconnect is ON / Energized 3. Reset breaker / replace fuses a. Check for breaker / fuse sizing b. Check fan / motor spin freely 4. Verify terminal and motor connections are secure 5. Place selector switch into the ON position 6. Megger motor: Consult BIOREM® service department 7. Check for ground fault 8. Check and grease bearings a. Ensure drain on fan housing is open. b. Remove any obstruction from shaft / etc…
No Flow / Erroneous flow measurement	1. Pump not running. 2. Broken / Seized pump impeller. 3. Pump bearings. 4. Inlet valve(s) closed 5. Blocked piping. 6. Moisture in gauge. 7. Faulty gauge.	1. Start pump. 2. Replace / free impeller 3. Grease / repair replace bearings 4. Ensure that all valves are open. 5. Determine source of blockage and remove. 6. Remove cover of gauge – drain – dry. 7. Replace gauge.
Excessive pump noise / vibration	1. Unbalanced impeller 2. Pump and motor not secured to base. 3. Pump and shaft bearings worn. 4. Pump shaft misaligned. 5. Debris / build-up on impeller.	1. Check impeller for buildup on pump impeller. a. Check for broken or chipped pieces. b. Clean and clear as required. 2. Ensure pump mounting is secure / tighten / install all bolts. 3. Replace worn bearings / grease if wear is not excessive. 4. Have motor and shaft aligned by a certified millwright. 5. Observe impeller for buildup – clean if necessary.
Humidification		
Water flow rate / Pressure reading outside of acceptable range*	1. Humidification nozzles plugged. 2. Inlet ball valve closed. 3. Low water pressure. 4. Y-strainer plugged / fouled. 5. Insufficient water flow rate. 6. Excessive water pressure 7. Humidification nozzle broken / missing 8. Humidification lance broken 9. Malfunctioning transmitter	1. Isolate water supply line – remove nozzles and clean. 2. Open ball valves. 3. Ensure water supply pressure is minimum 40psi. a. Verify the operation of the gauge. 4. Isolate Y-strainer – remove strainer screen – clean. 5. Ensure water line is sized for the appropriate capacity for both the humidification and irrigation water demand. 6. Install pressure control valve to reduce the incoming pressure to a maximum of 80psi. 7. Replace broken / missing nozzles. 8. Repair / replace lance. Replace transmitter.

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APPENDIX A. Glossary

Table 6: Abbreviations

c/w	comes with	PFD	process flow diagram
CPU	central processing unit	PLC	programmable logic controller
cfm	cubic feet per minute	ppb	parts per billion
gal	gallon	OU	odor units
gpd	gallons per day	D/T	dilution threshold
gpm	gallons per minute	R/T	recognition threshold
HMI	human machine interface	OU/ft^3	odor units per cubic foot
L	liter	OU/m^3	odor units per cubic meter
lpm	liter per minute	psi	pounds per square inch
MCC	motor control center	"WC	inches of water column
P&ID	process and instrumentation diagram	VFD	variable frequency drive
PC	personal computer	mA	milliAmperes

A.C. Motor
Consists of two basic parts: a rotating cylinder called a **rotor** and a stationary part called a **stator**. The **stator** surrounds the **rotor**. It has coil windings, which produce an alternating magnetic field. This magnetic field causes current to flow through the **rotor** conductors, resulting in rotational force. The **rotor** spins at a speed proportional to the frequency of the applied alternating current. The motor rotates at a set rotation depending on the frequency of the winding configuration.

Analog
An electrical signal that is proportional to the size of the variable being monitored or controlled. Analog signals in our systems are exclusively 4 to 20 mA. Analog signals can be 0 to 20 mA or 0 to 10 VDC. Analog signals are used to control devices which have variable speeds or positions.

Blow-down
The continuous bleeding of water from the system to prevent solids build-up and acidification of the water solution.

Contactor
The electrical switch component of the motor starter. The contactor protects the PLC by isolating it from high currents and voltages necessary to run most motors. A contactor operates as follows: an output of 120 V or less from the PLC energizes a magnetic coil and/or coils in the contactor. The magnetic field causes the contact(s) to pull in, completing the motor's circuit.

Corrosion
The attack upon metals by chemical agents, converting them to non-metallic products.

Current
The movement of electrons through a conductor (such as a wire). Electrical current is analogous to the flow of water through a pipe. Current is measures in Amperes (A) or milliAmperes (mA). The current direction can be either direct (DC) or alternating (AC). The current draw of a motor is stamped on the factory name plate of the motor.

Digital
A discrete signal, also known as digital, is either on or off. This type of signal is used for devices that are either open/close or on/off.

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Electrical Power
The rate of consumption of electrical energy. Power is calculated by multiplying the current by the voltage. Power is usually expressed in watts (W), kilowatts (kW), or horsepower (HP).

Foulants
The inclusion of unwanted materials that deposit or grow on the surface of the media.

Fouling
The gradual buildup of unwanted materials on the surface of the media or within the media bed. Fouling increases the pressure drop across the media bed and impacts the performance of the system.

HMI (Human Machine Interface)
A computer program featuring a graphical user interface, which allows the operator instant access and control of various parameters and equipment functions.

Media
A blend of materials used in the purification of the air stream.

Normally Open Switches (NO)
The circuit is open when no forces are acting on the switch.

Normally Closed Switches (NC)
The circuit is closed when no forces are acting on the switch.

Packing
A material used in the humidification of the air stream. The material increases the contact area of the water and the air.

pH
A term used to describe the hydrogen ion activity of a system. The pH scale ranges from 0-14. A solution with a pH below 7 is acidic, and any solution with a pH above 7 is basic. A pH of 7 is neutral.

ppm
parts per million. 1 ppm = 1 mg/L (assuming a specific gravity of 1.0).

Pressure Drop
A loss of pressure due to friction or flow restriction.

Voltage
The difference in electrical potential across two points. Voltage is measured in volts (V).

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APPENDIX B. Material Safety Data Sheets

Table 7: List of MSDS

MSDS	Substance	Pages	Dated
1	Media - LWE	4	Jan-07
2	Media - XLD®	5	Mar-08

Material Safety Data Sheets are provided by BIOREM® for the BIOREM® supplied materials only. Other MSDS for this project may be added into this section as required. The owner should request these documents from the supplier of the chemicals.

Always follow the information provided in the MSDS, failure to do so may result in personal injury or death.

BIOREM® shall not be responsible for any damage or injury including incidental, consequential, or special damages resulting from or in any way connected to the composition of materials not supplied by BIOREM® or the improper use of handling of materials in the operation of the system.

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MATERIAL SAFETY DATA SHEET
Biotrickling filter POPCORN LWE Media

SECTION 1 – Chemical Product and Company Identification

MSDS Name	Biotrickling Filter Media
Synonyms:	
Company Identification:	Biorem Technologies Inc. 7496 Wellington Road 34 Guelph, ON N1H 6H9
For information, call:	(519) 767-9100

SECTION 2 – Composition, Information on Ingredients

CAS #	Chemical Name	%	EINECS #
87347-84-0	SiO_2	71 MA.-%	Not Available
Not Available	Na_2O	14 MA.-%	Not Available
Not Available	CaO	9 MA.-%	Not Available
Not Available	Al_2O_3	3 MA.-%	Not Available
Not Available	MgO	2 MA.-%	Not Available
Not Available	K_2O	1 MA.-%	Not Available

SECTION 3 – Hazards Identification

Appearance:	Off-white color. Asymmetrical spherical solids ranging from 1mm to 20mm in diameter. WARNING! This is considered to be of low hazard in normal industrial handling.
Target Organs:	None.

Potential Health Effects

Eye:	No information found.
Skin:	No information found.
Ingestion:	No information found.
Inhalation:	No information found.
Chronic:	No information found.

SECTION 4 - First Aid Measures

Eyes:	Rinse eyes with water (keeping the eyelids open). Consult a doctor.
Skin:	Not applicable.
Ingestion:	Consult a doctor.
Inhalation:	Consult a doctor if glass dust was inhaled.
Notes to Physician:	Glass splinters can cause internal injuries to the trachea, stomach, and intestines.

SECTION 5 – Fire Fighting Measures

General Information:	Special protective equipment for fire fighting: Not applicable
Extinguishing Media:	Not applicable
Autoignition Temperature:	Not available.
Flash Point:	Not applicable
NFPA Rating:	Not published.
Explosion Limits, Lower: Upper:	Not available. Not available.

SECTION 6 – Accidental Release Measures

General Information:	Can be absorbed dry or wet.
Spills/Leaks:	Sweep up, then place into a suitable container for disposal. Avoid generating dusty conditions.

SECTION 7 – Handling and Storage

Handling:	Information for safe use: Not applicable Danger during processing: Avoid causing dust Information on fires and explosions: Not flammable
Storage:	Requirements for storage rooms and containers: Not applicable Additional information on storage conditions: Protect from dampness

SECTION 8 – Exposure Controls, Personal Protection

Engineering Controls:	Good general ventilation should be sufficient to control airborne levels.

Chemical Name	ACGIH	NIOSH	OSHA – Final PELs
Biotrickling filter Media	Information not available	Information not available	Information not available

Personal Protective Equipment:

Eyes:	Goggles required.
Skin:	Not applicable.
Clothing:	Not applicable.
Respirators:	Face mask required if dust present.

SECTION 9 – Physical and Chemical Properties

Physical State:	Solid
Appearance:	Creamy white
Odour:	Odourless
pH:	10.7 (20°C / 100g/L)
Vapour Pressure:	Not applicable
Vapour Density:	Not applicable
Evaporation Rate:	Not applicable
Softening Temperature	Approx. 700°C
Boiling Point:	Not applicable
Freezing/Melting Point:	Not applicable
Decomposition Temperature:	Not applicable
Solubility:	Approx. 2000mg/kg
Bulk Density, dry:	150 kg/m^3
Bulk Density, wet:	210 kg/m^3

SECTION 10 – Stability and Reactivity

Conditions to Avoid:	Not applicable
Incompatibilities with Other Materials:	Not applicable
Hazardous Decomposition Products:	Not applicable

SECTION 11 – Toxicological Information

RTECS#:	CAS#
LD50/LC50:	Not known
Carcinogenicity:	Biofilter media - not listed by ACGIH, IARC, NIOSH, NTP, or OSHA.
Epidemiology:	No information available.
Teratogenicity:	No information available.
Reproductive Effects:	No information available.
Neurotoxicity:	No information available.
Mutagenicity:	No information available.
Other Studies	Eye contact: Irritation Swallowing: Irritation of the mouth, throat, oesophagus, and gastro-intestinal tract Subacute to chronic toxicity: No data available

SECTION 12 – Ecological Information

Ecotoxicity:	No information available.
Environmental Fate:	No information reported.
Physical/Chemical:	No information available.
Other:	No information available.

SECTION 13 – Disposal Considerations

Dispose of in a manner consistent with federal, state and local regulations.

Disposal:	Not a hazardous material
Waste Key:	200102
Designation of waste:	soda-lime glass granulate

Not listed as a material banned from land disposal according to RCRA.

SECTION 14 – Transport Information

US DOT	No information available
IMO:	No information available
IATA:	Not a hazardous material.
RID/ADR:	Not applicable.
Canadian TDG:	No information available

SECTION 15 – Regulatory Information

US FEDERAL:

TSCA	No information available
Health and Safety Reporting List:	No information available
Chemical Test Rules:	No information available
Section 12b:	No information available
TSCA Significant New Use Rule:	No information available

SARA:

Section 302 (RQ):	No information available
Section 302 (TPQ):	No information available
Section 313:	No information available
Clean Air Act:	No information available
Clean Water Act:	No information available
OSHA:	No information available
US STATE:	No information available

SECTION 16 – Additional Information

MSDS Creation Date: January 11, 2007 Revision 001

The information above is believed to be accurate and represents the best information currently available to us. However, we make no warranty of merchantability or any other warranty, express or implied, with respect to such information, and we assume no liability resulting from it's use. Users should make their own investigations to determine the suitability of the information for their particular purposes. In no way shall Biorem Technologies Inc. be liable for any claims, losses, or damages of any third party or for the lost profits or any special, indirect, incidental, consequential or exemplary damages, howsoever arising.

MATERIAL SAFETY DATA SHEET
Biofilter XLD Media

SECTION 1 – Chemical Product and Company Identification

MSDS Name	Biofilter Media
Synonyms:	
Company Identification:	Biorem Technologies Inc. 7496 Wellington Road 34 Guelph, ON N1H 6H9
For information, call:	(519) 767-9100

SECTION 2 – Composition, Information on Ingredients

CAS #	Chemical Name	%	EINECS #
Not Available	Organic compost blend	0-25	Not Available
87347-84-0	SiO_2	53-71	Not Available
Not Applicable	Na_2O	11-14	Not Available
Not Applicable	CaO	7-9	Not Available
Not Applicable	Al_2O_3	2-3	Not Available
Not Applicable	MgO	1.5-2	Not Available
Not Applicable	K_2O	1	Not Available

SECTION 3 – Hazards Identification

Appearance:	Grey to black coloured solid. Asymmetrical spherical solids ranging from 1mm to 20mm in diameter. WARNING! This is considered to be of low hazard in normal industrial handling.
Target Organs:	None.

Potential Health Effects

Eye:	Dust may cause irritation.
Skin:	Excessive contact with skin may cause irritation. Various species of wood and wood dust can elicit allergic contact dermatitis in sensitized individuals.
Ingestion:	No hazard expected in normal industrial use.
Inhalation:	No hazard expected in normal industrial use. Excessive inhalation may cause nasal dryness, irritation and obstruction.
Chronic:	No information found.

SECTION 4 - First Aid Measures

Eyes:	Immediately flush with plenty of water for at least 15 minutes, occasionally lifting the upper and lower lids. If irritation continues, seek medical help.
Skin:	Immediately flush with plenty of soap and water for at least 15 minutes. If rash develops or irritation persists, seek medical attention.
Ingestion:	If large amounts of product ingested, do NOT induce vomiting. Seek medical help.
Inhalation:	Remove from exposure to fresh air. If persistent coughing or breathing difficulties, seek medical attention.
Notes to Physician:	Glass splinters can cause internal injuries to the trachea, stomach, and intestines. Treat symptomatically and supportively.

SECTION 5 – Fire Fighting Measures

General Information:	As in any fire, wear a self-contained breathing apparatus (SCBA) in a pressure-demand.
Extinguishing Media:	Use water spray, dry chemical or carbon dioxide.
Autoignition Temperature:	Not available.
Flash Point:	Not available.
NFPA Rating:	Not published.
Explosion Limits, Lower: Upper:	Not available. Not available.

SECTION 6 – Accidental Release Measures

General Information:	Use proper personal protective equipment as indicated in Section 8. Can be absorbed dry or wet.
Spills/Leaks:	Sweep up, then place into a suitable container for disposal. Avoid generating dusty conditions.

SECTION 7 – Handling and Storage

Handling:	Wash thoroughly after handling. Remove contaminated clothing and wash before reuse. Use with adequate ventilation. Minimize dust generation and accumulation. Do not get on skin or in the eyes. Do not ingest or inhale. Wash hands before eating.
Storage:	Store in a tightly closed container. Store in a cool, dry, well-ventilated area away from incompatible substances. Protect from dampness.

SECTION 8 – Exposure Controls, Personal Protection

Engineering Controls:	Good general ventilation should be sufficient to control airborne levels.

Chemical Name	ACGIH	NIOSH	OSHA – Final PELs
Biofilter Media	None listed	None listed	Dust, 5 mg/m^3 TWA; 10 mg/m^3 STEL

Personal Protective Equipment:

Eyes:	Wear appropriate protective eyeglasses or chemical safety goggles as described by OSHA's eye and face protection regulations in 29 CFR 1910.133.
Skin:	Wear puncture resistant gloves. Wear natural rubber apron and/or clothing.
Clothing:	Wear appropriate protective gloves and clothing to prevent skin exposure.
Respirators:	Follow the OSHA respirator regulations found in 29CFR 1910.134. Always use a NIOSH-approved respirator when necessary.

SECTION 9 – Physical and Chemical Properties

Physical State:	Solid
Appearance:	Dark brown to black
Odour:	Mild earthy or musty smell
pH:	6.0 to 10.0

SECTION 9 – Physical and Chemical Properties Continued….

Vapour Pressure:	Not applicable
Vapour Density:	Not applicable
Evaporation Rate:	Negligible
Softening Temperature	Approx. 700°C
Viscosity:	Not applicable
Boiling Point:	Not applicable
Freezing/Melting Point:	Not applicable
Decomposition Temperature:	Not applicable
Solubility:	Not available
Specific Gravity/Density:	18.07 lb/ft3 (dry), 23.26lb/ ft3 (wet)

SECTION 10 – Stability and Reactivity

Chemical Stability:	Stable under normal temperatures and pressures.
Conditions to Avoid:	Entry into a closed vessel should follow Confined space entry procedures. Oxygen may be deficient.
Incompatibilities with Other Materials:	Avoid contact with oxidizing agents and drying oils.
Hazardous Decomposition Products:	Thermal oxidative degradation of wood may produce irritating and toxic fumes and gases, including carbon monoxide, aldehydes and organic acids.
Hazardous Polymerization:	Has not been reported.

SECTION 11 – Toxicological Information

RTECS#:	CAS#
LD50/LC50:	None available.
Carcinogenicity:	Biofilter media - not listed by ACGIH, IARC, NIOSH, NTP, or OSHA.
Epidemiology:	No information available.
Teratogenicity:	No information available.
Reproductive Effects:	No information available.
Neurotoxicity:	No information available.
Mutagenicity:	No information available.
Other Studies	Eye contact: Irritation Swallowing: Irritation of the mouth, throat, oesophagus, and gastro-intestinal tract Subacute to chronic toxicity: No data available

SECTION 12 – Ecological Information

Ecotoxicity:	No information available.
Environmental Fate:	No information reported.
Physical/Chemical:	No information available.
Other:	No information available.

SECTION 13 – Disposal Considerations

Dispose of in a manner consistent with federal, state and local regulations.

RCRA D-Series Maximum Concentration of Contaminants:	Not listed.
RCRA D-Series Chronic Toxicity Reference Levels:	Not listed.

SECTION 13 – Disposal Considerations Continued….

RCRA F-Series	Not listed.
RDRA P-Series:	Not listed.
RCRA U-Series:	Not listed.

Disposal:	Not a hazardous material
Waste Key:	200102
Designation of waste:	soda-lime glass granulate

Not listed as a material banned from land disposal according to RCRA.

SECTION 14 – Transport Information

US DOT	No information available
IMO:	No information available
IATA:	Not a hazardous material.
RID/ADR:	Not applicable.
Canadian TDG:	No information available

SECTION 15 – Regulatory Information

US FEDERAL:

TSCA	Biofilter media is not on the TSCA Inventory.
Health and Safety Reporting List:	No information available
Chemical Test Rules:	Not under a Chemical Test Rule
Section 12b:	Not listed under TSCA Section 12b
TSCA Significant New Use Rule:	Nothing in this material has a SNUR under TSCA.

SARA:

Section 302 (RQ):	Nothing in this material has an RQ.
Section 302 (TPQ):	Nothing in this product has a TPQ.
Section 313:	Not reportable under Section 313.
Clean Air Act:	This material does not contain any hazardous air pollutants. This material does not contain any Class 1 Ozone depletors. This material does not contain any Class 2 Ozone depletors.
Clean Water Act:	None of the chemicals in this product are listed as Hazardous Substances under the CWA None of the chemicals in this product are listed as Priority Pollutants under the CWA None of the chemicals in this product are listed as Toxic Pollutants under the CWA
OSHA:	None of the chemicals in this product are considered highly hazardous by OSHA.
US STATE:	Not present on state lists from CA, PA, MN, MA, FL, or NJ. California No Significant Risk Level: Nothing in this product is listed.

EUROPEAN/INTERNATIONAL REGULATIONS:

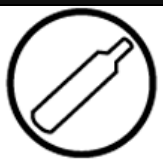
European Labeling in Accordance with EC Directives	
Hazard Symbols:	Not available
Risk Phrases:	R36/38 Irritating to eyes
Safety Phrases:	S22 Do not inhale dust S24/25 Avoid contact with skin S26 In case of contact with eyes, rinse immediately with plenty of water and seek medical advice S28 After contact with skin, wash immediately with plenty of water S36/37 Wear suitable protective clothing and gloves
WGK(Water Danger/Protection):	
CANADA:	None of the chemicals in this product are listed on the DSL/NDSL list Biofilter media is not listed on Canada's Ingredient Disclosure List.
Exposure Limits:	

SECTION 16 – Additional Information

MSDS Creation Date: March 12, 2008 Revision 001

The information above is believed to be accurate and represents the best information currently available to us. However, we make no warranty of merchantability or any other warranty, express or implied, with respect to such information, and we assume no liability resulting from it's use. Users should make their own investigations to determine the suitability of the information for their particular purposes. In no way shall Biorem Technologies Inc. be liable for any claims, losses, or damages of any third party or for the lost profits or any special, indirect, incidental, consequential or exemplary damages, howsoever arising.

Table 8: Hazard Symbols and Classes

The symbol represents…		It means that the material…	And that you should…
	**Class A: Compressed Gas**	• pose an explosion danger because the gas is being held in a container under pressure; • may cause its container to explode if heated (such as what would happen in a fire); • may also cause its container to explode if dropped.	• handle with care, do not drop container; • keep container away from potential sources of ignition; • store the container in designated areas.
	Class B: Flammable and Combustible Material	• will burn and are therefore potential fire hazards. • may burn at relatively low temperatures; flammable materials catch fire at lower temperatures than combustible materials. • may burst into flame spontaneously in air or may release a flammable gas on contact with water; • may cause a fire when exposed to heat, sparks, or flames or as a result of friction.	• keep the material away from heat sources and other combustible materials; • never smoke when working with or near the material; • store the containers in designated areas.
	Class D, Division 1: Poisonous & Infectious Materials - Immediate and Serious Toxic Effects	• are a potentially fatal poisonous substance; • may cause permanent damage if inhaled or swallowed or if they enter the body through skin contact; • may burn eyes or skin upon contact.	• handle the material with extreme caution; • avoid contact with the skin or eyes by wearing the proper protective equipment, including eye, face, and hand protection and protective clothing; • avoid inhaling by working in well-ventilated areas and/or wearing respiratory equipment; • wash and shower thoroughly after using; • store the containers in designated areas.

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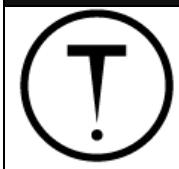
Hazard Symbols and Classes Cont'd

The symbol represents…		It means that the material…	And that you should…
	**Class D, Division 2: Poisonous & Infectious Materials - Other Toxic Effects**	• are poisonous substances that are not immediately dangerous to health; • may cause death or permanent damage as a result of repeated exposures over time; • may be a skin or eye irritant; • may be a sensitizer, which produces a chemical allergy; • may cause cancer; • may cause birth defects or sterility.	• avoid contact with the skin or eyes by wearing the proper protective equipment, including eye, face, and hand protection and protective clothing; • avoid inhaling by working in well-ventilated areas and/or wearing respiratory equipment; • store the containers in designated areas.
	Class D, Division 3: Poisonous & Infectious Materials - Biohazardous infectious material	• may cause a serious disease resulting in illness or death.	• take every measure to avoid contamination; • handle the material only when fully protected by the proper, designated equipment; • handle the material in designated areas where engineering controls are in place to prevent exposure.
	Class E: Corrosive Material	• cause severe eye and skin irritation upon contact; • cause severe tissue damage with prolonged contact; • may be harmful if inhaled.	• keep containers tightly closed; • avoid contact with the skin or eyes by wearing the proper protective equipment, including eye, face, and hand protection and protective clothing; • avoid inhaling by working in well-ventilated areas and/or wearing respiratory equipment.
	Class F: Dangerously Reactive Material	• are very unstable; • may react with water to release a toxic or flammable gas; • may explode as a result of shock, friction or increase in temperature; • may explode if heated when in a closed container; • may undergo vigorous polymerization.	• keep material away from heat; • open containers carefully, do not drop them; • store the material in a cool, flame-proof designated area.

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APPENDIX C. Warranty

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APPENDIX D. Drawings

Table 9: List of Drawings

Drawing	Drawing Number	Drawing Description
-	-	Cover Sheet
SS	-	ISA Symbology
SS	-	ISA Symbology Identifiers
PFD	SK-450-D-001 SH: 1 of 5	Process Flow Diagram
P&ID	SK-450-D-001 SH: 2 of 5	Exhaust Fan & Assoc. Equipment
P&ID	SK-450-D-001 SH: 3 of 5	Media Filter & Assoc. Equipment
P&ID	SK-450-D-001 SH: 4 of 5	Waterbox & Assoc. Equipment
P&ID	SK-450-D-001 SH: 5 of 5	Nutrient Addition & Assoc. Equipment
GA	SK-450-GA-000 SH: 1 thru 7	General Arrangement
SA	SK 250_ 450-SA-000 SH: 1 thru 4	Waterbox Panel
SA	SK 250_ 450-SA-001	Waterbox Panel Nutrient Addition
SA	SK-450-SA-000 SH: 1 thru 3	VESSEL ASSEMBLY
SA	SK-450-SA-001	BF Irrigation Spool
SA	SK-450-SA-002	BTF Irrigation Spool
ELEC	SK250_450-E-001 SH: 1 thru 2 of 3	Electrical Wiring Diagram
ELEC	SK250_450-E-001 SH: 3 of 3	Control Panel Layout Diagram

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BIOREM SK450 Process & Instrumentation Diagram Drawing Set

PROCESS AND INSTRUMENTATION DIAGRAM SET FOR

SK450

BIOREM

PROJECT NUMBER: XXXXF

VALVE/DAMPER & GATE SYMBOLS

NORMALLY CLOSED	NORMALLY OPEN	DESCRIPTION
		DIAPHRAGM
		BUTTERFLY
		GATE OR OTHER IN-LINE TYPE NOT OTHERWISE IDENTIFIED
		BALL
		PLUG OR ANGLE SEAT
		NEEDLE
		PINCH
K	K	KNIFE GATE
		GLOBE
		CHECK
		BACKFLOW PREVENTER
		INJECTION QUILL
		THREE WAY
		RUPTURE DISC (PRESSURE)
		RUPTURE DISC (VACCUUM)
		VACCUUM BREAKER
		PRESSURE REGULATOR
		BACK PRESSURE REGULATOR
		PRESSURE RELIEF MULTI FUNCTION VALVE
		FLOAT CONTROLLED
		Y STRAINER
		FOUR WAY

EQUIPMENT SYMBOLS

- COMPRESSOR PISTON
- REGENERATIVE BLOWER/FAN (R)
- AXIAL FLOW PUMP
- DESICCANT DRYER
- AIR DRYER
- METERING PUMP
- K-FACTOR =
- PADDLEWHEEL FLOWMETER
- FLOWMETER VORTEX OR MAGNETIC (TYPE INDICATED)
- INLINE STRAINER
- ROTAMETER (VARIABLE AREA FLOWMETERS)
- MEDIA OR PACKED BED
- PITOT TUBE
- LOBE BLOWER/FAN
- CENTRIFUGAL BLOWER/FAN
- SUBMERSIBLE PUMP
- CENTRIFUGAL PUMP
- POSITIVE DISPLACEMENT PUMP
- DIAPHRAGM PUMP
- FLUME
- ORIFICE PLATE IN QUICK CHANGE FITTING
- ORIFICE PLATE
- CALIBRATION COLUMN
- STATIC MIXER
- PULSATION DAMPENER
- SILENCER OR FILTER
- MUFFLER
- DIAPHRAGM SEAL
- CARTRIDGE FILTER
- VENT AND FILTER (F)
- MIXER
- FIXED SCREEN
- NOZZLE
- BACKDRAFT DAMPER
- HEAT EXCHANGER
- HEATER
- HEATING/COOLING COIL

LINE SYMBOLS & MISC

P&ID LINE TYPES

- PROCESS LINE
- EQUIPMENT/LINE SUPPLIED BY OTHERS
- BOUNDARY
- REVISED ITEM
- OPTIONAL/ADDER ITEM
- LOCAL PANEL

INSTRUMENTATION LINES

- I/P CONVERTER (ELECTRIC ANALOG TO PNEUMATIC SIGNAL CONVERTER)
- MECHANICAL LINK
- ULTRASONIC/ELECTROMAGNETIC
- INSTRUMENT CONNECTION
- ELECTRIC SIGNAL (ANALOG OR DIGITAL)
- SOFTWARE LINK
- CALCULATED VALUE
- PNEUMATIC LINE

- TERMINATION TAG
- PIPING SPOOL TAG
- REVISION TRIANGLE
- CONTINUATION SYMBOL
- THERMOWELL
- FLEXIBLE COUPLING
- FLEXIBLE HOSE
- VICTAULIC CONNECTION
- CAMLOCK CONNECTION
- FLANGED CONNECTION
- BLIND FLANGE
- REDUCER
- THREADED COUPLING
- CYLINDRICAL STRAINER
- FLOOR DRAIN

P&ID TIE – INS

EX.

SIGNAL
FROM
SIGNAL
F-D-003
FROM
SIGNAL
F-D-003
FROM

COMMON ABBREVIATIONS

OP	OPERATING POINT
SP	SET POINT
MCC	MOTOR CONTROL CENTER
HOA	HAND–OFF AUTO
LOR	LOCAL–OFF REMOTE
DI	DIGITAL INPUT
DO	DIGITAL OUTPUT
AI	ANALOG INPUT
AO	ANALOG OUTPUT

GENERAL INSTRUMENT FUNCTION SYMBOLS

	LOCATED ON SKID CONTROL PANEL	FIELD MOUNTED	AUXILIARY LOCATION, NORMALLY ACCESSIBLE TO OPERATOR
DISCRETE INSTRUMENTS			
HUMAN MACHINE INTERFACE HMI			
COMPUTER/DCS FUNCTION			
PROGRAMMABLE LOGIC CONTROL			

- HH / H / L / LL — PLC ALARM FUNCTION WITH MULTIPLE TRIGGER POINTS SEE INSTRUMENT LETTERS
- INSTRUMENTS SHARING COMMON HOUSING
- PILOT LIGHT
- UNDEFINED INTERLOCK LOGIC
- PLC–X — SYSTEMS WITH MULTIPLE PLC'S
- Σ SUMMING
- Σ/n AVERAGING
- < LOW SELECTING
- > HIGH SELECTING
- f(x) UNSPECIFIED FUNCTION

VALVE & GATE ACTUATOR SYMBOLS

NOTE: ON LOSS OF PRIMARY POWER (PNEUMATIC, ELECTRICAL OR HYDRAULIC)
XX: FC = FAIL CLOSED, FO = FAIL OPEN, FL = FAIL TO LAST POSITION
IF NOT SPECIFIED ASSUME FC.

- PNEUMATIC DIAPHRAGM
- DOUBLE ACTING PNEUMATIC CYLINDER (INST.AIR LINES NOT ALWAYS SHOWN)
- SPRING CLOSE PNEUMATIC CYLINDER (INST.AIR LINES NOT ALWAYS SHOWN)
- SPRING OPEN PNEUMATIC CYLINDER (INST.AIR LINES NOT ALWAYS SHOWN)
- SOLENOID
- TS TRAVEL STOP
- VALVE POSITIONER
- ELECTRIC MOTOR (ANALOG – CONTROL)
- ELECTRIC MOTOR (DIGITAL– OPEN/CLOSED)
- ELECTRIC MOTOR (DIGITAL– OPEN DIGITAL – CLOSE)
- HAND WHEEL
- HAND LEVER

LINE DESIGNATION

(SIZE,SCHEDULE,MATERIAL)

SIZE (x"), SCHEDULE, MATERIAL

EX. 4", SCH.80, PVC

MOST COMMON MATERIAL'S

SCH.80, PVC	SCH.40, C.S.
SCH.80, CPVC	P.E. TUBING
SCH.10, 316L SS	SS TUBING
SCH.40, 316L SS	NYLON TUBING
SCH.10, 304L SS	FRP DUCT
SCH.40, 304L SS	316LSS DUCT

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2. TOLERANCES:
FRACTIONS ± 1/32
2 PLACE DEC. ±.030
3 PLACE DEC. ±.010
ANGLES ±1.0°

CUSTOMER:

TITLE: ISA SYMBOLOGY

JOB #:

SCALE:

SIZE: B

DRAWING NUMBER: SH:1of 1

REV:

REV	DATE	DESCRIPTION	BY
REVISIONS			

MECHANICAL OR INSTRUMENT DEVICE TAG IDENTIFICATION PREFIX

AV	AIR VENT	NZ	NOZZLE
AC	AIR COMPRESSOR	P	PUMP
AE/AIT	ANALYSIS ELEMENT WITH ANALYSIS INDICATING TRANSMITTER	PE/PIT	PRESSURE ELEMENT WITH PRESSURE INDICATING TRANSMITTER
AE/AT	ANALYSIS ELEMENT WITH ANALYSIS TRANSMITTER	PE/PT	PRESSURE ELEMENT WITH PRESSURE TRANSMITTER
B	BLOWER	PI	PRESSURE INDICATOR
BF	BIOFILTER	PRV	PRESSURE REGULATING VALVE
BPV	BACK PRESSURE VALVE	PS*	PRESSURE SWITCH
BTF	BIOTRICKLING FILTER	PSV	PRESSURE RELIEF VALVE
CV	CHECK VALVE/INJECTION QUILL	SCR	SCREEN
DR	AIR DRIER	SG	SIGHT GLASS
EF	EXHAUST FAN	STR	STRAINER
FCV	FLOW CONTROL VALVE	SV	SAMPLE VALVE
FE/FIT	FLOW ELEMENT WITH FLOW INDICATING TRANSMITTER	TE/TIT	TEMPERATURE ELEMENT WITH TEMPERATURE INDICATING TRANSMITTER
FE/FQI	FLOW ELEMENT WITH FLOW INDICATING TOTALIZER	TE/TT	TEMPERATURE ELEMENT WITH TEMPERATURE TRANSMITTER
FE/FT	FLOW ELEMENT WITH FLOW TRANSMITTER	TI	TEMPERATURE INDICATOR
FI	FLOW INDICATOR	TK	TANK
FV	AUTOMATIC VALVE	TS*	TEMPERATURE SWITCH
H	HEATER	YY	SOLENOID FOR PNEUMATIC CONTROL OF AUTOMATIC VALVE
HC	HEATING COIL		
HCV	HAND CONTROL VALVE		
HV	HAND VALVE		
LCV	LEVEL CONTROL VALVE		
LE/LIT	LEVEL ELEMENT WITH LEVEL INDICATING TRANSMITTER		
LE/LT	LEVEL ELEMENT WITH LEVEL TRANSMITTER		
LG	LEVEL SIGHT GLASS		
LS*	LEVEL SWITCH		
ME	MIST ELIMINATOR		
MD	MEDIA		
MFV	MULTI FUNCTION VALVE (COMBINATION RELIEF & BACKPRESSURE VALVE FOR METERING PUMPS)		
MX	MIXER		

* ADD THE SUFFIX HH (HIGH HIGH), H (HIGH), L (LOW), LL (LOW LOW) AS REQUIRED FOR THESE ITEMS.

* ADD THE SUFFIX HH (HIGH HIGH), H (HIGH), L (LOW), LL (LOW LOW) AS REQUIRED FOR THESE ITEMS.

ISA TEXT ABBREVIATIONS

	MEASURED OR INDICATING VARIABLE	MODIFIER	READOUT OR PASSIVE FUNCTION	OUTPUT FUNCTION	MODIFIER
A	ANALYSIS		ALARM		
B	BURNER, COMBUSTION		USERS CHOICE	USERS CHOICE	USERS CHOICE
C	USERS CHOICE			CONTROL	
D	USERS CHOICE	DIFFERENTIAL			
E	VOLTAGE		SENSOR (PRIMARY ELEMENT)		
F	FLOW RATE	RATIO (FRACTION)			
G	USERS CHOICE		GLASS, VIEWING DEVICE		
H	HAND				HIGH
I	CURRENT (ELECTRICAL)		INDICATE		
J	POWER	SCAN			
K	TIME, TIME SCHEDULE	TIME RATE OF CHANGE		CONTROL STATION	
L	LEVEL		LIGHT		LOW
M	USERS CHOICE	MOMENTARY			MIDDLE, INTERMEDIATE
N	LOG REMOVAL		USERS CHOICE	USERS CHOICE	USERS CHOICE
O	USERS CHOICE		ORIFICE, RESTRICTION		
P	PRESSURE, VACUUM		POINT (TEST) CONNECTION		
Q	QUANTITY	INTEGRATE, TOTALISE			
R	RADIATION		RECORD		
S	SPEED, FREQUENCY	SAFETY		SWITCH	
T	TEMPERATURE			TRANSMIT	
U	MULTIVARIABLE		MULTIFUNCTION	MULTIFUNCTION	MULTIFUNCTION
V	VIBRATION, MECHANICAL ANALYSIS			VALVE, DAMPER, LOUVER	
W	WEIGHT, FORCE		WELL		
X	UNCLASSIFIED	X AXIS	AVERAGE	UNCLASSIFIED	UNCLASSIFIED
Y	EVENT, STATE OR PRESENT	Y AXIS		RELAY, COMPUTE, CONVERT	
Z	POSITION, DIMENSION	Z AXIS		DRIVER, ACTUATOR, UNCLASSIFIED FINAL CONTROL ELEMENT	

REVISIONS			
REV	DATE	DESCRIPTION	BY

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FRACTIONS ± 1/32
2 PLACE DEC. ±.030
3 PLACE DEC. ±.010
ANGLES ±1.0°

SCALE:

CUSTOMER:

TITLE: ISA SYMBOLOGY IDENTIFIERS

JOB #:

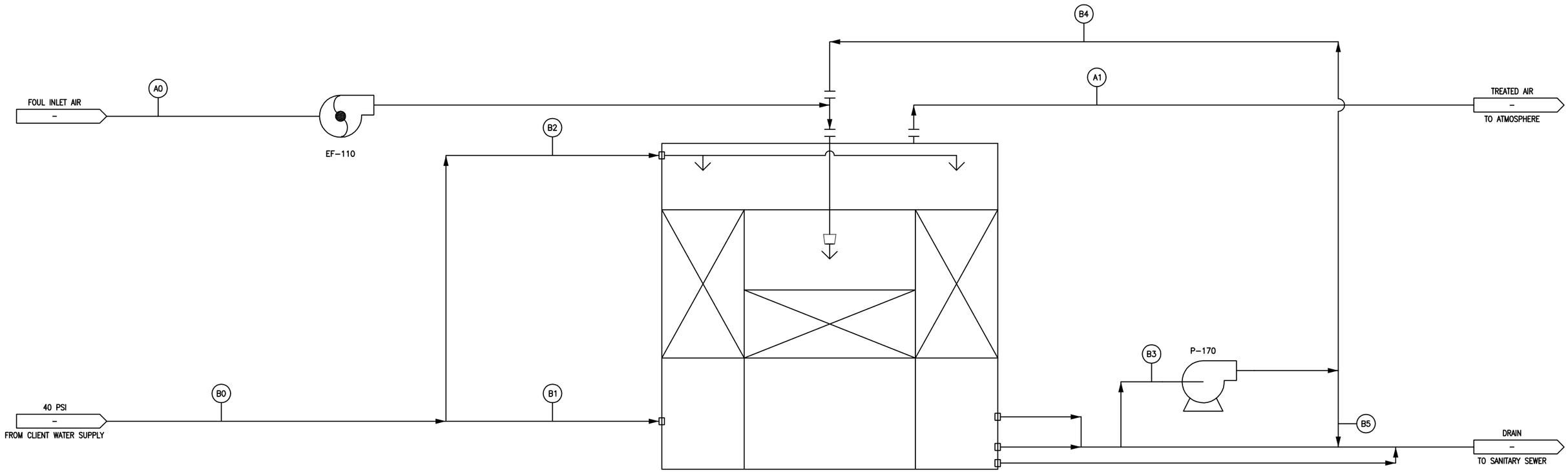
SIZE: B

DRAWING NUMBER: SH:1of 1

REV:

SK450 Process-Flow Table

STREAM	FLOW	RH	H2S	TRS	TEMP	Ph
A0	450 CFM	≥50%	100 PPM (AVG) 200 PPM (PEAK)	2.5-3 PPM	50-100°F	-
A1	450 CFM	100%	≤100 PPB	-	50-100°F	-
B0	458.5 GPD	-	-	-	50-100°F	5-8
B1	447 GPD	-	-	-	50-100°F	5-8
B2	11.5 GPD	-	-	-	50-100°F	5-8
B3	11.5 GPM	-	-	-	50-100°F	1-3
B4	11.1 GPM	-	-	-	50-100°F	1-3
B5	0.3 GPM	-	-	-	50-100°F	1-3



REV	DATE	DESCRIPTION	BY
01	21/01/10	ADDITION OF PG 5, NUTRIENT ADDITION	BAD
00	03/11/009	FOR REVIEW AND APPROVAL	BAD

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2. TOLERANCES:
FRACTIONS ± 1/32
2 PLACE DEC. ±.030
3 PLACE DEC. ±.010
ANGLES ±1.0°

SCALE: N/A

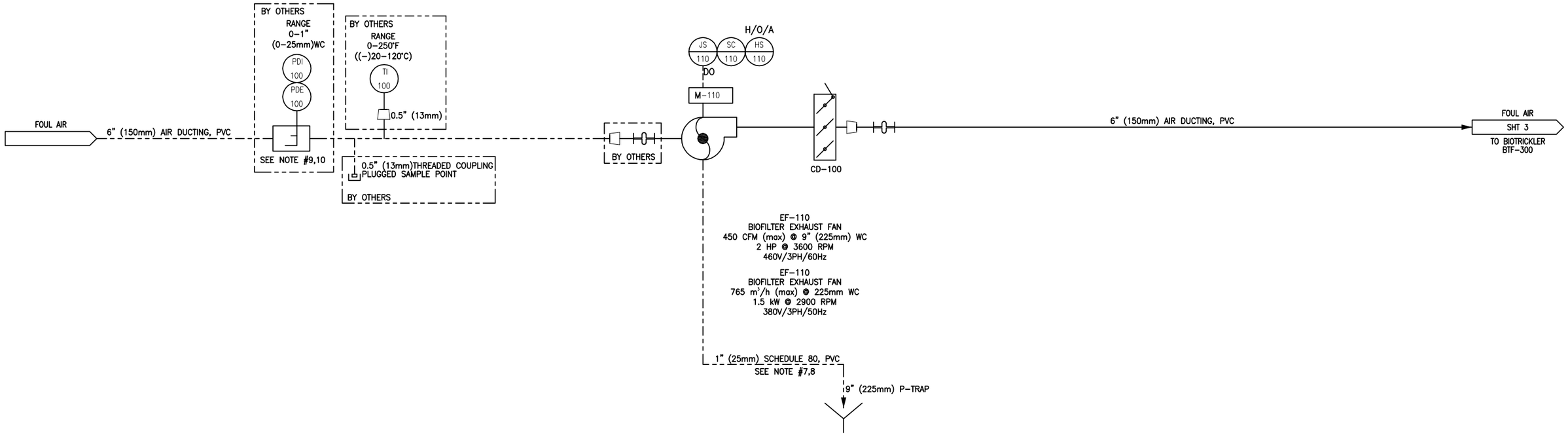
CUSTOMER:

TITLE: SK450 PROCESS FLOW DIAGRAM

JOB #: XXXXF

SIZE: B | DRAWING NUMBER: SK450-D-000 SH:1of 5 | REV: 01

NOTES:
1. ALL DOTTED PIPES, DUCTS, FLEXIBLE CONNECTORS AND EQUIPMENT BY OTHERS.
2. ALL EXPOSED WATER LINES TO BE HEAT TRACED AND INSULATED OR PAINTED FOR UV PROTECTION AS SPECIFIED.
3. ELECTRICAL WIRING BETWEEN INSTRUMENTATION AND BIOFILTER CONTROL PANEL TO BE SUPPLIED AND INSTALLED BY OTHERS.
4. ALL ELECTRICAL COMPONENTS LOCATED WITHIN 3 FEET OF THE ODOR CONTROL SYSTEM SHALL BE RATED FOR N.E.C. CLASS 1, DIVISION 2, GROUP D AREAS.
5. ALL PIPING AND AIR DUCTING SUPPORTS ARE SUPPLIED AND INSTALLED BY OTHERS.
6. INSTALLATION TO BE COMPLETED BY OTHERS.
7. LENGTH OF PIPE RUN FOR DRAIN FROM SOURCE NOT TO EXCEED 12 FEET PRIOR TO DISCHARGE INTO LARGER DRAIN LINE OR FLOOR DRAIN.
8. DRAIN LINES WITH (1–1/2 X FAN DISCHARGE PRESSURE)" P–TRAP PROVIDED BY OTHERS.
9. PITOT TUBE TO HAVE 8 ½ X DUCT DIA. UPSTREAM OF STRAIGHT DUCT, & 1 ½ X DUCT DIA. DOWSTREAM OF STRAIGHT DUCT.
10. PDI SHALL BE SUPPLIED WITH PRE–ASSEMBLED DRIP LEGS, TO BE INSTALLED BY OTHERS.
11. ALL PIPE TO BE SCH 80 PVC.



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00	03/11/09	FOR REVIEW AND APPROVAL	BAD

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APPROVED BY:		

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2. TOLERANCES:
FRACTIONS ± 1/32
2 PLACE DEC. ±.030
3 PLACE DEC. ±.010
ANGLES ±1.0°

SCALE: N/A

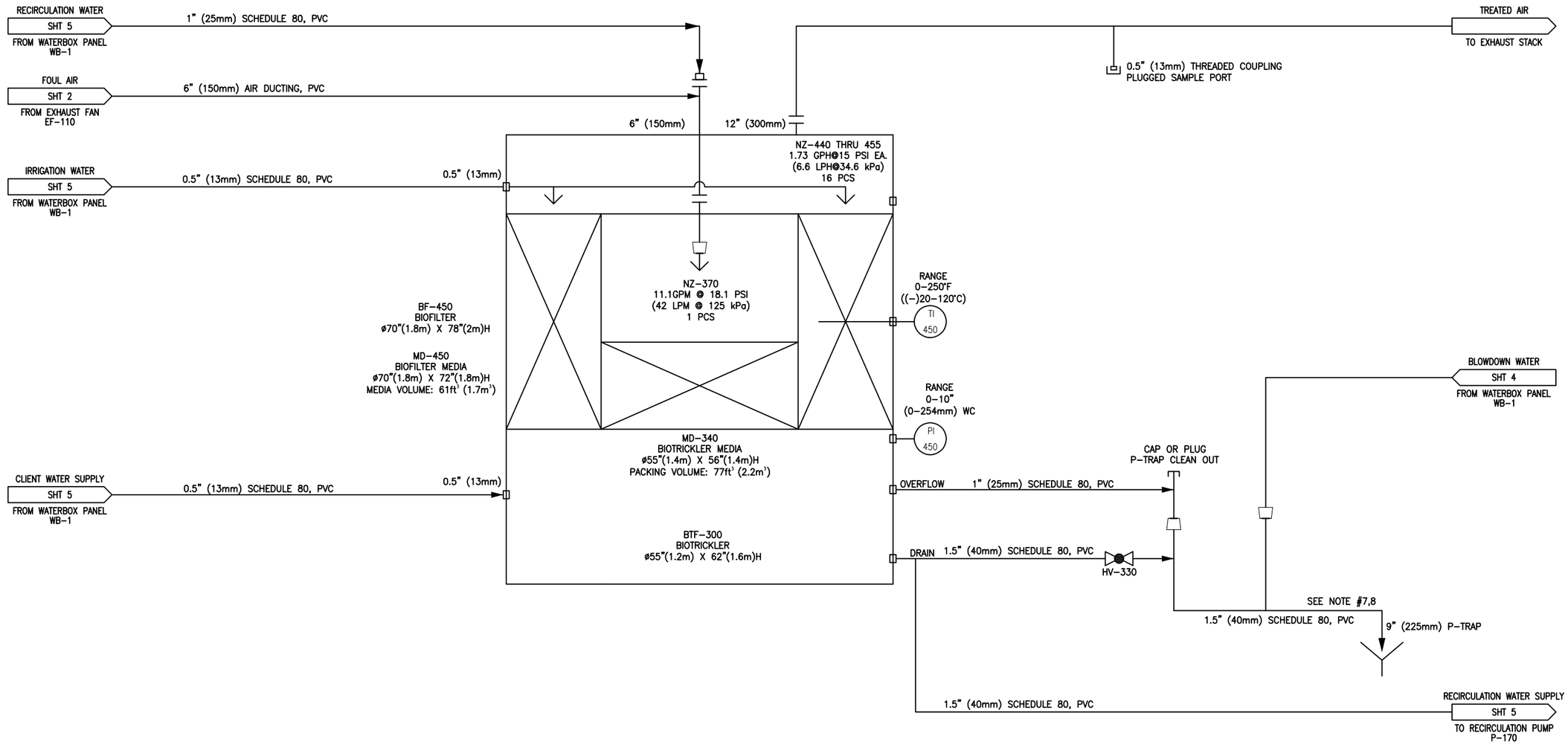
CUSTOMER:

TITLE: SK450
EXHAUST FAN & ASSOC. EQUIPMENT

JOB #: XXXXF

SIZE: B | DRAWING NUMBER: SK450–D–000 SH:2of 5 | REV: 01

NOTES:
1. ALL DOTTED PIPES, DUCTS, FLEXIBLE CONNECTORS AND EQUIPMENT BY OTHERS.
2. ALL EXPOSED WATER LINES TO BE HEAT TRACED AND INSULATED OR PAINTED FOR UV PROTECTION AS SPECIFIED.
3. ELECTRICAL WIRING BETWEEN INSTRUMENTATION AND BIOFILTER CONTROL PANEL TO BE SUPPLIED AND INSTALLED BY OTHERS.
4. ALL ELECTRICAL COMPONENTS LOCATED WITHIN 3 FEET OF THE ODOR CONTROL SYSTEM SHALL BE RATED FOR N.E.C. CLASS 1, DIVISION 2, GROUP D AREAS.
5. ALL PIPING AND AIR DUCTING SUPPORTS ARE SUPPLIED AND INSTALLED BY OTHERS.
6. INSTALLATION TO BE COMPLETED BY OTHERS.
7. LENGTH OF PIPE RUN FOR DRAIN FROM SOURCE NOT TO EXCEED 12 FEET PRIOR TO DISCHARGE INTO LARGER DRAIN LINE OR FLOOR DRAIN.
8. DRAIN LINES WITH (1-1/2 X FAN DISCHARGE PRESSURE)" P-TRAP PROVIDED BY OTHERS.
9. PITOT TUBE TO HAVE 8 ½ X DUCT DIA. UPSTREAM OF STRAIGHT DUCT, & 1 ½ X DUCT DIA. DOWSTREAM OF STRAIGHT DUCT.
10. PDI SHALL BE SUPPLIED WITH PRE-ASSEMBLED DRIP LEGS, TO BE INSTALLED BY OTHERS.
11. ALL PIPE TO BE SCH 80 PVC.



REV	DATE	DESCRIPTION	BY
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00	03/11/09	FOR REVIEW AND APPROVAL	BAD

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APPROVAL	NAME	DATE (DD/MM/YY)
DRAWN BY:	B.DERYCK	03/11/09
DESIGNED BY:	B.DERYCK	03/11/09
CHECKED BY:		
APPROVED BY:		

UNLESS OTHERWISE SPECIFIED:
1. DIMENSIONS ARE IN INCHES
2. TOLERANCES:
FRACTIONS ± 1/32
2 PLACE DEC. ±.030
3 PLACE DEC. ±.010
ANGLES ±1.0°

SCALE: N/A

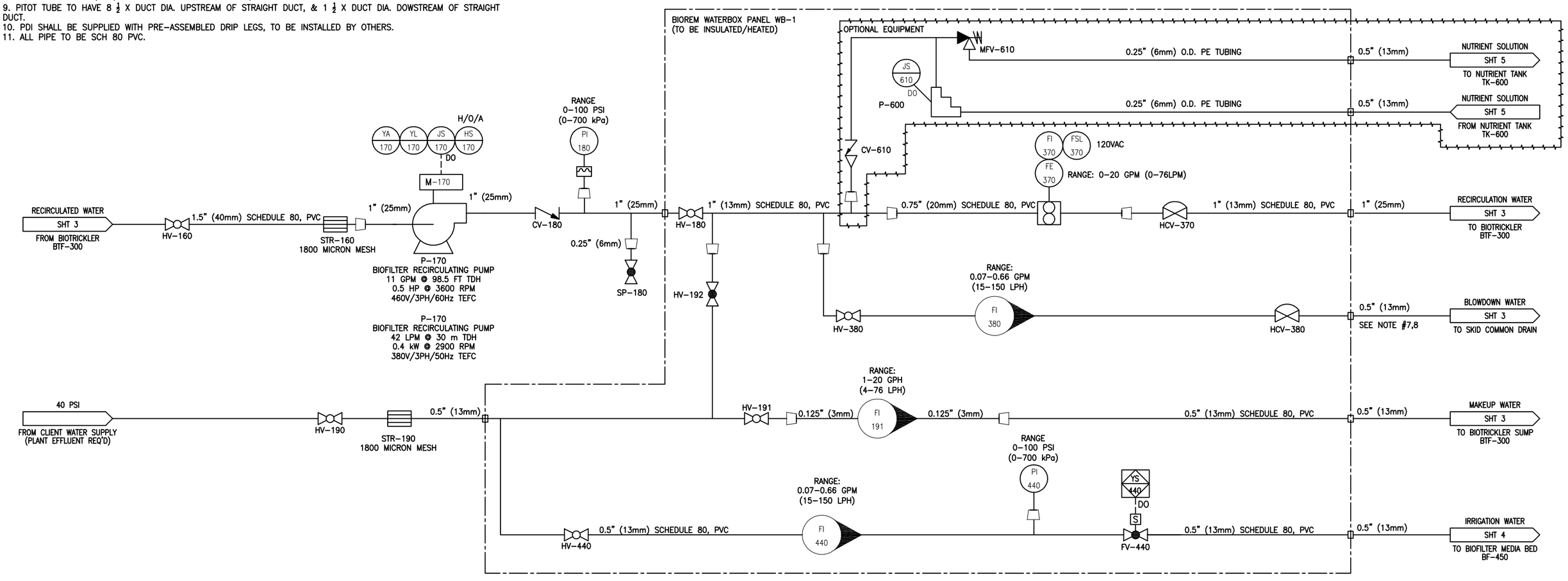
CUSTOMER:

TITLE: SK450
MEDIA FILTER & ASSOC. EQUIPMENT

JOB #: XXXXF

SIZE: B | DRAWING NUMBER: SK450-D-000 SH:3of 5 | REV: 01

NOTES:
1. ALL DOTTED PIPES, DUCTS, FLEXIBLE CONNECTORS AND EQUIPMENT BY OTHERS.
2. ALL EXPOSED WATER LINES TO BE HEAT TRACED AND INSULATED OR PAINTED FOR UV PROTECTION AS SPECIFIED.
3. ELECTRICAL WIRING BETWEEN INSTRUMENTATION AND BIOFILTER CONTROL PANEL TO BE SUPPLIED AND INSTALLED BY OTHERS.
4. ALL ELECTRICAL COMPONENTS LOCATED WITHIN 3 FEET OF THE ODOR CONTROL SYSTEM SHALL BE RATED FOR N.E.C. CLASS 1, DIVISION 2, GROUP D AREAS.
5. ALL PIPING AND AIR DUCTING SUPPORTS ARE SUPPLIED AND INSTALLED BY OTHERS.
6. INSTALLATION TO BE COMPLETED BY OTHERS.
7. LENGTH OF PIPE RUN FOR DRAIN FROM SOURCE NOT TO EXCEED 12 FEET PRIOR TO DISCHARGE INTO LARGER DRAIN LINE OR FLOOR DRAIN.
8. DRAIN LINES WITH (1–1/2 X FAN DISCHARGE PRESSURE)" P–TRAP PROVIDED BY OTHERS.
9. PITOT TUBE TO HAVE 8 ½ X DUCT DIA. UPSTREAM OF STRAIGHT DUCT, & 1 ½ X DUCT DIA. DOWSTREAM OF STRAIGHT DUCT.
10. PDI SHALL BE SUPPLIED WITH PRE–ASSEMBLED DRIP LEGS, TO BE INSTALLED BY OTHERS.
11. ALL PIPE TO BE SCH 80 PVC.



REV	DATE	DESCRIPTION	BY
01	21/01/10	ADDITION OF PG 5, NUTRIENT ADDITION	BAD
00	03/11/09	FOR REVIEW AND APPROVAL	BAD

REVISIONS

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DESIGNED BY:	B.DERYCK	03/11/09
CHECKED BY:		
APPROVED BY:		

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2. TOLERANCES:
FRACTIONS ± 1/32
2 PLACE DEC. ±.030
3 PLACE DEC. ±.010
ANGLES ±1.0°

SCALE: N/A

CUSTOMER:

TITLE: SK450 WATER BOX & ASSOC. EQUIPMENT

JOB #: XXXXF

SIZE: B

DRAWING NUMBER: SK450–D–000 SH:4of 5

REV: 01

NOTES:
1. ALL DOTTED PIPES, DUCTS, FLEXIBLE CONNECTORS AND EQUIPMENT BY OTHERS.
2. ALL EXPOSED WATER LINES TO BE HEAT TRACED AND INSULATED OR PAINTED FOR UV PROTECTION AS SPECIFIED.
3. ELECTRICAL WIRING BETWEEN INSTRUMENTATION AND BIOFILTER CONTROL PANEL TO BE SUPPLIED AND INSTALLED BY OTHERS.
4. ALL ELECTRICAL COMPONENTS LOCATED WITHIN 3 FEET OF THE ODOR CONTROL SYSTEM SHALL BE RATED FOR N.E.C. CLASS 1, DIVISION 2, GROUP D AREAS.
5. ALL PIPING AND AIR DUCTING SUPPORTS ARE SUPPLIED AND INSTALLED BY OTHERS.
6. INSTALLATION TO BE COMPLETED BY OTHERS.
7. LENGTH OF PIPE RUN FOR DRAIN FROM SOURCE NOT TO EXCEED 12 FEET PRIOR TO DISCHARGE INTO LARGER DRAIN LINE OR FLOOR DRAIN.
8. DRAIN LINES WITH (1–1/2 X FAN DISCHARGE PRESSURE)" P–TRAP PROVIDED BY OTHERS.
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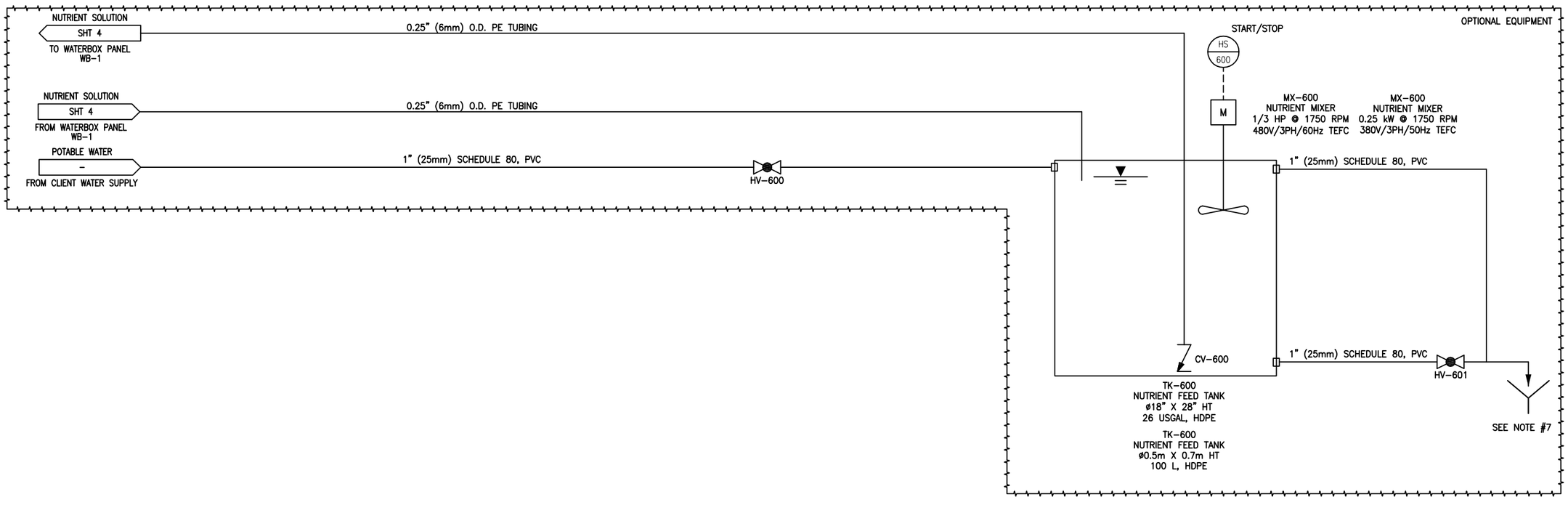
10. PDI SHALL BE SUPPLIED WITH PRE–ASSEMBLED DRIP LEGS, TO BE INSTALLED BY OTHERS.
11. ALL PIPE TO BE SCH 80 PVC.



REV	DATE	DESCRIPTION	BY
01	21/01/10	ADDITION OF PG 5, NUTRIENT ADDITION	BAD
00	03/11/09	FOR REVIEW AND APPROVAL	BAD

REVISIONS

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APPROVED BY:		

UNLESS OTHERWISE SPECIFIED:
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2. TOLERANCES:
FRACTIONS ± 1/32
2 PLACE DEC. ±.030
3 PLACE DEC. ±.010
ANGLES ±1.0°

SCALE: N/A

CUSTOMER:

TITLE: SK450
NUTRIENT ADDITION & ASSOC. EQUIPMENT

JOB #: XXXXF

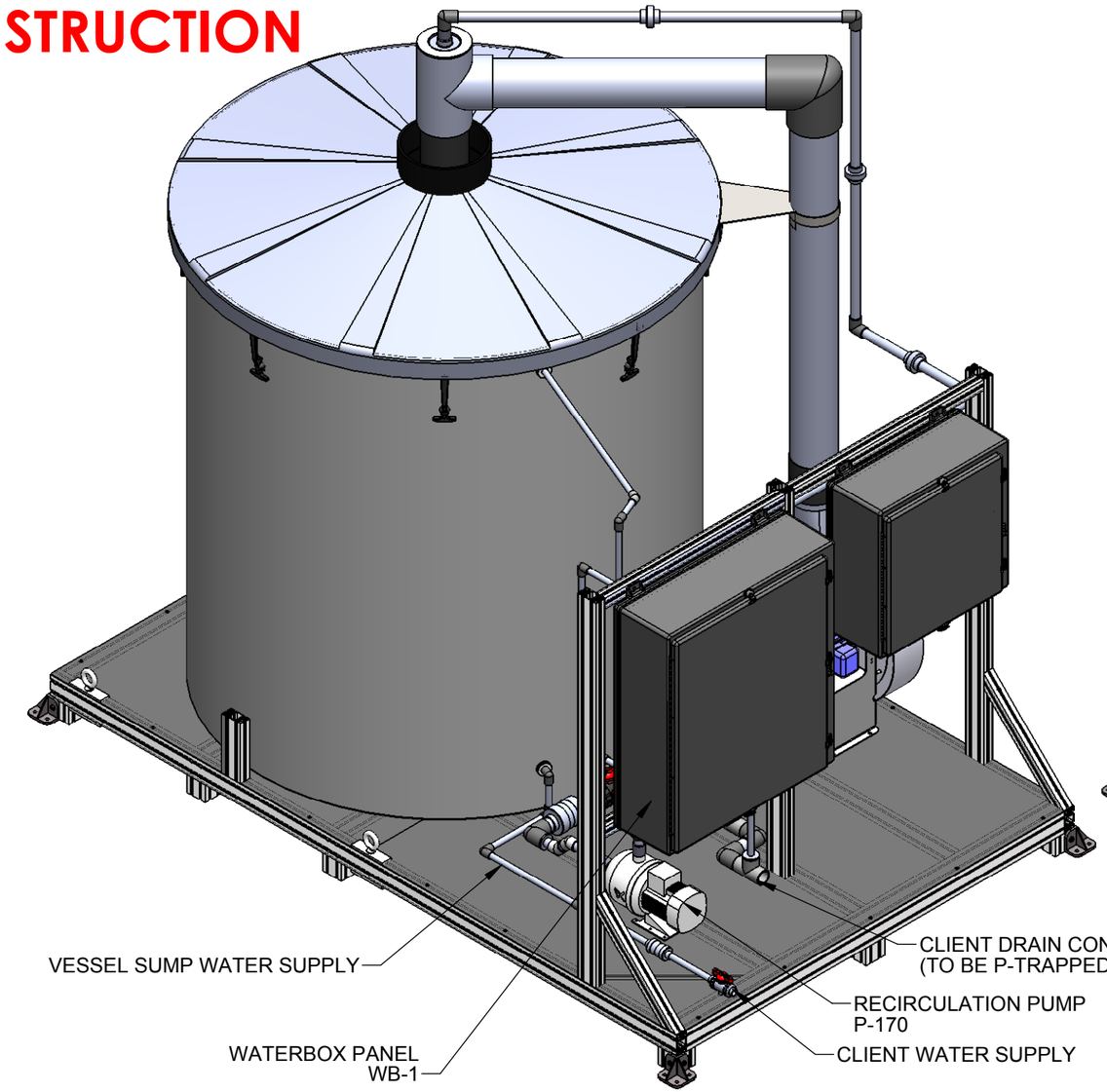
SIZE: B

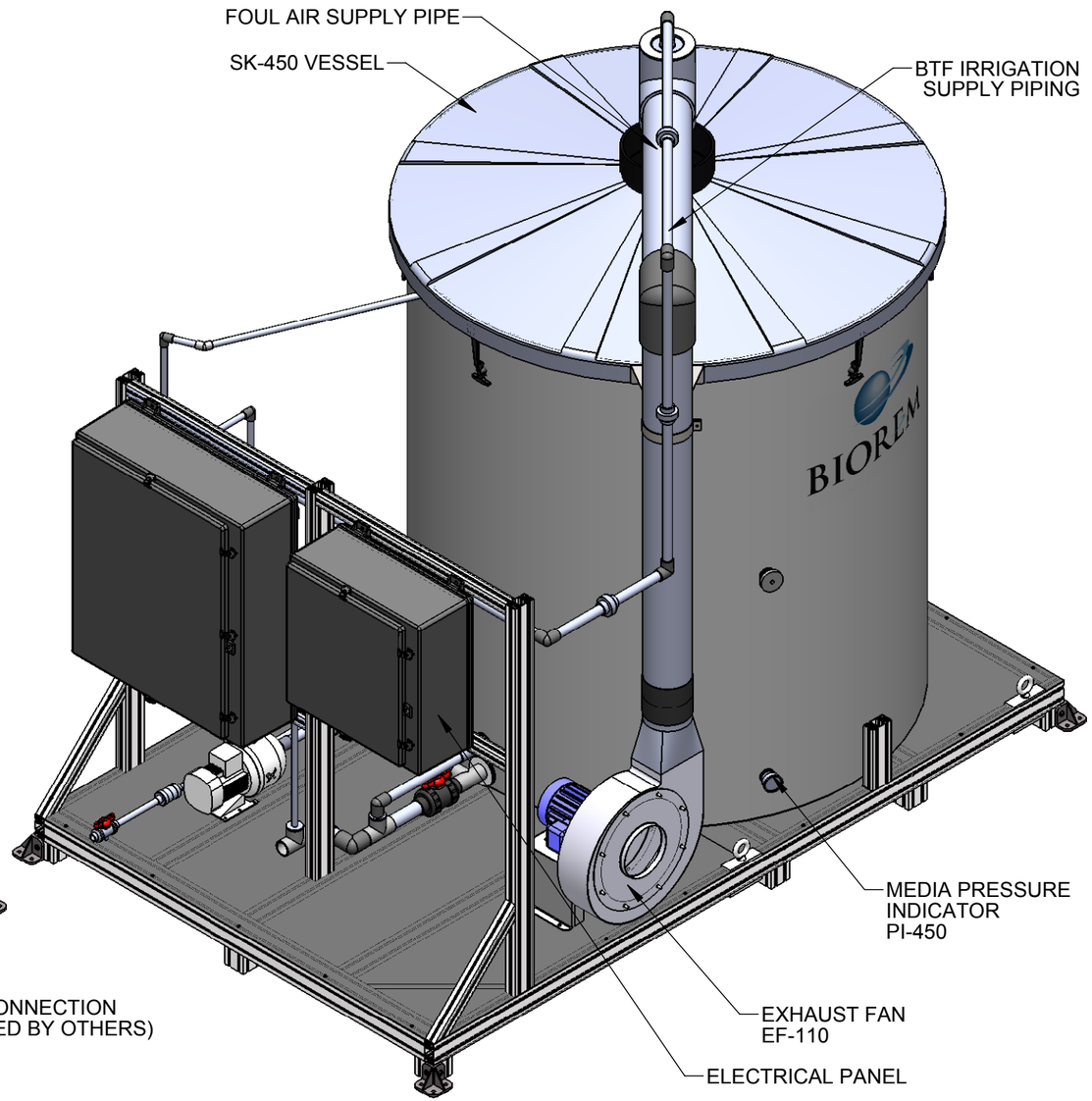
DRAWING NUMBER: SK450–D–000 SH:5of 5

REV: 01

PRELIMINARY
NOT FOR CONSTRUCTION

REVISIONS			
REV.	DATE	DESCRIPTION	BY
00	12/11/2009	FOR REVIEW AND APPROVAL	BAD





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APPROVED BY:		12/11/09

UNLESS OTHERWISE SPECIFIED

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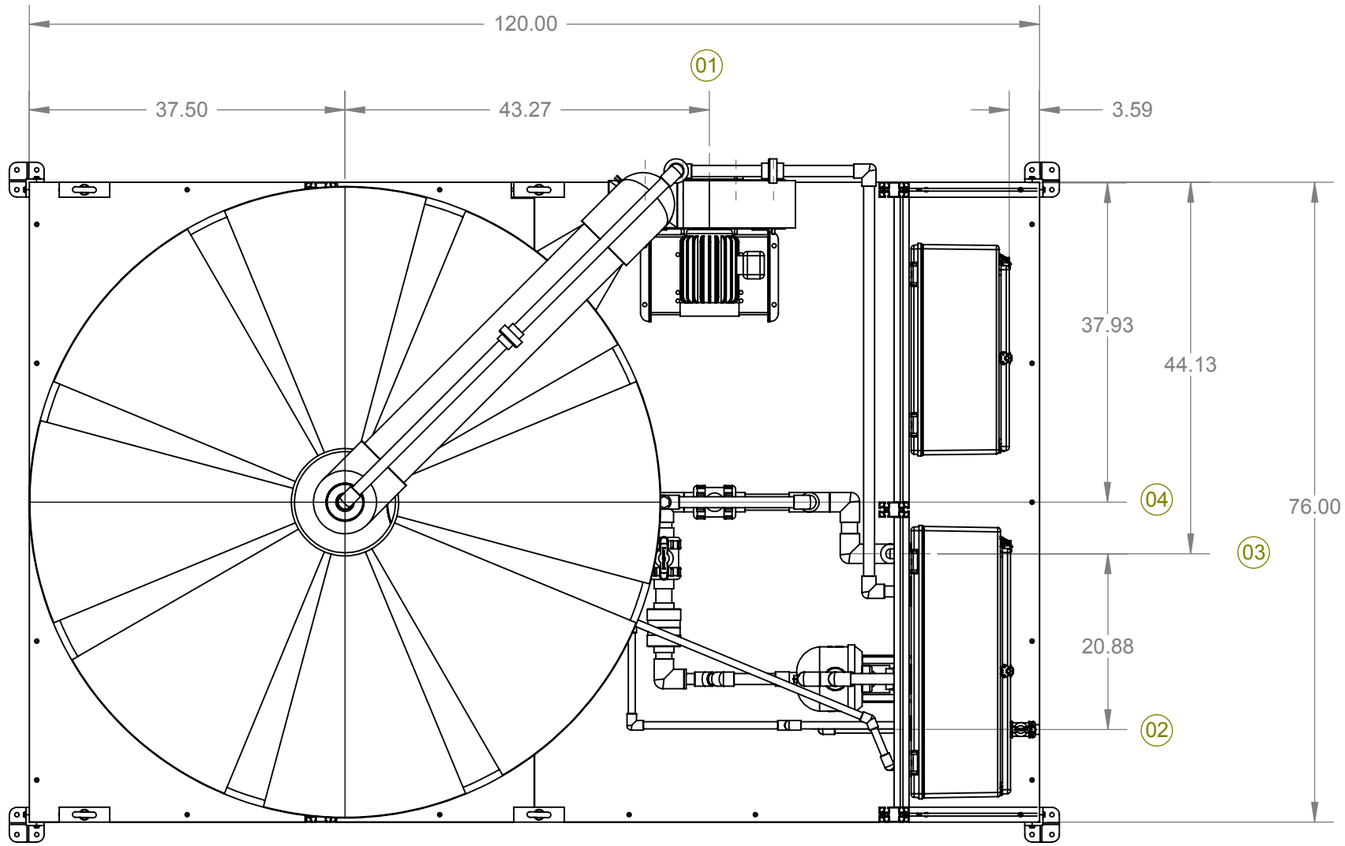
2. TOLERANCES:
   FRACTIONS ± 1/32
   2 PLACE DEC. ±.030
   3 PLACE DEC. ±.010
   ANGLES ±1.0°

CLIENT: SK-450

TITLE: SK-450 GENERAL ARRANGEMENT

PROJECT: XXXXF

SCALE: 1:20 | SIZE: B | DRAWING NUMBER: SK450-GA-000 | SHT 1 OF 7 | REV: 00



T.P.	SIZE	TYPE	DESCRIPTION
01	8"	FLG	FAN INLET
02	0.5"	SOC	CLIENT WATER SUPPLY
03	1.5"	SOC	TO CLIENT DRAIN
04	12"	N/A	VESSEL EXHAUST

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APPROVED BY:		12/11/09

UNLESS OTHERWISE SPECIFIED

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2. TOLERANCES:
FRACTIONS ± 1/32
2 PLACE DEC. ±.030
3 PLACE DEC. ±.010
ANGLES ±1.0°

CLIENT: SK-450

TITLE: SK-450 GENERAL ARRANGEMENT

PROJECT: XXXXF

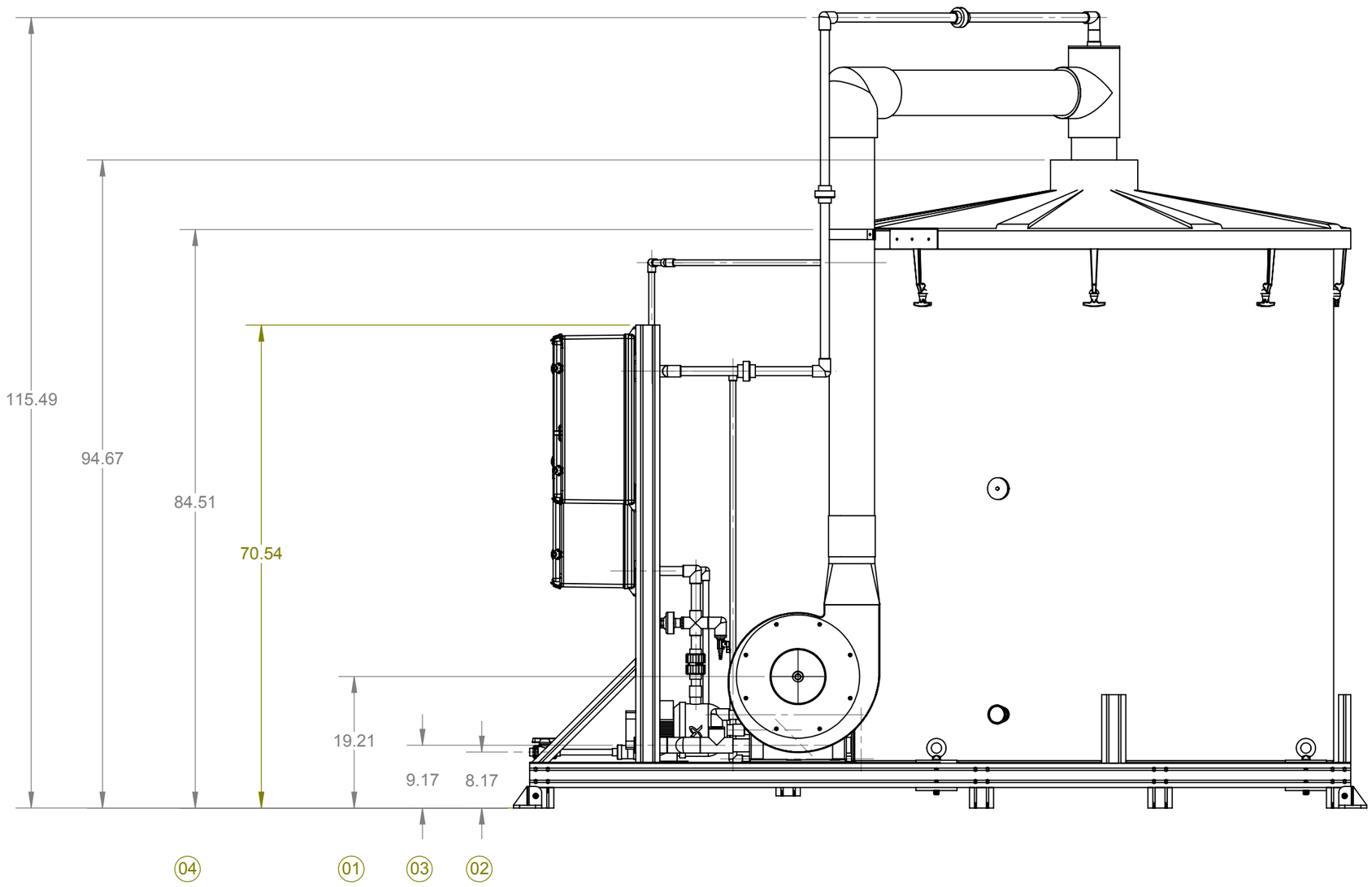
SCALE: 1:18

SIZE: B

DRAWING NUMBER: SK450-GA-000

SHT 2 OF 7

REV: 00



T.P.	SIZE	TYPE	DESCRIPTION
01	8"	FLG	FAN INLET
02	0.5"	SOC	CLIENT WATER SUPPLY
03	1.5"	SOC	TO CLIENT DRAIN
04	12"	N/A	VESSEL EXHAUST

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APPROVED BY:		12/11/09

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2. TOLERANCES:
   FRACTIONS ± 1/32
   2 PLACE DEC. ±.030
   3 PLACE DEC. ±.010
   ANGLES ±1.0°

CLIENT: SK-450

TITLE: SK-450 GENERAL ARRANGEMENT

PROJECT: XXXXF

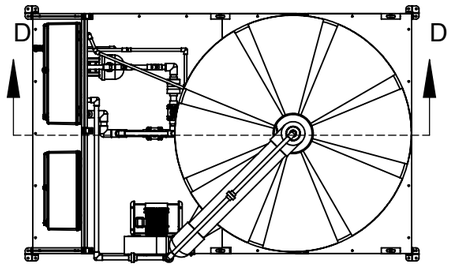
SCALE: 1:18

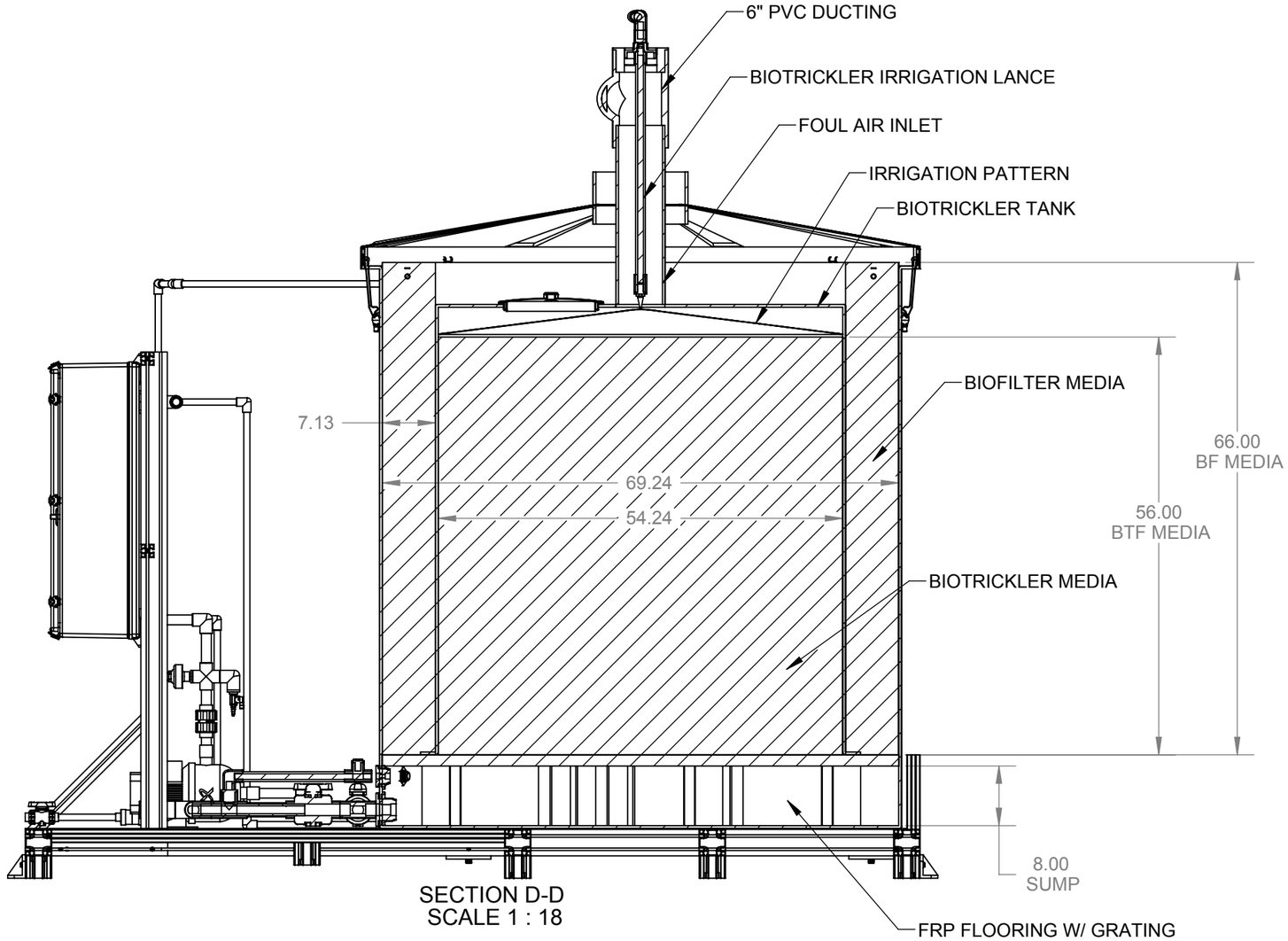
SIZE: B

DRAWING NUMBER: SK450-GA-000

SHT 3 OF 7

REV: 00





SECTION D-D
SCALE 1 : 18

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DRAWN BY:	B.D.	12/11/09
DESIGNED BY:	B.D.	12/11/09
CHECKED BY:		12/11/09
APPROVED BY:		12/11/09

UNLESS OTHERWISE SPECIFIED

1. DIMENSIONS IN INCHES
2. TOLERANCES:
   FRACTIONS ± 1/32
   2 PLACE DEC. ±.030
   3 PLACE DEC. ±.010
   ANGLES ±1.0°

CLIENT: SK-450

TITLE: SK-450 GENERAL ARRANGEMENT

PROJECT: XXXXF

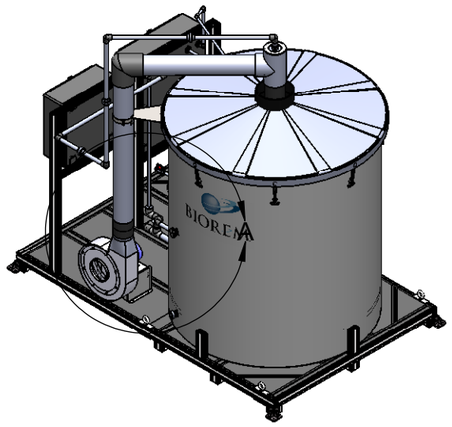
SCALE: 1:48

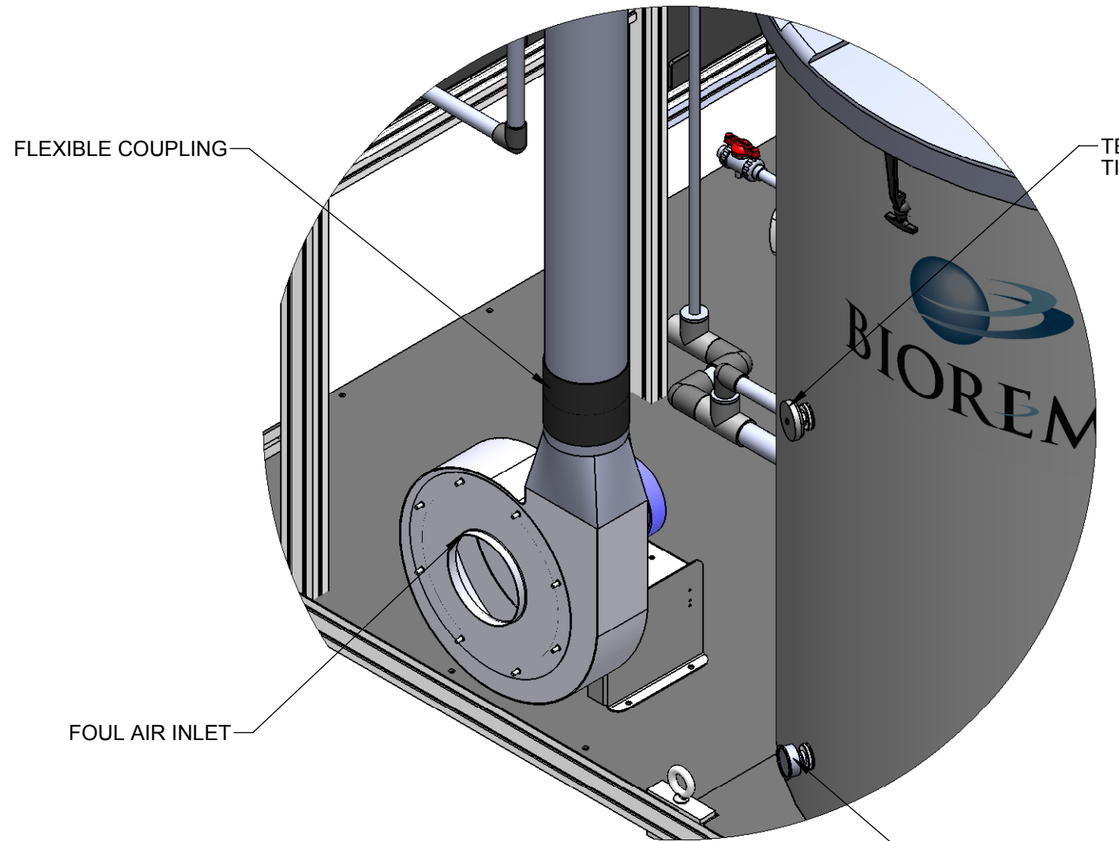
SIZE: B

DRAWING NUMBER: SK450-GA-000

SHT 4 OF 7

REV: 00





DETAIL A
SCALE 1 : 12

BIOREM

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CHECKED BY:		12/11/09
APPROVED BY:		12/11/09

UNLESS OTHERWISE SPECIFIED

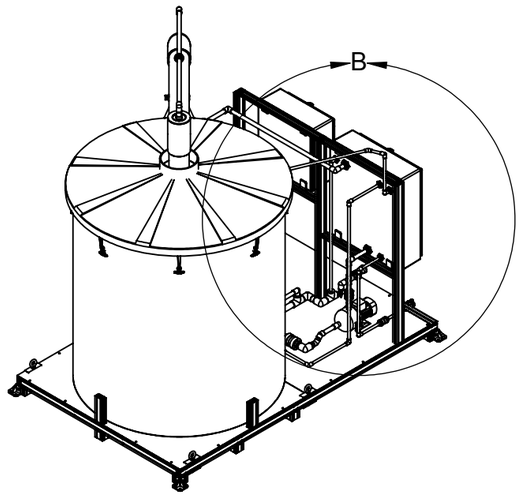
1. DIMENSIONS IN INCHES
2. TOLERANCES:
   FRACTIONS ± 1/32
   2 PLACE DEC. ±.030
   3 PLACE DEC. ±.010
   ANGLES ±1.0°

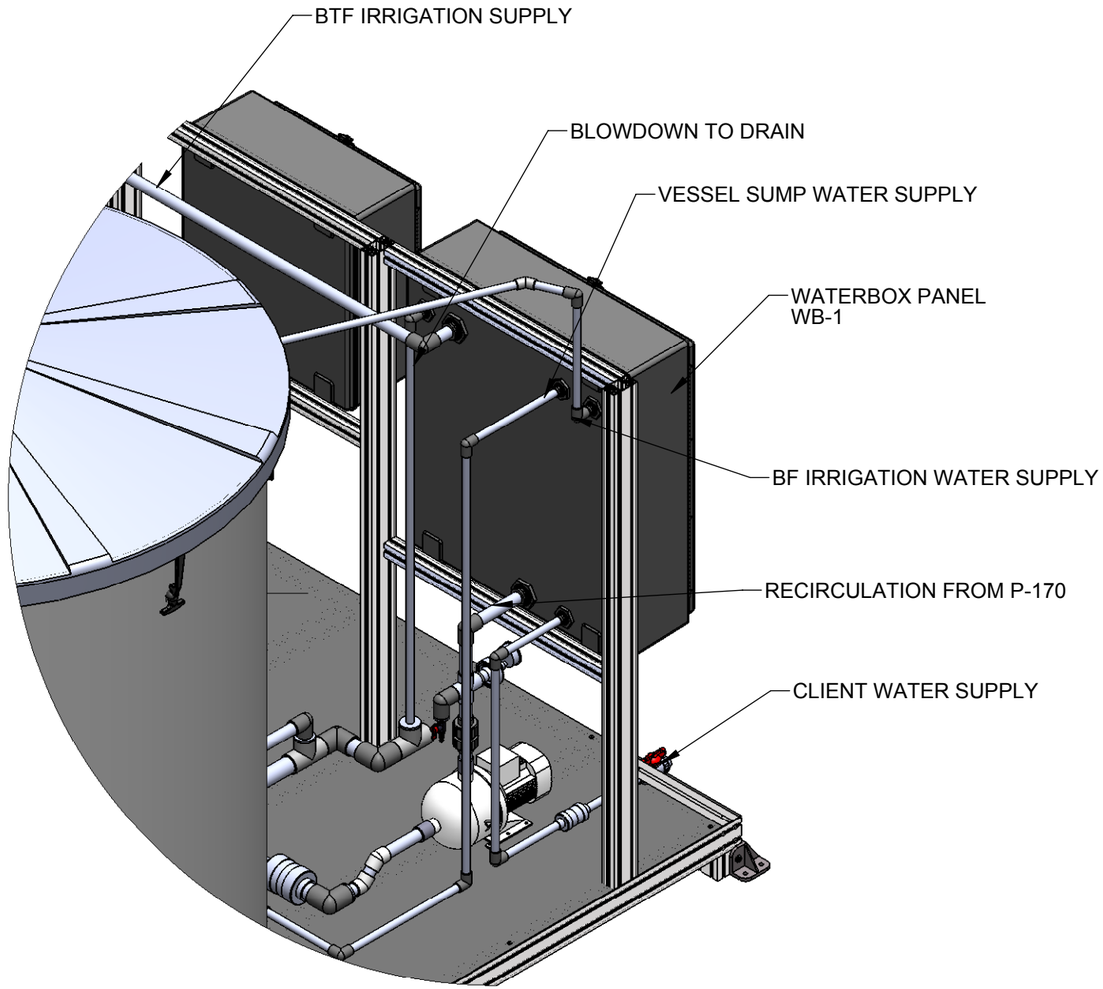
CLIENT: SK-450

TITLE: SK-450 GENERAL ARRANGEMENT

PROJECT: XXXXF

SCALE: 1:50 | SIZE: B | DRAWING NUMBER: SK450-GA-000 | SHT 5 OF 7 | REV: 00





DETAIL B
SCALE 1 : 16

BIOREM

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DESIGNED BY:	B.D.	12/11/09
CHECKED BY:		12/11/09
APPROVED BY:		12/11/09

UNLESS OTHERWISE SPECIFIED

1. DIMENSIONS IN INCHES
2. TOLERANCES:
FRACTIONS ± 1/32
2 PLACE DEC. ±.030
3 PLACE DEC. ±.010
ANGLES ±1.0°

CLIENT: SK-450

TITLE: SK-450 GENERAL ARRANGEMENT

PROJECT: XXXXF

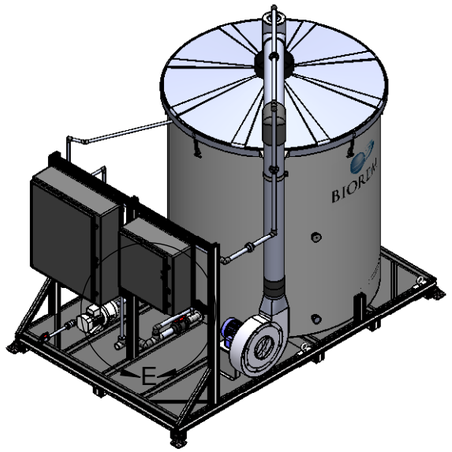
SCALE: 1:50

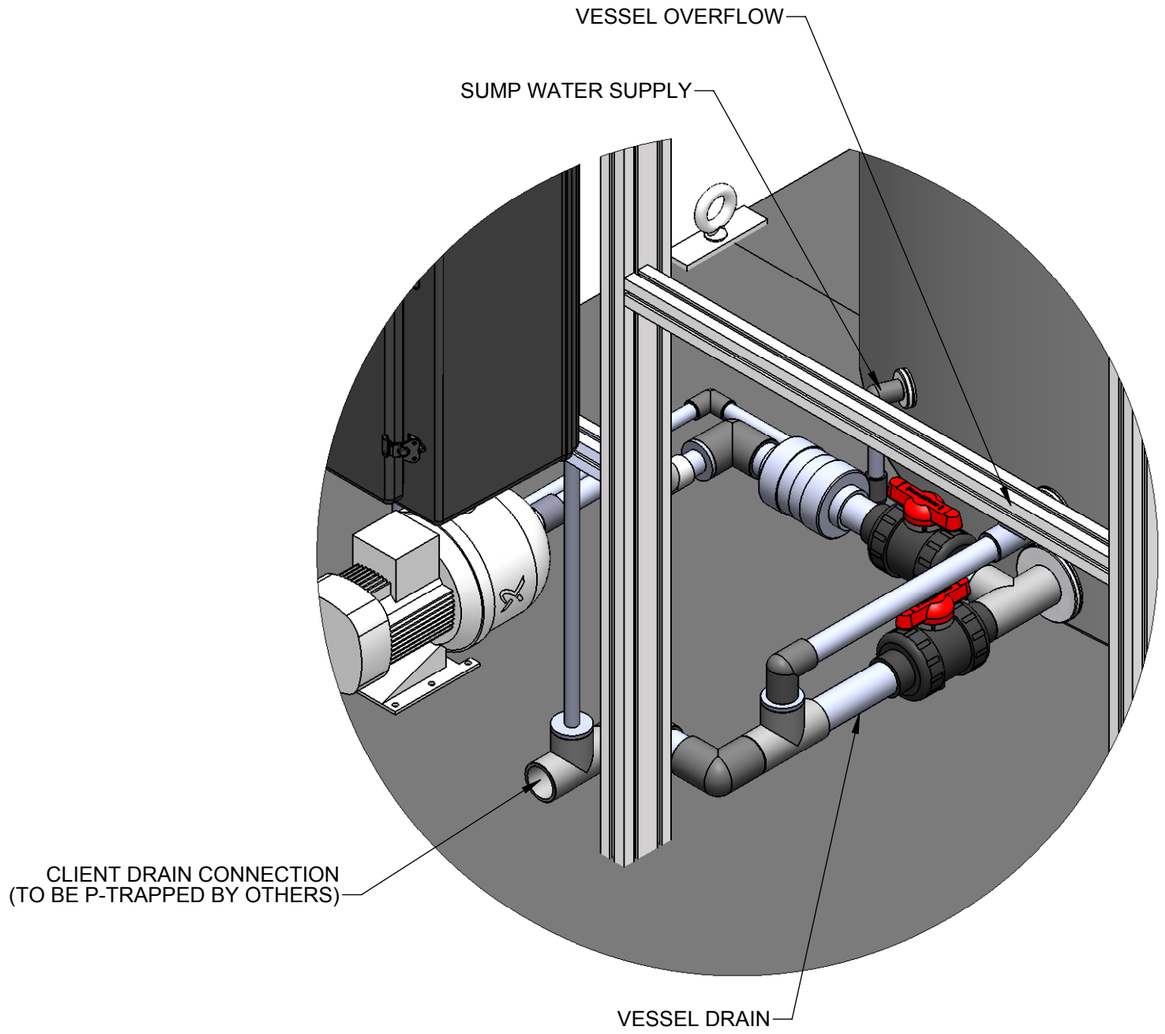
SIZE: B

DRAWING NUMBER: SK450-GA-000

SHT 6 OF 7

REV: 00





DETAIL E
SCALE 1 : 8

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APPROVED BY:		12/11/09

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2. TOLERANCES:
   FRACTIONS ± 1/32
   2 PLACE DEC. ±.030
   3 PLACE DEC. ±.010
   ANGLES ±1.0°

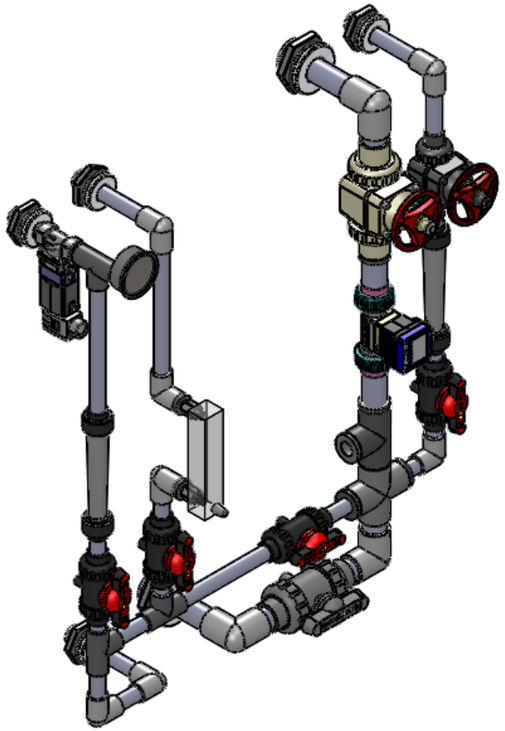
CLIENT: SK-450

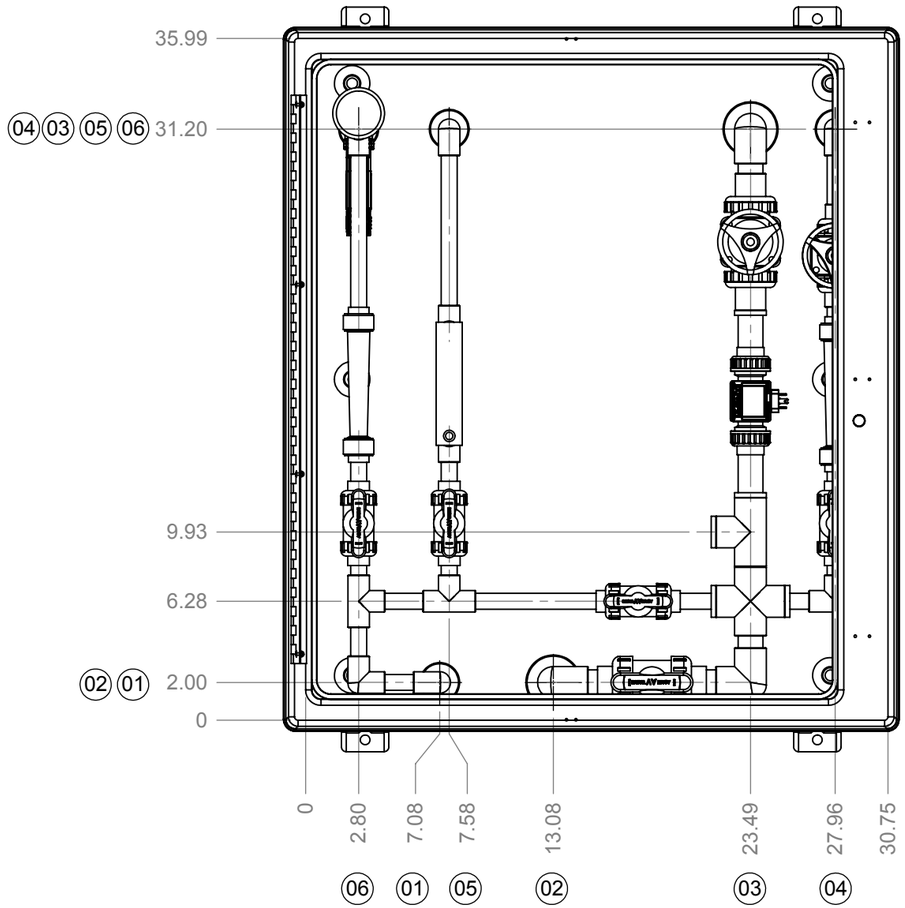
TITLE: SK-450 GENERAL ARRANGEMENT

PROJECT: XXXXF

SCALE:	SIZE:	DRAWING NUMBER:	SHT 7 OF 7	REV:
1:50	B	SK450-GA-000		00

REVISIONS			
REV.	DATE	DESCRIPTION	BY
00	06/11/2009	FOR REVIEW AND APPROVAL	BAD





T.P.	SIZE	TYPE	DESCRIPTION
01	0.5"	FNPT	CLIENT WATER INLET
02	1"	FNPT	RECIRCULATION WATER FROM P-170
03	1"	FNPT	RECIRCULATION TO NZ-370
04	0.5"	FNPT	BLOWDOWN TO DRAIN
05	0.5"	FNPT	MAKE-UP WATER TO SUMP
06	0.5"	FNPT	IRRIGATION WATER TO MEDIA

BIOREM
Breathe Easy...

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UNLESS OTHERWISE SPECIFIED

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2. TOLERANCES:
   FRACTIONS ± 1/32
   2 PLACE DEC. ±.030
   3 PLACE DEC. ±.010
   ANGLES ±1.0°

CLIENT: SK450/250 WATERBOX

TITLE: WATERBOX PANEL

PROJECT: XXXXF

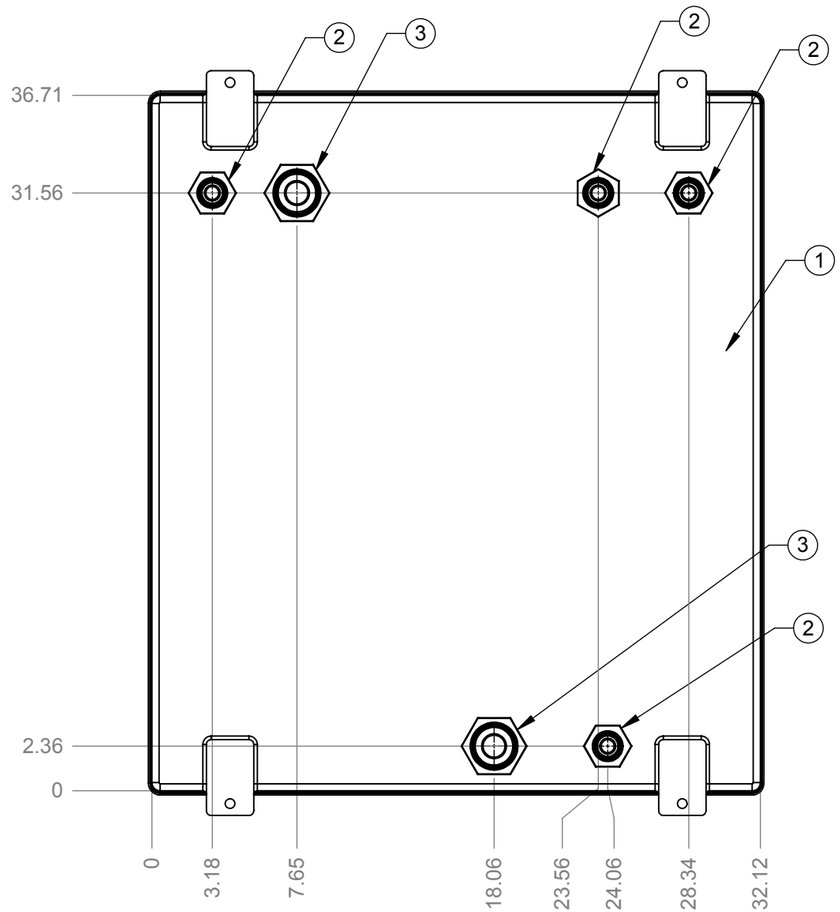
SCALE: 1:8

SIZE: B

DRAWING NUMBER: SK250_450-SA-000 SHT 1 OF 4

REV: 00

BOM Table(Restructured)				
ITEM NO.	PART#.	MAS #	DESCRIPTION	QTY
1	N363010HWT		ENCLOSURE, FRP, 36X30X10	1
2		10-11-00003	TANK ADAPTER, 0.5", Socket End x Female Thread, PVC, SCH80, EPDM	4
3		10-11-00005	TANK ADAPTER, 1", Socket End x Female Thread, PVC, SCH80, EPDM	2



NOTES:

1. QUANTITY REQUIRED - 1

2. PRODUCTION:
   - REMOVE ALL BURRS, FLASH, TAPE AND FOREIGN PARTICLES.
   - THREADED JOINTS TO BE MADE USING "HERCULES BLUE BLOCK, THREAD AND GASKET SEALANT, OR EQUAL.
   - ALL PVC SOCKET WELD JOINTS TO BE PRIMED AND GLUED USING HOT 203 PVC CEMENT OR EQUAL.
   - ALL CPVC SOCKET WELD JOINTS TO BE PRIMED AND GLUED USING CHARLIE 412 CPVC SOLVENT CEMENT.
   - ALL PIPING TO BE PROPERLY SUPPORTED.
   - CAP AND SEAL ALL TIE POINTS BEFORE SHIPPNG.
   - ELECTRICAL CONDUIT TO BE INSTALLED BY ON SITE ELECTRICAL CONTRACTOR.

3. ALL VALVES AND INSTRUMENTATION TO BE PROPERLY TAGGED.

4. ALL PIPING, FITTINGS, AND INSTRUMENTATION TO CONFORM TO EITHER:
   - ASTM D-1784: "RIGID POLY VINYL CHLORIDE (PVC) COMPOUNDS AND CHLORINATED POLY VINYL CHLORIDE (CPVC) COMPOUNDS
   - ASTM D-2464: "THREADED PVC PLASTIC PIPE FITTINGS, SCHEDULE 80"
   - ASTM F437: "THREADED CPVC PLASTIC PIPE FITTINGS, SCHEDULE 80"
   - ASTM D-2467: "SOCKET TYPE PVC PLASTIC PIPE FITTINGS, SCHEDULE 80"
   - ASTM F439: "SOCKET TYPE CPVC PLASTIC PIPE FITTINGS, SCHEDULE 80"
   - ANSI B16.5: "AMERICAN NATIONAL STANDARD - PIPE FLANGES AND FLANGED FITTINGS"
   -ASTM D 3982-92: "STANDARD SPECIFICATIONS FOR CONTACT MOLDED FIBERGLASS"

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APPROVED BY:		6/11/09

UNLESS OTHERWISE SPECIFIED

1. DIMENSIONS IN INCHES
2. TOLERANCES:
   FRACTIONS ± 1/32
   2 PLACE DEC. ±.030
   3 PLACE DEC. ±.010
   ANGLES ±1.0°

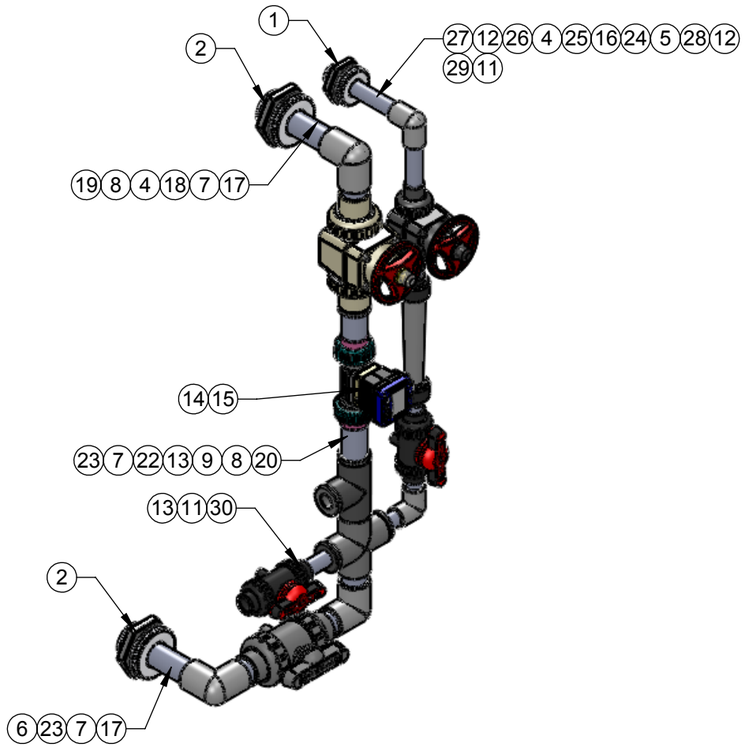
CLIENT:

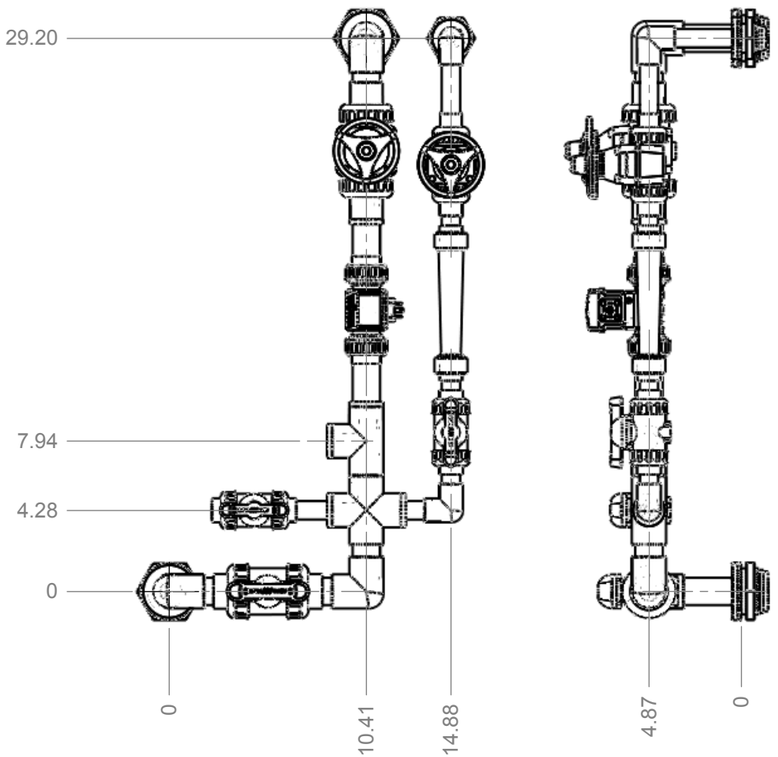
SK450/250 WATERBOX

TITLE: WATERBOX PANEL

PROJECT: XXXXF

SCALE:	SIZE:	DRAWING NUMBER:	REV:
1:8	B	SK250_450-SA-000 SHT 2 OF 4	00





BOM Table(Restructured)(Restructured)					
ITEM NO.	PART#.	MAS #	DESCRIPTION	LENGTH	QTY
1		10-11-00003	TANK ADAPTER, 0.5", Socket End x Female Thread, PVC, SCH80, EPDM		1
2		10-11-00005	TANK ADAPTER, 1", Socket End x Female Thread, PVC, SCH80, EPDM		2
4	14-A010ES	09-07-00002	1" TYPE 14 DIAPHRAGM VALVE, PVC, EPDM, TRUE UNION, SOC		1
4	14-A005ES	09-07-00001	0.5" TYPE 14 DIAPHRAGM VALVE, PVC, EPDM, TRUE UNION, SOC		1
5	21A005ES	09-06-00001	0.5" Type 21 Ball Valve, PVC, EPDM, True Union SOC		1
6	1601010	09-06-00002	1" TYPE 21 BALL VALVE, PVC, EPDM, TRUE UNION SOC	HV-600 HV-601	1
7	806-010	10-02-00005	90°Elbow, 1", Socket End, PVC, SCH80		3
8	837-131	10-06-00004	Flush Style Reducer Bushing, 1 x 0.75", Spigot x Socket, PVC, SCH80		2
9	801-010	10-08-00005	TEE, 1", Socket End, PVC, SCH80		1
10	838-130	10-06-00024	Flush Style Reducer Bushing, 1 x 0.5", Spigot x FT, PVC, SCH80		1
11	837-130	10-06-00003	Flush Style Reducer Bushing, 1 x 0.5", Spigot x Socket, PVC, SCH80		2
12	806-005	10-02-00003	90°Elbow, 0.5", Socket End, PVC, SCH80		2
13	420-010	10-12-00005	CROSS, 1", Socket End, PVC, SCH80		1
14	423951	08-20-00002	Burkert Water Flow Element, S030, 3/4", PVC True Union Flow Element		1
15	434 871	08-18-00001	FLOW INDICATING SWITCH, NEMA 4X RATED ENCLOSURE, 24 VDC WITH PNP TRANSISTOR SWITCH		1
16	FCA00151	08-17-00012	Rotameter, 0.07-0.66gpm, Dual Scale, 1/2" PVC, 0.04 PSI pressure drop		1
17	10-27-00003		1" SCH80 PVC PIPE	4.37	2
18	10-27-00003		1" SCH80 PVC PIPE	2.76	1
19	10-27-00003		1" SCH80 PVC PIPE	3.45	1
20	10-27-00003		1" SCH80 PVC PIPE	3.75	1
21	10-27-00003		1" SCH80 PVC PIPE	2.25	1
22	10-27-00003		1" SCH80 PVC PIPE	2.88	1
23	10-27-00003		1" SCH80 PVC PIPE	2.41	2
24			0.5" SCH80 PVC PIPE	2	1
25			0.5" SCH80 PVC PIPE	4.32	1
26			0.5" SCH80 PVC PIPE	4.43	1
27			0.5" SCH80 PVC PIPE	2.75	1
28			0.5" SCH80 PVC PIPE	1.87	1
29			0.5" SCH80 PVC PIPE	2.75	1
30			0.5" SCH80 PVC PIPE	3	1

NOTES:

1. QUANTITY REQUIRED - 1

2. PRODUCTION:
   - REMOVE ALL BURRS, FLASH, TAPE AND FOREIGN PARTICLES.
   - THREADED JOINTS TO BE MADE USING "HERCULES BLUE BLOCK, THREAD AND GASKET SEALANT, OR EQUAL.
   - ALL PVC SOCKET WELD JOINTS TO BE PRIMED AND GLUED USING HOT 203 PVC CEMENT OR EQUAL.
   - ALL CPVC SOCKET WELD JOINTS TO BE PRIMED AND GLUED USING CHARLIE 412 CPVC SOLVENT CEMENT.
   - ALL PIPING TO BE PROPERLY SUPPORTED.
   - CAP AND SEAL ALL TIE POINTS BEFORE SHIPPNG.
   - ELECTRICAL CONDUIT TO BE INSTALLED BY ON SITE ELECTRICAL CONTRACTOR.

3. ALL VALVES AND INSTRUMENTATION TO BE PROPERLY TAGGED.

4. ALL PIPING, FITTINGS, AND INSTRUMENTATION TO CONFORM TO EITHER:
   - ASTM D-1784: "RIGID POLY VINYL CHLORIDE (PVC) COMPOUNDS AND CHLORINATED POLY VINYL CHLORIDE (CPVC) COMPOUNDS
   - ASTM D-2464: "THREADED PVC PLASTIC PIPE FITTINGS, SCHEDULE 80"
   - ASTM F437: "THREADED CPVC PLASTIC PIPE FITTINGS, SCHEDULE 80"
   - ASTM D-2467: "SOCKET TYPE PVC PLASTIC PIPE FITTINGS, SCHEDULE 80"
   - ASTM F439: "SOCKET TYPE CPVC PLASTIC PIPE FITTINGS, SCHEDULE 80"
   - ANSI B16.5: "AMERICAN NATIONAL STANDARD - PIPE FLANGES AND FLANGED FITTINGS"
   - ASTM D 3982-92: "STANDARD SPECIFICATIONS FOR CONTACT MOLDED FIBERGLASS"

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APPROVAL	NAME	DD/MM/YY
DRAWN BY:	B.D.	6/11/09
DESIGNED BY:	B.D.	6/11/09
CHECKED BY:		6/11/09
APPROVED BY:		6/11/09

UNLESS OTHERWISE SPECIFIED

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   FRACTIONS ± 1/32
   2 PLACE DEC. ±.030
   3 PLACE DEC. ±.010
   ANGLES ±1.0°

CLIENT: SK450/250 WATERBOX

TITLE: WATERBOX PANEL

PROJECT: XXXXF

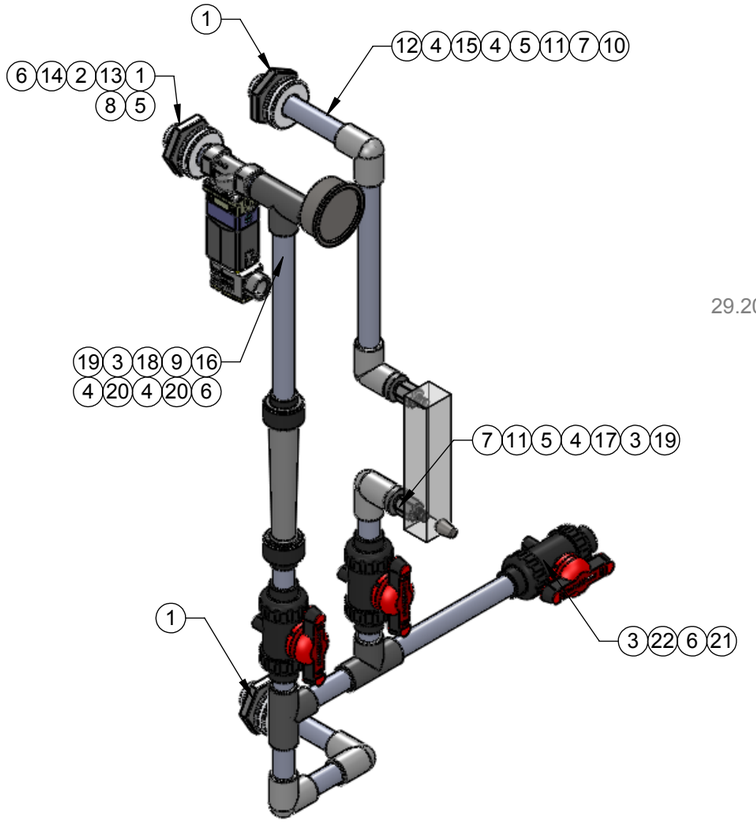
SCALE: 1:8

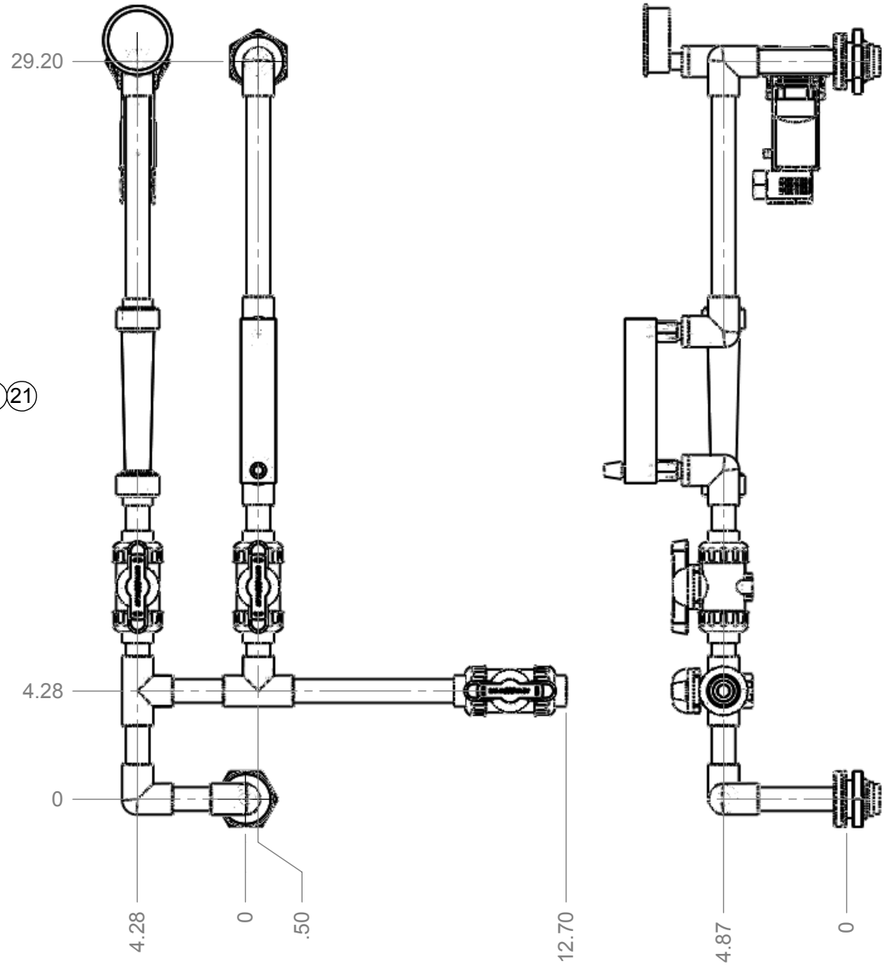
SIZE: B

DRAWING NUMBER: SK250_450-SA-000

SHT 3 OF 4

REV: 00





BOM Table(Restructured)(Restructured)					
ITEM NO.	PART#.	MAS #	DESCRIPTION	LENGTH	QTY
1		10-11-00003	TANK ADAPTER, 0.5", Socket End x Female Thread, PVC, SCH80, EPDM		3
2	457 872	09-09-00001	0.5" 2/2-way Type 5282 Solenoid Valve w. Servo Diaphragm, NC, Brass, NBR, NPT, 120 VAC		1
3	21A005ES	09-06-00001	0.5" Type 21 Ball Valve, PVC, EPDM, True Union SOC		3
4	806-005	10-02-00003	90°Elbow, 0.5", Socket End, PVC, SCH80		5
5	838-072	10-06-00022	Flush Style Reducer Bushing, 0.5 x 0.25", Spigot x FT, PVC, SCH80		3
6	801-005	10-08-00003	TEE, 0.5", Socket End, PVC, SCH80		3
7	48805K252		ADAPTER, REDUCER, MNPT X FNPT, 1/4"X1/8", 316SS		2
8	631008S02BXLL100#/KPA	08-07-00003	Pressure Indicator, 0-100 psi, 0-700 kPa, Dual Range, 316 SS, Back Mount 1/4" MNPT		1
9	FCA00151	08-17-00012	Rotameter, 0.07-0.66gpm, Dual Scale, 1/2" PVC, 0.04 PSI pressure drop		1
10	VFB-83D-SSV		VARIABLE AREA FLOWMETER, 1-20GPH, 1/8" PROCESS CONNECTION, POLYCARBONATE		1
11	861-039	10-13-00011	NIPPLE, 0.25" x 2", THREADED BOTH ENDS, PVC, SCH80		2
12			0.5" SCH80 PVC PIPE	4.43	2
13			0.5" SCH80 PVC TOE NIPPLE	0.85	1
14			0.5" SCH80 PVC TOE NIPPLE	1.11	1
15			0.5" SCH80 PVC PIPE	9.66	1
16			0.5" SCH80 PVC PIPE	9.5	1
17			0.5" SCH80 PVC PIPE	2.37	1
18			0.5" SCH80 PVC PIPE	2.13	1
19			0.5" SCH80 PVC PIPE	1.87	2
20			0.5" SCH80 PVC PIPE	3.25	2
21			0.5" SCH80 PVC PIPE	3.75	1
22			0.5" SCH80 PVC PIPE	7.73	1

NOTES:

1. QUANTITY REQUIRED - 1

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APPROVAL	NAME	DD/MM/YY
DRAWN BY:	B.D.	6/11/09
DESIGNED BY:	B.D.	6/11/09
CHECKED BY:		6/11/09
APPROVED BY:		6/11/09

UNLESS OTHERWISE SPECIFIED
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FRACTIONS ± 1/32
2 PLACE DEC. ±.030
3 PLACE DEC. ±.010
ANGLES ±1.0°

CLIENT: SK450/250 WATERBOX

TITLE: WATERBOX PANEL

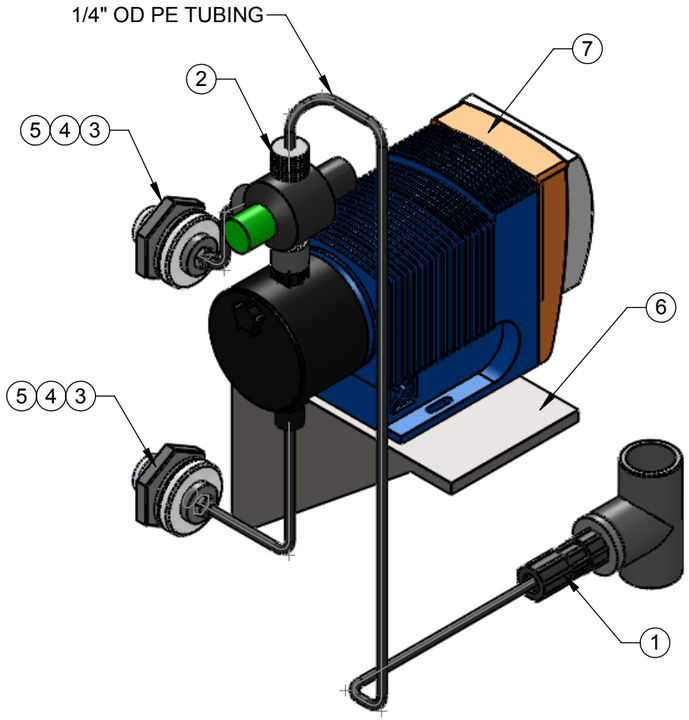
PROJECT: XXXXF

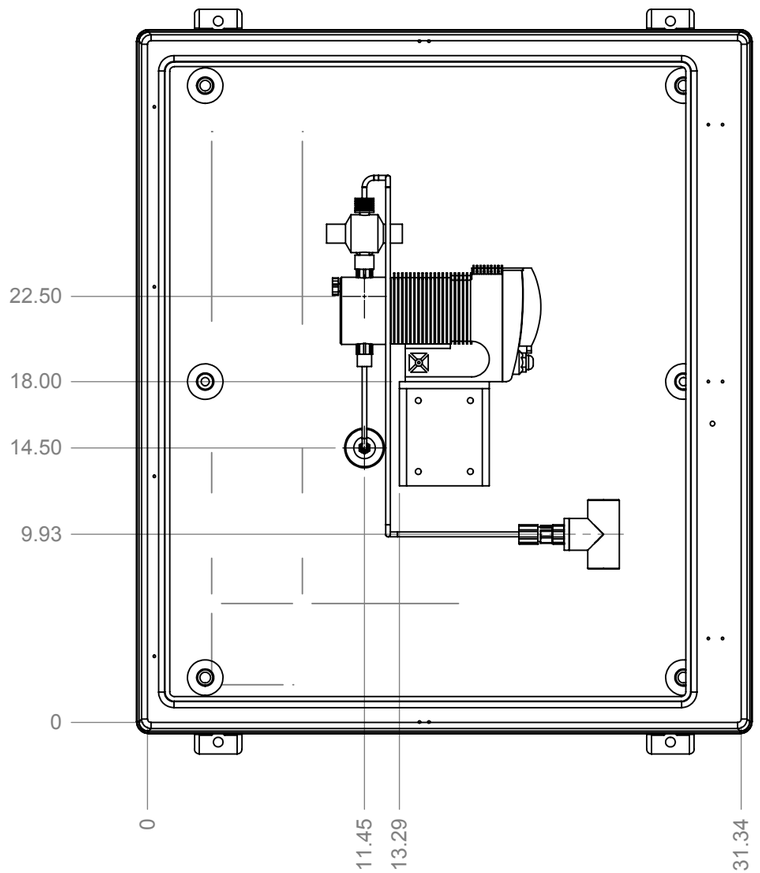
SCALE: 1:6

SIZE: B

DRAWING NUMBER: SK250_450-SA-000 SHT 4 OF 4

REV: 00





REV.	DATE		BY
00		FOR REVIEW AND APPROVAL	BAD

BOM Table(Restructured)

ITEM NO.	PART#.	MAS #		QTY
1	7924580		Injection Valve, PVC, EPDM, 0.25" tubing x 1/2" MNPT, to be used with	1
2	791715		MULTIFUNCTION VALVE, PVDF, EPDM, 1/4" OD x 3/16" ID TUBING, TO BE USED WITH BETA4A-1000	1
3			TANK ADAPTER, 0.5", FEMALE THREAD, PVC, SCH80, EPDM	2
4	839-072		Flush Style Reducer Bushing, 0.5 x 0.25", MT x FT, PVC, SCH80	2
5	1901K22		MCMASTER CARR, PUSH TO CONNECT FITTING,0.25" OD TUBE X 0.25" MNPT, PVDF	2
6	810164	MFG	CHEMICAL PUMP MOUNTING BRACKET, BETA4A	1
7	BT4A1005PPE360UD010000		BETA SOLENOID DIAPHRAGM METERING PUMP, BETA 4a -	1

NOTES:

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   - ANSI B16.5: "AMERICAN NATIONAL STANDARD - PIPE FLANGES AND FLANGED FITTINGS"
   -ASTM D 3982-92: "STANDARD SPECIFICATIONS FOR CONTACT MOLDED FIBERGLASS"

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APPROVAL	NAME	DD/MM/YY
	B.D.	6/11/09
	B.D.	6/11/09
		6/11/09
		6/11/09

UNLESS OTHERWISE SPECIFIED
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FRACTIONS ± 1/32
2 PLACE DEC. ±.030
3 PLACE DEC. ±.010
ANGLES ±1.0°

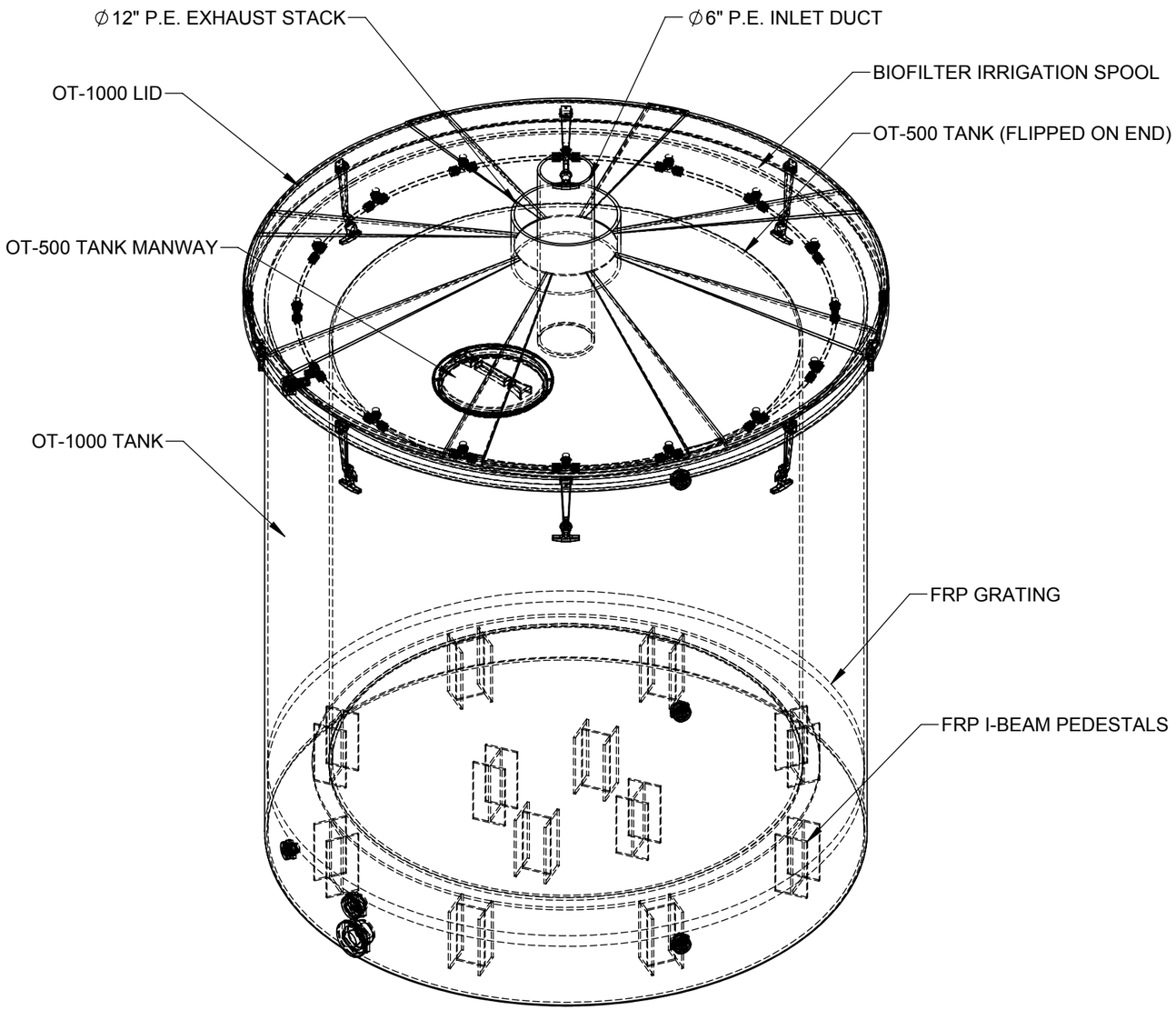
CLIENT: SK450/250 WATERBOX

TITLE: WATERBOX PANEL

XXXXF

SCALE: 1:8 | SIZE: B | DRAWING NUMBER: SK250_450-SA-000 SHT 1 OF 1 | REV: 00

REVISIONS			
REV.	DATE	DESCRIPTION	BY
00	18/11/2009	FOR REVIEW AND APPROVAL	BAD



BOM Table(Restructured)(Restructured)				
ITEM NO.	PART#.	MAS #	DESCRIPTION	QTY
1			PEDESTAL, 4" FRP WF I-BEAM WF, 8" TALL	12
2			GRATING, PULTRUDED, 70" DIA.	1
3		03-02-00001	inorganic, XLD	1
4		03-03-00101	Inorganic, LWE, 8-16	1
5	OT-500		TANK, OPEN TOP, POLYETHYLENE, 500 GALLONS, 2200 LITRES, 55" DIA X 62"	1
6			TANK MANWAY, 12" DIAMETER, POLYETHYLENE	1
7	SK450-SA-001		SK450 BF IRRIGATION SPOOL	1
8	OT-1000		TANK, OPEN TOP, POLYETHYLENE, 1000 GALLONS, 4500 LITRES, 70" DIA X 78"	1
9	OT-1000-L		TANK LID, POLYETHYLENE, 70" DIA	1
10	1685A420		LATCH, RUBBER T-HANDLE WITH STAINLESS STEEL STRIKE, 6-61/64" LONG	8
11		10-11-00027	TANK ADAPTER, 0.5", FEMALE THREAD, PVC, SCH80, EPDM	4
12		10-11-00007	Tank Adapter, 1.5", Socket x FNPT, PVC, SCH80, EPDM	1
13		10-11-00005	Tank Adapter, 1", Socket x FNPT, PVC, SCH80, EPDM	1
14		10-11-00003	TANK ADAPTER, 0.5", Socket End x Female Thread, PVC, SCH80, EPDM	1
15	10-8-8-P-PG	10-15-00014	Male Connectors 10, 0.5" Tube O.D., 0.5" Pipe Thread, 0.75"-20 Thread, Polypropylene, Plastic gripper for plastic tubing- 220 PSI	1

NOTES:

1. BTF AND BF MEDIA NOT SHOWN FOR CLARITY.

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DRAWN BY:	B.D.	17/11/09
DESIGNED BY:	B.D.	17/11/09
CHECKED BY:		17/11/09
APPROVED BY:		17/11/09

UNLESS OTHERWISE SPECIFIED

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FRACTIONS ± 1/32
2 PLACE DEC. ±.030
3 PLACE DEC. ±.010
ANGLES ±1.0°

CLIENT: SK450

TITLE: SK450 VESSEL ASSEMBLY

PROJECT: XXXXF

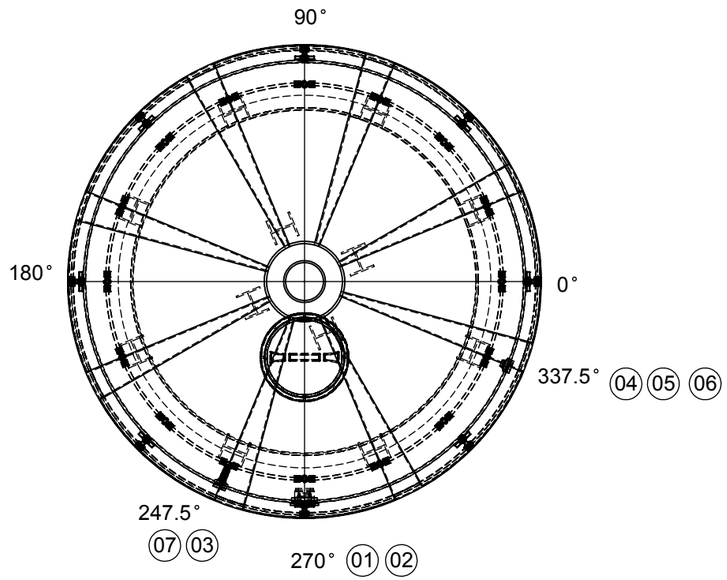
SCALE: 1:16

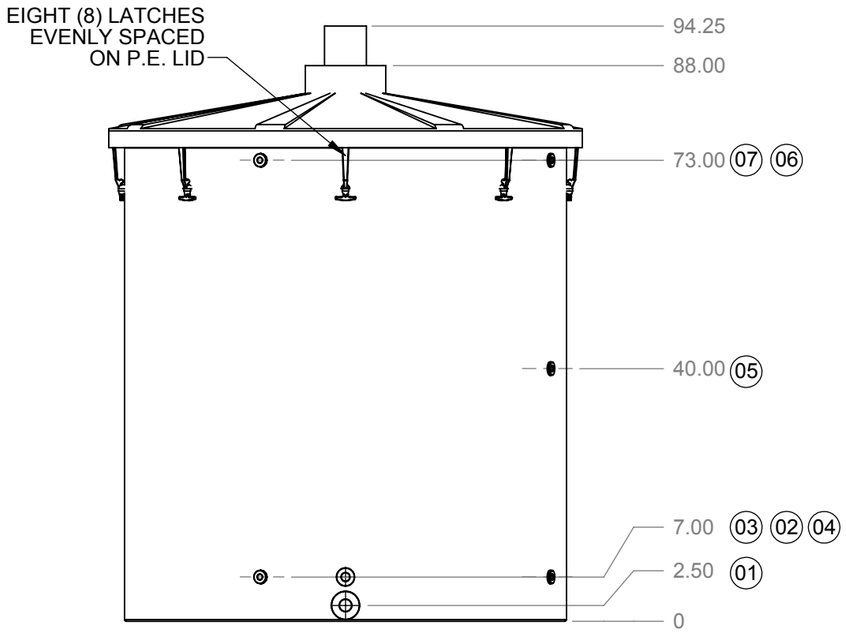
SIZE: B

DRAWING NUMBER: SK450-SA-000

SHT 1 OF 3

REV: 00





T.P.	SIZE	TYPE	DESCRIPTION
01	1.5"	SOC	VESSEL DRAIN
02	1"	FNPT	VESSEL OVERFLOW
03	0.5"	SOC	SUMP WATER INLET
04	0.5"	FNPT	PDI LOW PRESSURE
05	0.5"	FNPT	TEMPERATURE GAUGE PORT
06	0.5"	FNPT	PDI HIGH PRESSURE
07	0.5"	SOC	BF IRRIGATION CONNECTION

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CHECKED BY:		17/11/09
APPROVED BY:		17/11/09

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2 PLACE DEC. ±.030
3 PLACE DEC. ±.010
ANGLES ±1.0°

CLIENT: SK450

TITLE: SK450 VESSEL ASSEMBLY

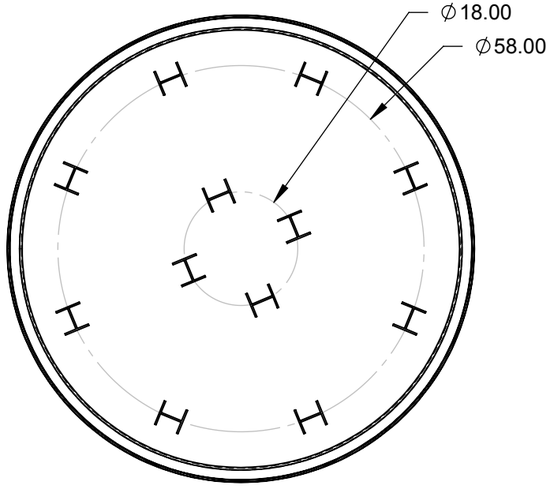
PROJECT: XXXXF

SCALE: 1:24

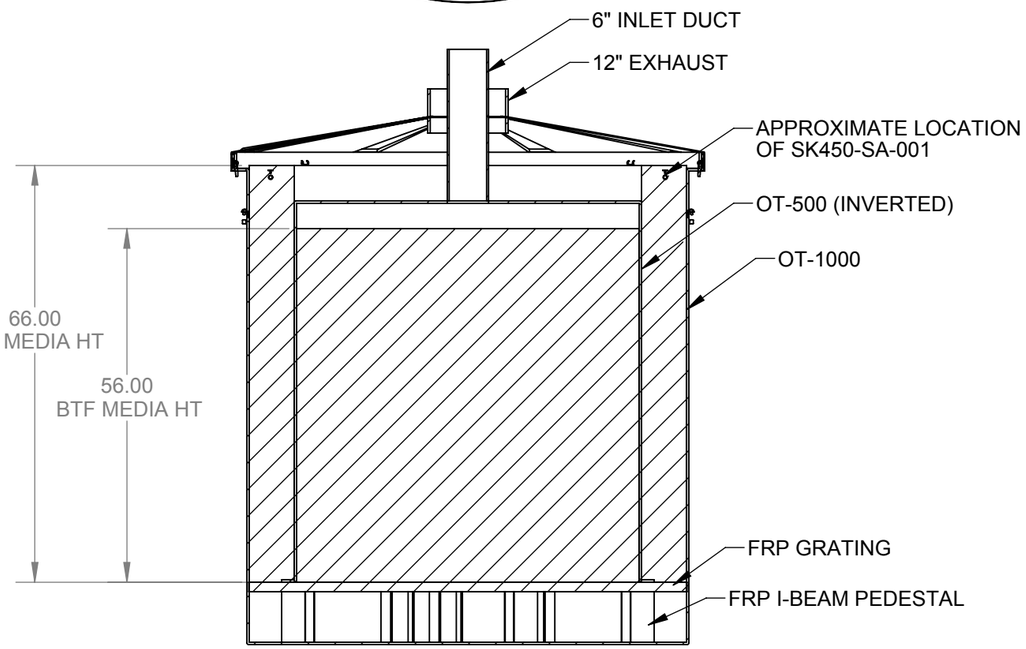
SIZE: B

DRAWING NUMBER: SK450-SA-000 SHT 2 OF 3

REV: 00



FRP I-BEAM PEDESTAL LAYOUT



SECTION A-A

BIOREM
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DESIGNED BY:	B.D.	17/11/09
CHECKED BY:		17/11/09
APPROVED BY:		17/11/09

UNLESS OTHERWISE SPECIFIED

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3 PLACE DEC. ±.010
ANGLES ±1.0°

CLIENT: SK450

TITLE: SK450 VESSEL ASSEMBLY

PROJECT: XXXXF

SCALE: 1:24

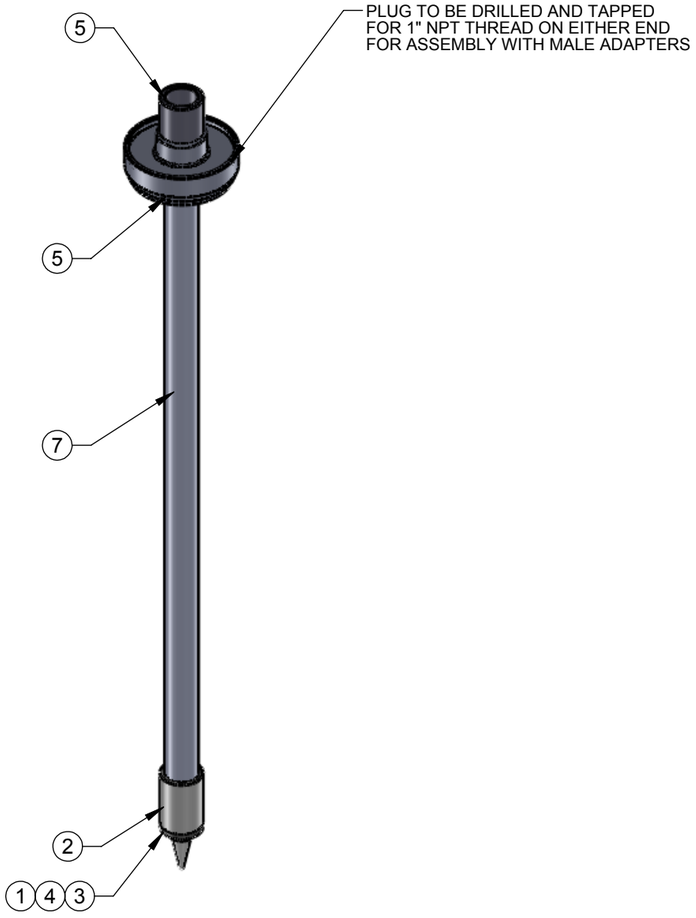
SIZE: B

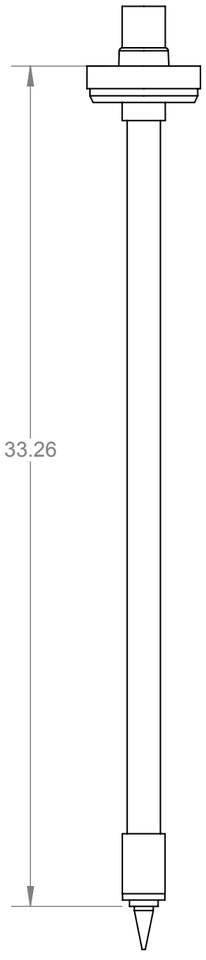
DRAWING NUMBER: SK450-SA-000

SHT 3 OF 3

REV: 00

REVISIONS			
REV.	DATE	DESCRIPTION	BY
00	13/11/2009	FOR REVIEW AND APPROVAL	BAD





BOM Table(Restructured)(Restructured)					
ITEM NO.	PART#.	MAS #	DESCRIPTION	LENGTH	QTY
1	3/8-TF20-170-PVC	09-13-00050	BETE TF-20 120 DEG, 3/8" MNPT, PVC, PIGTAIL		1
2	830-010	10-04-00005	Coupling, 1", Socket End, PVC, SCH80		1
3	837-130	10-06-00003	Flush Style Reducer Bushing, 1 x 0.5", Spigot x Socket, PVC, SCH80		1
4	838-073		Flush Style ReduceBushing, 0.5 x 0.375", Spigot x FT, PVC, SCH80		1
5	836-010	10-11-00041	Male Adapter, 1", SOC x MNPT, PVC, SCH80		2
6			IPS CLEAN OUT PLUG, 4", SCH40		1
7	10-27-00003		1" SCH80 PVC PIPE	32.16	1

NOTES:

1. QUANTITY REQUIRED - 1

2. PRODUCTION:
   - REMOVE ALL BURRS, FLASH, TAPE AND FOREIGN PARTICLES.
   - THREADED JOINTS TO BE MADE USING "HERCULES BLUE BLOCK, THREAD AND GASKET SEALANT, OR EQUAL.
   - ALL PVC SOCKET WELD JOINTS TO BE PRIMED AND GLUED USING HOT 203 PVC CEMENT OR EQUAL.
   - ALL CPVC SOCKET WELD JOINTS TO BE PRIMED AND GLUED USING CHARLIE 412 CPVC SOLVENT CEMENT.
   - ALL PIPING TO BE PROPERLY SUPPORTED.
   - CAP AND SEAL ALL TIE POINTS BEFORE SHIPPNG.
   - ELECTRICAL CONDUIT TO BE INSTALLED BY ON SITE ELECTRICAL CONTRACTOR.

3. ALL VALVES AND INSTRUMENTATION TO BE PROPERLY TAGGED.

4. ALL PIPING, FITTINGS, AND INSTRUMENTATION TO CONFORM TO EITHER:
   - ASTM D-1784: "RIGID POLY VINYL CHLORIDE (PVC) COMPOUNDS AND CHLORINATED POLY VINYL CHLORIDE (CPVC) COMPOUNDS
   - ASTM D-2464: "THREADED PVC PLASTIC PIPE FITTINGS, SCHEDULE 80"
   - ASTM F437: "THREADED CPVC PLASTIC PIPE FITTINGS, SCHEDULE 80"
   - ASTM D-2467: "SOCKET TYPE PVC PLASTIC PIPE FITTINGS, SCHEDULE 80"
   - ASTM F439: "SOCKET TYPE CPVC PLASTIC PIPE FITTINGS, SCHEDULE 80"
   - ANSI B16.5: "AMERICAN NATIONAL STANDARD - PIPE FLANGES AND FLANGED FITTINGS"
   - ASTM D 3982-92: "STANDARD SPECIFICATIONS FOR CONTACT MOLDED FIBERGLASS"

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APPROVAL	NAME	DD/MM/YY
DRAWN BY:	B.D.	13/11/09
DESIGNED BY:	B.D.	13/11/09
CHECKED BY:		13/11/09
APPROVED BY:		13/11/09

UNLESS OTHERWISE SPECIFIED
1. DIMENSIONS IN INCHES
2. TOLERANCES:
   FRACTIONS ± 1/32
   2 PLACE DEC. ±.030
   3 PLACE DEC. ±.010
   ANGLES ±1.0°

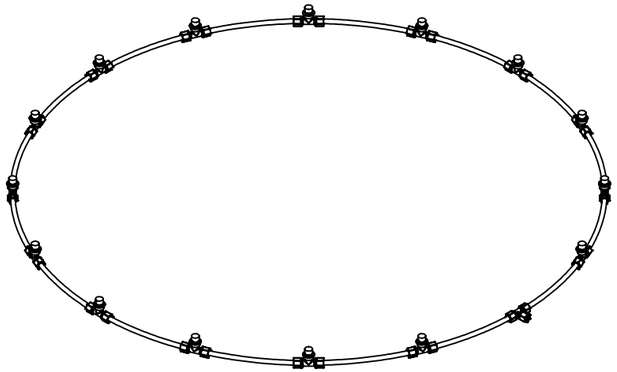
CLIENT: SK450

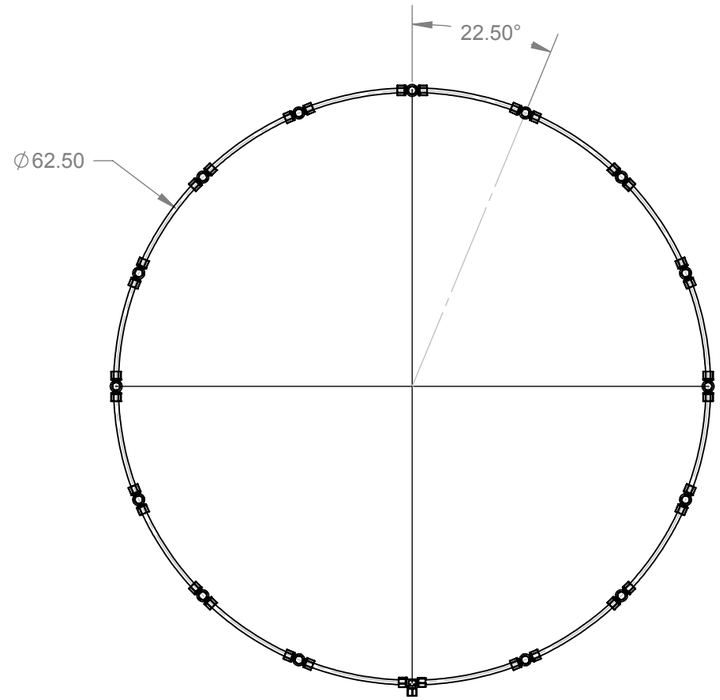
TITLE: SK450 BTF IRRIGATION SPOOL

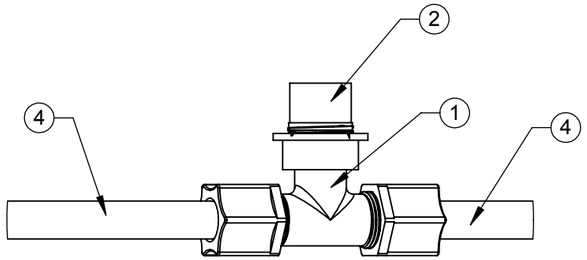
PROJECT: XXXXF

SCALE: 1:6 | SIZE: B | DRAWING NUMBER: SK450-SA-002 | SHT 1 OF 1 | REV: 00

REVISIONS			
REV.	DATE	DESCRIPTION	BY
00	13/11/2009	FOR REVIEW AND APPROVAL	BAD







DETAIL A
SCALE 1 : 2

BOM Table(Restructured)				
ITEM NO.	PART#.	MAS #	DESCRIPTION	QTY
1	60-8-8-P-PG	10-23-00007	Male Branch Tees 60,0.5" Tube O.D,0.5" Pipe Thread,0.75"-20 Thread, Polypropylene, Plastic gripper for plastic tubing- 220 PSI	15
2	XS-360TS-050		Plastic Irrigation Nozzle, 0.5" FNPT, 0-17.3 GPH @ 0.4.7 Radius	15
3	70-8-P-PG	10-24-00005	Union Tees 70, 0.5" Tube O.D, 0.75"-20 Thread, Polypropylene, Plastic gripper for plastic tubing- 220 PSI	1
4			Poly Tubing, 0.5" OD x 0.375" ID	1

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APPROVAL	NAME	DD/MM/YY
DRAWN BY:	B.D.	13/11/09
DESIGNED BY:	B.D.	13/11/09
CHECKED BY:		13/11/09
APPROVED BY:		13/11/09

UNLESS OTHERWISE SPECIFIED

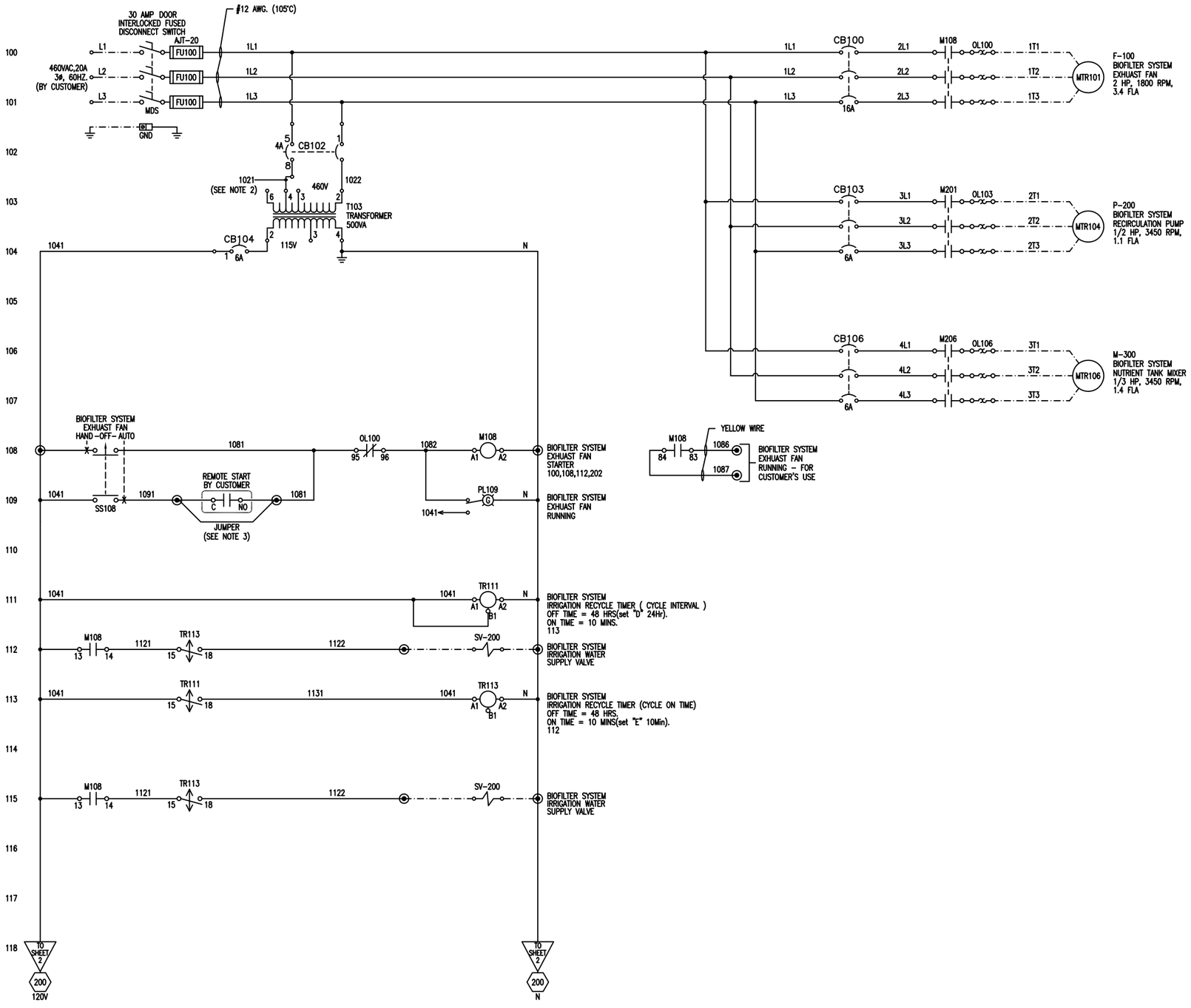
1. DIMENSIONS IN INCHES
2. TOLERANCES:
   FRACTIONS ± 1/32
   2 PLACE DEC. ±.030
   3 PLACE DEC. ±.010
   ANGLES ±1.0°

CLIENT: SK450

TITLE: SK450 BF IRRIGATION SPOOL

PROJECT: XXXXF

SCALE: 1:16 | SIZE: B | DRAWING NUMBER: SK450-SA-001 | SHT 1 OF 1 | REV: 00



NOTES:

1. ENCLOSURE WIRE CODE UNLESS STATED OTHERWISE:
   - 380VAC: 12AWG TEW/MTW BLACK
   - 120VAC: 16AWG TEW/MTW RED
   - 120VAC NEUTRAL: 16AWG TEW/MTW WHITE
   - DC VOLTAGE: 16AWG TEW/MTW BLUE
   - OTHER SOURCE: 16AWG TEW/MTW YELLOW
2. TRANSFORMER JUMPER INSTALLED DURING CONTROL PANEL ASSEMBLY.
3. REMOVE JUMPER IF REMOTE START CONTACT(S) ARE WIRED INTO THE CIRCUIT.

REV	DATE	DESCRIPTION
A	10FEB10	ISSUED FOR APPROVAL

REVISIONS

IDT REF:
CAD REF:

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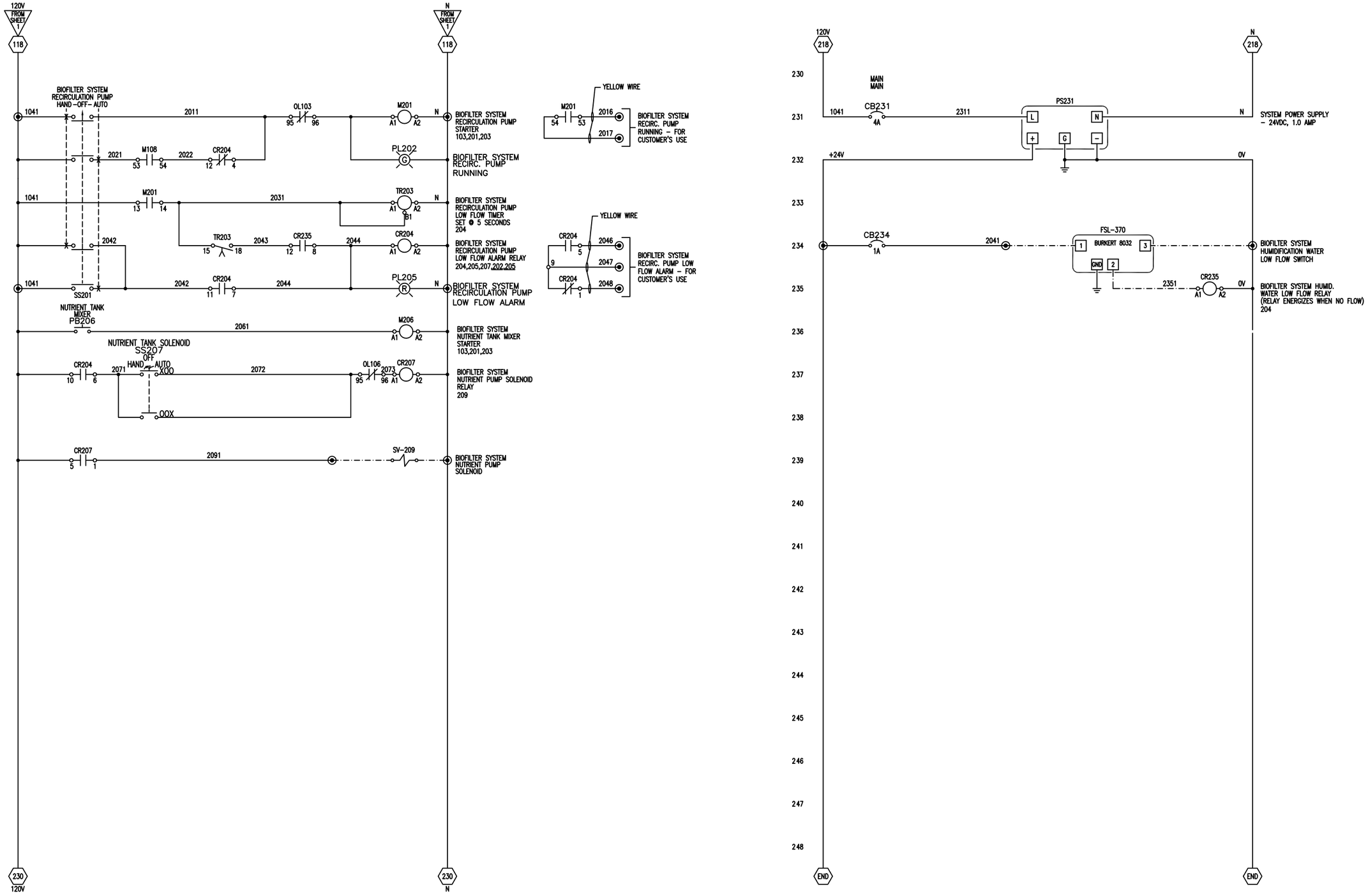
APPROVAL	NAME	DATE (DD/MM/YY)
DRAWN BY:	J.P.	10FEB10
DESIGNED BY:	TBD	TBD
CHECKED BY:		
APPROVED BY:		

UNLESS OTHERWISE SPECIFIED:
1. DIMENSIONS ARE IN INCHES
2. TOLERANCES:
FRACTIONS ± 1/32
2 PLACE DEC. ± .030
3 PLACE DEC. ± .010
ANGLES ±1.0°

CUSTOMER: U500
TITLE: U500 ODOUR CONTROL SYSTEM ELECTRICAL WIRING DIAGRAM
JOB #: ####X
SCALE: N.T.S.
SIZE: D
DRAWING NUMBER: SK250_450-E-001 SH: 1 of 3
REV: A



NOTES:

1. ENCLOSURE WIRE CODE UNLESS STATED OTHERWISE:
   - 380VAC: 12AWG TEW/MTW BLACK
   - 120VAC: 16AWG TEW/MTW RED
   - 120VAC NEUTRAL: 16AWG TEW/MTW WHITE
   - DC VOLTAGE: 16AWG TEW/MTW BLUE
   - OTHER SOURCE: 16AWG TEW/MTW YELLOW

REV	DATE	DESCRIPTION
A	10FEB10	ISSUED FOR APPROVAL

REVISIONS

IDT REF:
CAD REF:

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BIOREM TECHNOLOGIES INC.

APPROVAL	NAME	DATE (DD/MM/YY)
DRAWN BY:	J.P.	10FEB10
DESIGNED BY:	TBD	TBD
CHECKED BY:		
APPROVED BY:		

UNLESS OTHERWISE SPECIFIED:
1. DIMENSIONS ARE IN INCHES
2. TOLERANCES:
FRACTIONS ± 1/32
2 PLACE DEC. ± .030
3 PLACE DEC. ± .010
ANGLES ± 1.0°

CUSTOMER: U500
TITLE: SCHEMATIC
U500 ODOUR CONTROL SYSTEM
ELECTRICAL WIRING DIAGRAM
JOB #: TBD

SCALE: N.T.S.
SIZE: D
DRAWING NUMBER: SK250_450-E-002 SH: 2 of 3
REV: A

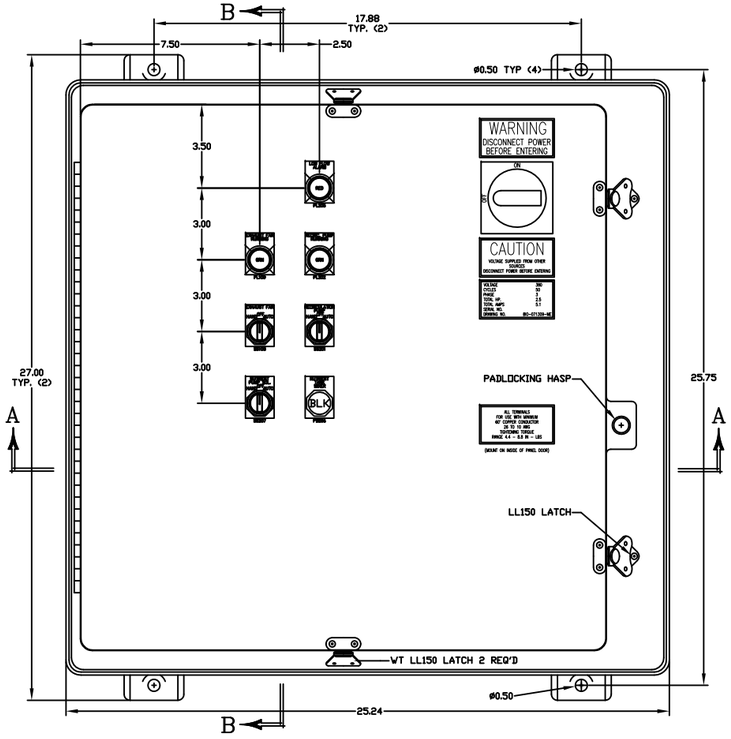
WARNING
DISCONNECT POWER
BEFORE ENTERING

CAUTION
VOLTAGE SUPPLIED FROM OTHER SOURCES
DISCONNECT POWER BEFORE ENTERING

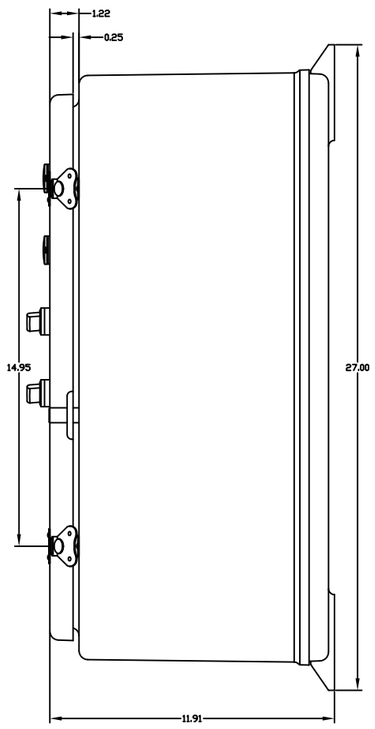
VOLTAGE	380
CYCLES	50
PHASE	3
TOTAL HP.	2.5
TOTAL AMPS	5.1
SERIAL NO.	
DRAWING NO.	BIO-071309-ME

ALL TERMINALS
FOR USE WITH MINIMUM
60° COPPER CONDUCTOR
26 TO 10 AWG
TIGHTENING TORQUE
RANGE 4.4 - 8.8 IN - LBS

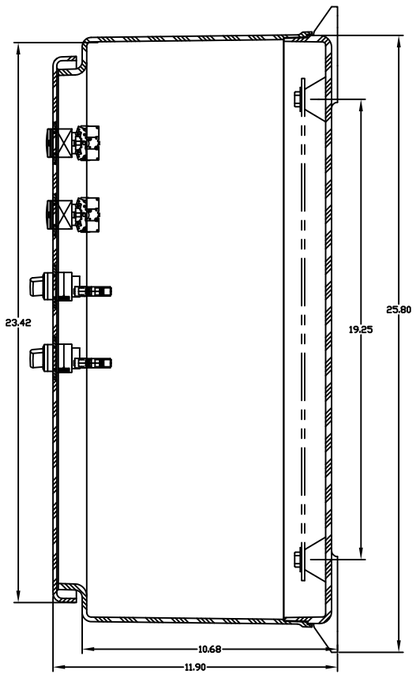
(MOUNT ON INSIDE OF PANEL DOOR)



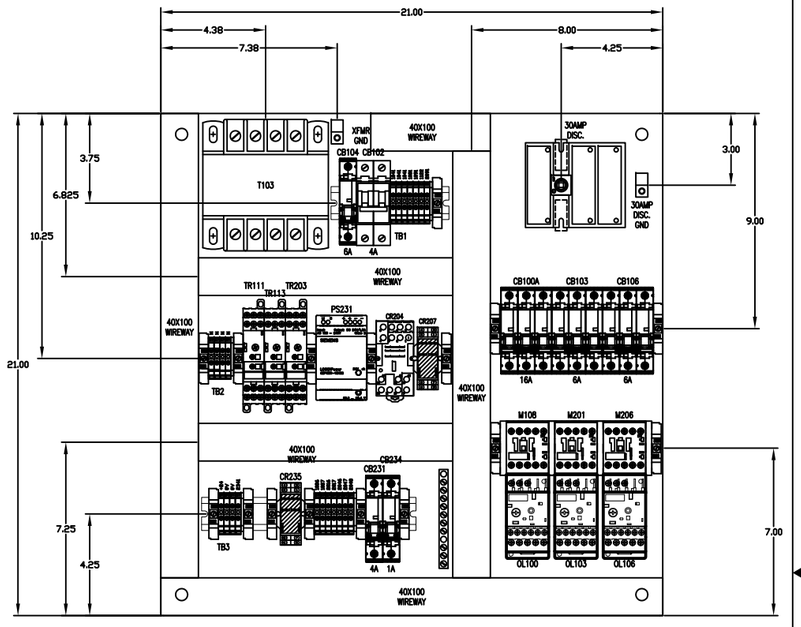
FRONT VIEW



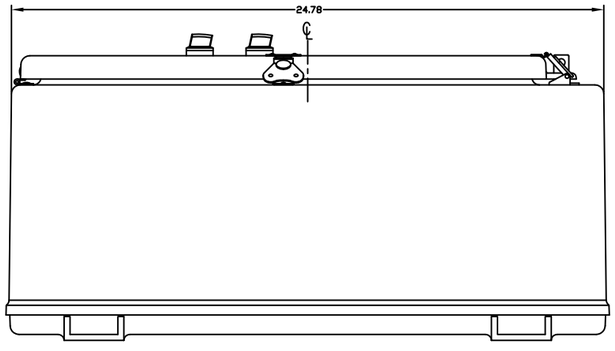
SIDE VIEW



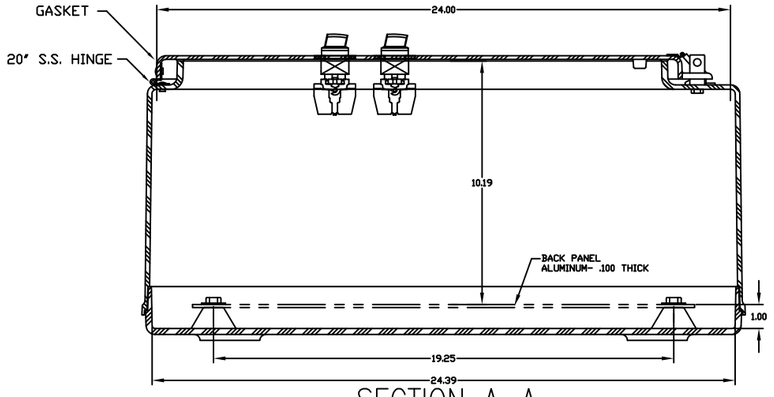
SECTION B-B



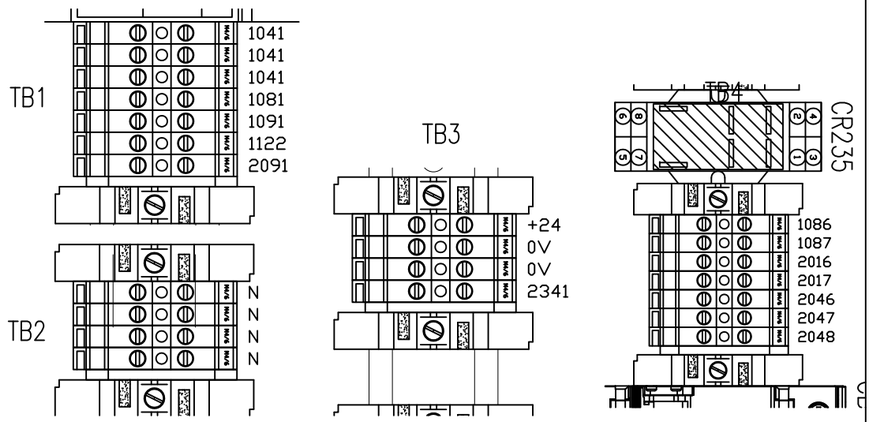
PANEL



BOTTOM VIEW



SECTION A-A



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Great Lakes Controls Of New York

DRAWN	J.PTASZEK
DATE	2/10/10
CHECKED	TBD
DATE	
APPROVED	R.SIMONCELLI
DATE	

TITLE: BIOREM U500 ENCLOSURE LAYOUT

SIZE	DWG. NO.	REV
B	SK250_450-E-003	A
SCALE NONE	SERIAL NO	SHEET 3 OF 3

APPENDIX E. Process Control Philosophy

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APPENDIX F. As-Installed Set Points

Table 10: As-Installed Setpoints

Set Point	Set Point Description	Value
FE/FIT-370	Recirculation Flow	11.1 GPM
PI-180	Recirculation Pressure	18.1 psi
FI-380	Blow-Down Line Flow	0
	Air Flow Rate	450 CFM
FI-440	Irrigation Flow Rate	0.7 GPM
PI-440	Irrigation Line Pressure	15 psi
FV-440	Duration	35 min

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APPENDIX G. Equipment, Instrumentation and Spare Parts Catalogue

Instructions for Ordering Parts

1. Contact BIOREM Service Department. Refer to Contact Information page for telephone numbers & addresses of equipment primary supplier and supplier local representative.
2. Specify the part number and description as shown in Equipment, Instrumentation, & Spare Parts Catalogue.
3. List the quantity needed.
4. Provide billing and shipping address.
5. Provide name and telephone number of authorized.
6. Suggest best method of shipment.

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SK-450
Equipment, Instrumentation and Spare Parts Catalogue

Vol II Tab#	Qty	Unit	Item Description	BIOREM Part #	Manufacturer's Part #	Manufacturer	BIOREM TAG #	Recom'd Spare Parts
	77	CU/FT	MEDIA, LWE, 8-16 mm,	03-03-00101				-
	61	CU/FT	MEDIA, XLD	03-02-00001				-
	1	EA	BLOWER, CENTRIFUGAL, 500 CFM @ 9.5 IWG, 230/460 VAC	05-01-00011				Set of bearings & belts
	1	EA	PUMP, GRUNDFOS, 1/2 HP	05-04-00010				Set of O-R
	1	EA	NOZZLE, 3/8" TF20 PVC 170	09-13-00050				1
	1	EA	1" SERIES S4 INLINE STRAINE, PVC, EPDM, SOC, MESH-26 (750 MICRON)	09-17-00002				1
	1	EA	PRESSURE INDICATOR,0-10"WC,0-250MM,316SS,1/4" MNPT	08-07-00008				1
	1	EA	PRESSURE INDICATOR 0-100 PSI, BACKMOUNT W/ISOLATOR	08-07-00004				1
	1	EA	TEMP INDICATOR, 4", 0-250 DEGREE, 316 SS	08-13-00002				-
	1	EA	0.25" SERIES LC LABCOCK,PVC, EPDM, MNPTXHOSE	09-11-00001				-
	2	EA	1/2" BALL VALVE,ASAHI	09-06-00002				-
	1	EA	1 " BALL CHECK VALVE, ASAHI	09-05-00002				-
	2	EA	1 1/2" BALL VALVE, ASAHI	09-06-00003				-
	1	EA	INLINE STRAINER, 1/2", PRAHER	09-17-00001				1
	4	EA	1/2" BALL VALVE, TRUE UNION	09-06-00001				-
	1	EA	1/2" BRASS SOLENOID VALVE	09-09-00001				-
	1	EA	1/2" DIAPHRAM VALVE	09-07-00001				-
	1	EA	1" DIAPHRAM VALVE	09-07-00002				-
	1	EA	3/4" INSTALLATION FITTING	08-20-00002				-
	1	EA	PRESSURE INDICATOR 0-100 PSI, BACKMOUNT	08-07-00003				1
	2	EA	ROTAMETER, 1/2" PVC 0.07-0.6 GPM	08-17-00012				-
	1	EA	FLOW SWITCH 24 VDC, PNP	08-18-00001				-
	1	EA	DWYER FLOWMETER, VFB83SSV, 1-20 GPH					-

SK Series
ELECTRICAL BILL OF MATERIALS

Qty	Unit	Manufacturer's Part #	Item Description	Manufacturer
31	ea	011511607	TB, Standard	ABB
1	ea	011836816	End Barrier	
1	ea	017666704	10 pole jumper	
22	ea	020635116	End Stop	
1	ea	5SY4204-8	Circuit Breaker, 2 Pole 4 Amp	Siemens
1	ea	5SY4104-8	Circuit Breaker, 1 Pole 4 Amp	
2	ea	5SY4306-8	Circuit Breaker, 3 Pole 6 Amp	
1	ea	5SY4316-8	Circuit Breaker, 3 Pole 16 Amp	
1	ea	5SY4101-7	Circuit Breaker, 1 Pole, 1 Amp	
1	ea	3TX7114-5LC03	DPDT, 15A Plug In Relay 24VDC	
1	ea	5SY4106-7	Circuit Breaker, 1 Pole, 6 Amp	
1	ea	MT0500A	Control Transformer	
1	ea	3RT1016-1AK61	9 A Contactor	
2	ea	3RT1015-1AK61	7 A Contactor	
3	ea	3RB2016-2PB0	O.L. 1 - 4A	
3	ea	3RP1505-1RW30	Multi-F Timer Relay AC/DC, 240V	
1	ea	3TX7114-5LF13	DPDT, 15A Plug In Relay 120VAC	
2	ea	3TX7144-1E6	Relay Socket	
2	ea	3SB3001-6AA20	Rd Pilot Light	
1	ea	3SB3001-6AA40	Green Pilot Light	
2	ea	3SB3400-1QC	120 VAC LED Green	
1	ea	3SB3400-1QB	120 VAC LED Red	
2	ea	3SB3000-2DA11	3 Position Selector Switch	
10	ea	3SB3400-0A	Contact Block, NO/NC	
1	ea	ECG14	Ground Bar	
1	ea	6EP1331-1SH02	Power Supply	
1	ea	3TX7117-5PF13	4 Pole 15A Relay	
1	ea	3TX7144-1E9	4 Pole Relay Socket	
1	ea	3SB3000-2GA11	3 Position Selector Switch Spr. Ret.	
1	ea	3SB3000-0AA11	Black Push Button	
1	ea	3SB3400-0D		
1	ea	3RH1911-1HA22	Aux Contact	
1	ea	CFS361J5	Fusicle Disconnect	
1	ea	CFSH5R12	Handle	
1	ea	CFSS5200	Shaft	
3	ea	AJT20	Fuses, 20 Amp	Ferraz

APPENDIX H. Observation and Monitoring Datasheet

CUSTOMER: _____

	DATE:							
	TIME:							
	OPERATOR:							
General Parameters:	***Optimal Range***							
Inlet Air Differential Pressure: Equipment Tag #:PDI/PDE-100	< 1" W.C.							
Inlet Air Temperature: Equipment Tag #: TI-100	50°F - 100°F							
Recirculation Flow Rate: Equipment Tag #: FE/FIT-370	11.1 GPM							
Recirculation Line Pressure: Equipment Tag #: PI-180	18.1 psi							
Total Irrigation Flow: Equipment Tag #: FI-440								
Irrigation Line Pressure: Equipment Tag #: PI-440	15 psi							
Media Temperature: Equipment Tag #: TI-450	50°F - 104°F							
Media Pressure Differential: Equipment Tag #: PDI-450	≤ 8" W.C.							
Exhaust Odor (Yes or No):	**NO**							
Comments: _____								

It is the responsibility of the site personel to monitor the parameters listed above on a daily basis and notify the manufacturer if a considerable deviation in values occurs.

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APPENDIX I. BIOSERVE Package – Quarterly Media Samples

As part of the comprehensive monitoring program BIOSERVE is used to maintain the quality of the media bed. BIOSERVE is a preventative maintenance package that is offered for purchase for the first year of operation and can be renewed at the end of the service contract.

Media samples are drawn by the OWNER at varying depths across the biofilter bed on a quarterly basis (as per the biofilter media sampling protocol and the media sample sheet). These samples are then sent to BIOREM®'s laboratory for analysis.

The **Biofilter Media Sampling Protocol** outlines the preparation, execution and shipping of the samples back to BIOREM®. This protocol should be followed to minimize contamination and ensure accuracy of the sample.

A **Media Sample Sheet** is used to record the location of the samples along with the ambient conditions, and visual observations.

The BIOSERVE package monitors the following parameters:

- Media Moisture;
- pH of the Biofilter Media;
- Bacterial Enumeration;
- Particle Size Analysis;
- Nutrient Characterization;
- Mineral Deposit Analysis; Quantification
- Other parameters as required (application dependant)

Media Moisture
Monitoring the amount of moisture on the media is critical for achieving maximum removal efficiency (the expected range for an active biofilter is 20% - 40% on a dry weight basis). The moisture levels are important for maintaining proper levels of bacteria as well as proper air distribution. Low moisture content can be an indication of preferential flow. Therefore, evidence of surface dry out should be addressed immediately through the addition of water with the irrigation system.

pH of Biofilter Media
The pH and moisture is measured to determine if any limitations are being put on the growth of the bacteria population. The pH allows for optimal bacterial activity and diverse bacterial population (the optimal range for pH should be within 5 – 9).

Bacterial Enumeration
Total heterotrophic bacteria will be quantified on 3 media samples. Values are reported as colony forming units per gram of media. This parameter provides an indirect method of assessing the relative state of the odor control equipment (for an active biofilter an acceptable average should be 10^6 - 10^8 colony forming units / gram).

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Particle Size Distribution

The monitoring and trending of particle size over the life span of the biofilter allows for determining decomposition of the media. Correlation of the particle size and increased differential pressure provides advanced warning on media breakdown and requirement for media change out.

Nutrient Characterization

The media samples from the biofilter will be drawn together to form a composite for analysis. The nutrient profile allows for identification of any nutrient deficiencies, which may occur during the operational lifetime of the biofilter. Table 11 lists the nutrients measured in the analysis.

Table 11: Nutrient Characterization

Nutrient/Component	Item Description
NH_4, NO_3	Nitrogen sources which are immediately available to the microorganisms.
Total N	Measures total Nitrogen, both available and unavailable forms.
TOC	Total Organic Carbon determines amount of carbon available.
Mg, K	Salts are nutritional requirements for bacteria.
PO_4	Key nutrient component required for bacterial health.

Mineral Deposit Analysis; Quantification

Mineral Deposit Analysis determines the amount of total sulfate ions accumulated on the surface of the media. An abundance of sulfate ions can lead to the formation of insoluble salts which can bind together forming large areas of solid mass. By quantifying the results it allows for potential problems to be identified and resolved.

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APPENDIX J. Media Sample Sheet

EXAMPLE - MEDIA SAMPLE SHEET

CLIENT NAME: _____ **CONTACT NAME:** _____

SYSTEM: _____ **MEDIA TYPE:** BIOSORBENS (1/4 Gallon per sample)

EVENT NUMBER: _____ **SAMPLE TO BE TAKEN ON:** _____

SAMPLED BY: _____ **DATE SAMPLE TAKEN:** _____
(Operator Name)

AMBIENT CONDITIONS: Please circle the condition(s) that apply below **Ambient Temperature:** _____

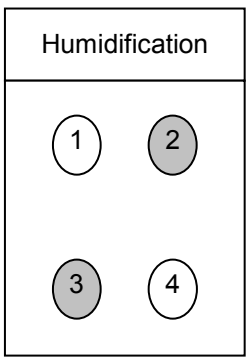
Sunny **Cloudy** **Raining** **Snowing** **Other:** _____

SAMPLE INFORMATION

- Please see diagram below for sample location numbers. The shaded circles are the locations at which sampling should occur.
- Please record the visual observations of the media being sampled. Examples are shown below the table in 4 categories: Moisture, Color, Consistency and Smell.

SAMPLE NUMBER	BIOFILTER NUMBER	SAMPLE LOCATION	Depth (inches)	VISUAL OBSERVATIONS (moisture, color, consistency, smell)
1		2	2	
2		2	36	
3		3	2	
4		3	36	

EXAMPLES OF VISUAL OBSERVATIONS:



Moisture
1. Very Dry **2**. Dry **3.** Moist **4.** Wet **5.** Very Wet

Color
A. Black **B.** Brown **C.** White **D.** Patchy

Consistency
a. Slimy **b.** Furry **c.** Clumpy **d.** Loose

Smell (like contaminants)
S. Strong **M.** Mild **N.** None

For Biorem® Use Only:
Ship Date:
Date Received:
Received By:

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APPENDIX K. Installation Guides

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BIOFILTER MEDIA INSTALLATION GUIDELINE

Overview

This manual provides an overview of the media installation procedures. It is recommended that all instructions, diagrams and illustrations be read and viewed prior to initial system installation. Any questions or concerns are to be directed to BIOREM Technologies Inc.

Packing slips should be verified to ensure correct volume of media has arrived and has not sustained damage. (If damage has occurred, digital photos should be taken and sent to BIOREM with damage note on packing slip).

1. Personnel Safety Precautions

Follow all plant approved safety procedures.

Work safety regulations and accident prevention regarding work using electrical power and other substances must be observed and adhered to.

The biofilter and humidification chamber are considered to be confined spaces. Trained operators and personnel should follow the plant approved confined space entry safety procedures at all times.

Due to the biological nature of the filter material used in the system, safe work procedures must be followed whenever handling the media. Also clean maintenance practices should be administered at all times when handling the filter media.

Please contact a manufacturer's technical representative from BIOREM if you require any further information.

Additional handling and safety procedures can be found with attached MSDS sheets.

2. Media Delivery and Storage

Media may be delivered by the following methods based on the scope of supply of the project:

- ***End-dump trailers in bulk delivered on site.***

Media must be placed on a clean, self draining, non-porous surface such as an asphalt pad or tarpaulin. This is to minimize contamination prior to installation.

Figure 1: Media in bulk with tarpaulin cover and concrete blocks

If the media requires storage for more then one day a tarpaulin must be used to cover the entire surface of the media.

- ***2500lbs bags delivered on site by flat-bed trailer.***

Bags should be placed together and inspected to ensure proper amount has arrived.

Figure 2: Media in bags

If storage is required for more then one day tops should be covered with flap of bag and left on skid.

A tarpaulin is recommended to cover bags for extended storage (> 1 week).

3. Media Installation

Remove all biofilter covers prior to media placement. Type of biofilter covers may vary.

Figure 3: Lids of BASYS™ vessel with Wing-nut fastener and plate

Ensure interior of biofilter vessel / basin is clear and free of components. Inspect interior of biofilter vessel / basin for debris or foreign material.

Confirm media support floor is installed and screen is fastened to the floor.

Figure 1: Interior of BASYS™ vessel

Figure 5: Interior of BIOFILTAIR™ basin

SAFETY – *These recommendations should be read prior to handling media.*

Media should NOT be handled without proper onsite safety equipment. Safety glasses, hard-hat and work boots should be worn.

Latex gloves or work gloves must be worn to ensure that media does not come into contact with exposed skin.

Dusk masks (N95 or P100 particle size) are required when handling media on arrival as it may be dry and particles may be airborne.

Additional handling and safety procedures can be found with attached MSDS sheets.

Before proceeding with media installation, ensure that correct height is properly marked (using a chalk-line on the inside of the vessel.
Utilizing a back-hoe, excavator or front-end loader to scoop the media into the biofilter; or a telescopic belt conveyor to place the media into the biofilter. The media should not drop a distance greater than 5 feet to reduce the risk of damage.

Figure 6: Telescopic belt placing media

Figure 7: Front-end loader for media installation

If media is delivered in bulk sacks use fork-lift to lift bag by handles and open shoot at bottom, allowing media to pour into biofilter.

Figure 8: Installing media in bags

To reduce the risk of contamination and damage, please refrain from driving on the media

Install the media in layers to take into account any deviations in particle sizes and settling rates.

Ensure media is level for optimal performance and air coverage.

APPENDIX L. Preliminary Start-Up Procedure

Preliminary Start-Up and Commissioning Schedule:
The following is the preliminary schedule with planned start-up activities which will take place prior to commissioning and after all equipment has been installed by the contractor.

Mechanical/Electrical:

- Visual inspection of installation to determine any deficiencies prior to electrical or mechanical engagement
- Review of installed system to the contract drawings including system general arrangement and system P&ID's to ensure proper location and placement of supplied equipment. Check to ensure all media is installed to correct height.
- After review and confirmation of contract drawings to installed equipment, representative will turn on the system's water supply and check for any leaks as well as proper flow levels. He will also ensure all sumps are filled and the proper valves in the intended position. If preliminary start-up takes place outdoors in winter months, the sump and water lines will be drained to ensure freezing does not occur (when applicable)
- Set timer on irrigation line as per design, test for leaks and proper spray coverage of media irrigation.
- The necessary motors will be bumped to ensure proper rotation
- Once rotation, electrical and mechanical as described above is performed, the system will be started, the design air flow will be achieved via control dampers, and the instrumentation will be properly set to given design parameters
- Ensure system design parameters have not been changed, modify as needed. (if lag between initial start-up and commissioning time is scheduled)
- Engage irrigation cycle to thoroughly saturate the media bed
- Fill vessel sump to design level, ensure all valves are in proper position.
- In conjunction with the electrical commissioning, the system will be started and odorous air will be drawn into the media bed. The system will remain running at this time.
- Operator training will take place at this time.

The Electrical/Mechanical start up as described is estimated to take 2-4 man days depending on system being commissioned.

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APPENDIX M. Maintenance Bulletins

Insert any applicable maintenance Bulletins from BIOREM® Service Department into this section of the manual.

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Biofilter Media Maintenance

BIOREM® provides two categories of biofilter media, selected to compliment the vessel design and the application. All BIOREM® biofilter media are designed to provide long term, uninterrupted service, but are subject to deterioration under harsh operating conditions. The life of the media is determined by the chemical constituents in the air stream, operating temperature, system design, exposure to the elements and other site specific factors.

The two categories of media are organic and permanent synthetic. They are differentiated by the materials of composition and degree of stability.

Organic media generally consist of derivatives of trees and are subject to compaction and biodegradation over time. As a result, the back pressure through a bed of organic media will slowly increase until it reaches a level that restricts the volume of air flow, necessitating conditioning or replacement of the media.

Permanent synthetic media is composed of mineral based components that do not significantly compact and are non-biodegradable. Inorganic media will sustain a consistent back pressure and performance over extended time periods and do not require frequent replacement.

Maintenance of biofilter media is as follows:

- Maintain even moisture control of media through consistent operation of the pre-humidification system to keep the inlet RH above 98% and through maintenance of the surface irrigation system.
- Inspect all spray nozzles for proper operation weekly to ensure the capacity and distribution pattern of water is sustained as per design. Clean and/or replace any faulty nozzles.
- Inspect operation of pumps and solenoid valves weekly and record volume of water used in the system. Ensure high/low sump levels are maintained
- Inspect drains to ensure they do not become plugged and avoid flooding of the media bed.
- Maintain operating records in accordance with the schedule provided by the manufacturer and note any deviations from control points
- Provide fan maintenance as per manufacturer's schedule.
- Inspect surface distribution of air flow pattern, where applicable and look for any short circuiting of airflow
- Remove weed growth from surface of biofilter and any root balls that may have formed
- Inspect open top systems for the presence of burrowing rodents and if present, remove from site
- Keep surface of biofilter free from debris, equipment and foreign objects.
- Avoid unnecessary foot passage and placement of machinery on surface of bed. Place boards or wood panel temporarily over bed if used for foot passage
- Collect samples of media for submission to manufacturer as per instructions
- If back pressure rises to more than double the initial operating level, contact manufacturer for instructions. The corrective action will depend on the cause of the backpressure, operating conditions and equipment design.

Rev. 000 – March 2009

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APPENDIX N. Service Reports

Insert all Service Reports provided by the BIOREM® Service Department into this section of the manual.

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BIOREM SK450 New York Blower Performance Data

The New York Blower Company

Fan-to-Size
Fan Selection Data

Project:	
Location:	
Contact:	

Fan Design

Product:	Compact GI	Arrangement:	4
Size/Model:	125	Drive type:	Direct
Wheel Material:	316 SST		
Wheel Width:	100.0 %	Wheel Diameter:	100.0 %

Operating Conditions

Volume Flow Rate:	450 CFM	Fan Speed:	3500 rpm
Fan Static Pressure:	8.92 in wg	Fan Input Power:	1.30 bhp
Outlet Velocity:	2848 ft/min	VP/SP ratio:	0.0522
Altitude (above mean sea level):	0 ft	Operating Temperature:	90 Deg F
Operating Inlet Airstream Density:	0.0690 lb/ft3		
Static Efficiency:	48.48%	Mechanical Efficiency:	51.01%
Maximum Operating Temperature:	90 Deg F	Maximum Safe Operating Speed:	4000 rpm

Operating cost is $213.22 for 2080 hours with a 90% efficient motor when energy unit cost per kW-hr is 0.095

Standard Conditions

Volume Flow Rate:	450 CFM	Fan Speed:	3500 rpm
Fan Static Pressure:	9.7 in wg	Fan Input Power:	1.41 bhp
Density at Mean Sea Level :	0.0750 lb/ft3	Max. Safe Speed at 70 Deg F:	4000 rpm

Sound Power Level Ratings Levels expressed in dB (power levels reference 10^(-12) watts)

Center Frequency (Hz):	**63**	**125**	**250**	**500**	**1000**	**2000**	**4000**	**8000**	
Octave Bands:	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**Overall**
Total Fan Power Levels*:	82.8	96.5	100.5	91.5	87.5	82.8	77.5	76.5	102.6
Inlet Power Levels**:	79.8	93.5	97.5	88.5	84.5	79.8	74.5	73.5	99.6
Outlet Power Levels**:	79.8	93.5	97.5	88.5	84.5	79.8	74.5	73.5	99.6

*As corrected for point of operation (location on fan curve)
**Unsilenced Inlet and Outlet power ratings are 3 dB lower than total fan power levels under the assumption that "half" of the sound power can be attributed to each opening. Silenced power ratings include this 3 dB reduction as well as the silencer attenuation.

Estimated Sound Pressure Levels Expressed in dB (pressure levels reference $2x10^{-7}$ microbar)

Directivity/Reflection Factor (Q) is 1, spherical radiation; Distance is 5 ft.; A-weighting is in use.

The estimated sound pressure level outside the fan due to an open inlet OR outlet is 77.7 dBA at 5.0 feet. The estimated sound pressure level outside the fan when BOTH inlet and outlet are ducted is 66.8 dBA at 5.0 feet (Housing Radiated Noise).

Your Representative:
R J Wondrack Company
300 Stoutenger Street
East Syracuse, NY 13057
Phone: (315) 437-4440
Fax: (315) 437-9783
E-Mail: chris.clarkson@wondrack.com

The New York Blower Company certifies that the Compact GI fan is licensed to bear the AMCA Air Performance Seal. The ratings shown are based on tests and procedures performed in accordance with AMCA Publication 211 and comply with the requirements of the AMCA Certified Ratings program.

AMCA Licensed for Air Performance without Appurtenances (Accessories). Power (bhp) excludes drives.

Performance certified is for installation type: D - ducted inlet, ducted outlet.

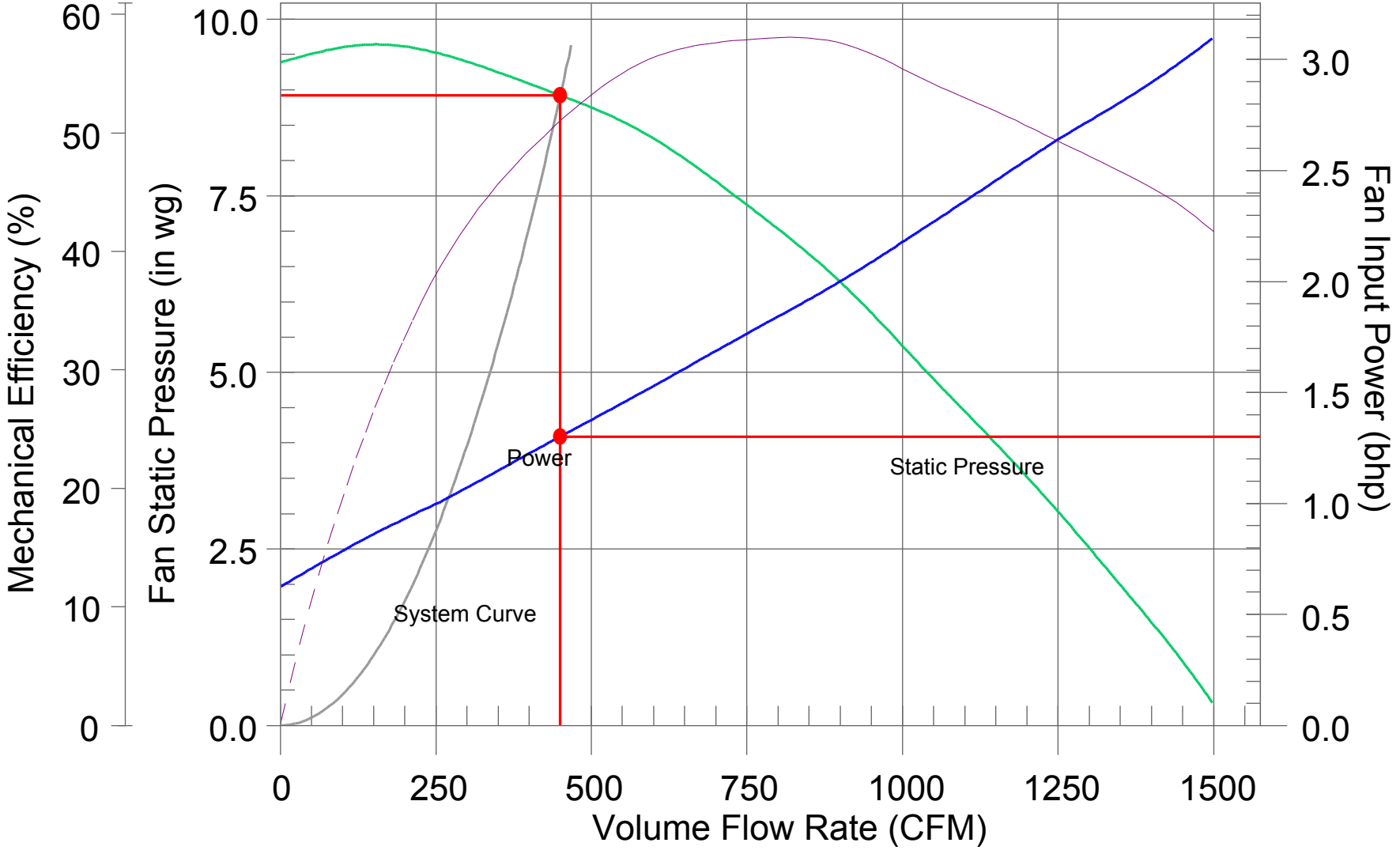
The New York Blower Company

Fan-to-Size

Compact GI
125
Arr.: 4

Volume Flow Rate: 450 CFM
Fan Static Press.: 8.92 in wg
Speed: 3500 rpm
Power: 1.30 bhp

Temp.: 90 Deg F
Altitude: 0 ft
Density: 0.0690 lb/ft3
Outlet Velocity: 2848 ft/min



AMCA Licensed for Air Performance without Appurtenances (Accessories). Power (bhp) excludes drives.
Performance certified is for installation type: D - ducted inlet, ducted outlet.

Customer:
Biorem
SK-250

[v1.75.100-R -- October 2007] Date Printed: 11/6/2009
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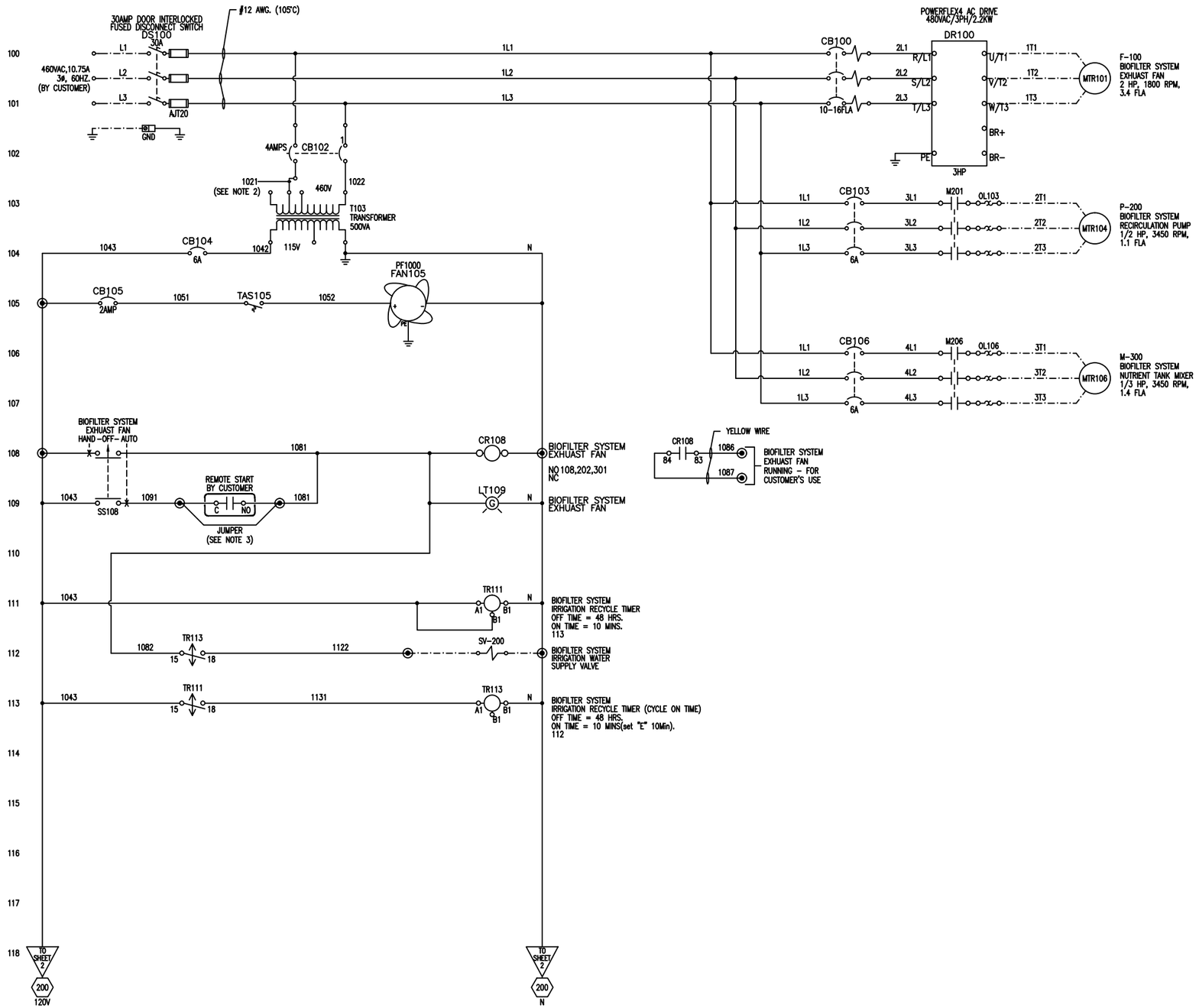
Your Sales Representative:
R J Wondrack Company
Phone: (315) 437-4440

BIOREM SK450 Electrical Drawings,

- Control System Electrical Wiring Diagram BIOREM Dwg. No.: SK250_450-E-001 S 1 of 4
- Control System Electrical Wiring Diagram BIOREM Dwg. No.: SK250_450-E-001 S 2 of 4
- Control System Electrical Wiring Diagram, BIOREM Dwg. No.: SK250_450-E-001 S 3 of 4
- Control Panel Layout Diagram, BIOREM Dwg. No.: SK250_450-E-001 S 4 of 4

Control System Electrical Wiring Diagram BIOREM Dwg. No.: SK250_450-E-001 S 1 of 4



NOTES:

1. ENCLOSURE WIRE CODE UNLESS STATED OTHERWISE:
   - 380VAC: 12AWG TEW/MTW BLACK
   - 120VAC: 16AWG TEW/MTW RED
   - 120VAC NEUTRAL: 16AWG TEW/MTW WHITE
   - DC VOLTAGE: 16AWG TEW/MTW BLUE
   - OTHER SOURCE: 16AWG TEW/MTW YELLOW
2. TRANSFORMER JUMPER INSTALLED DURING CONTROL PANEL ASSEMBLY.
3. REMOVE JUMPER IF REMOTE START CONTACT(S) ARE WIRED INTO THE CIRCUIT.

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2. TOLERANCES
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2 PLACE DEC. ±.030
3 PLACE DEC. ±.010
ANGLES ±1/2°

CUSTOMER: SK-450 THERMA-FLITE

TITLE: U500 ODOUR CONTROL SYSTEM ELECTRICAL WIRING DIAGRAM

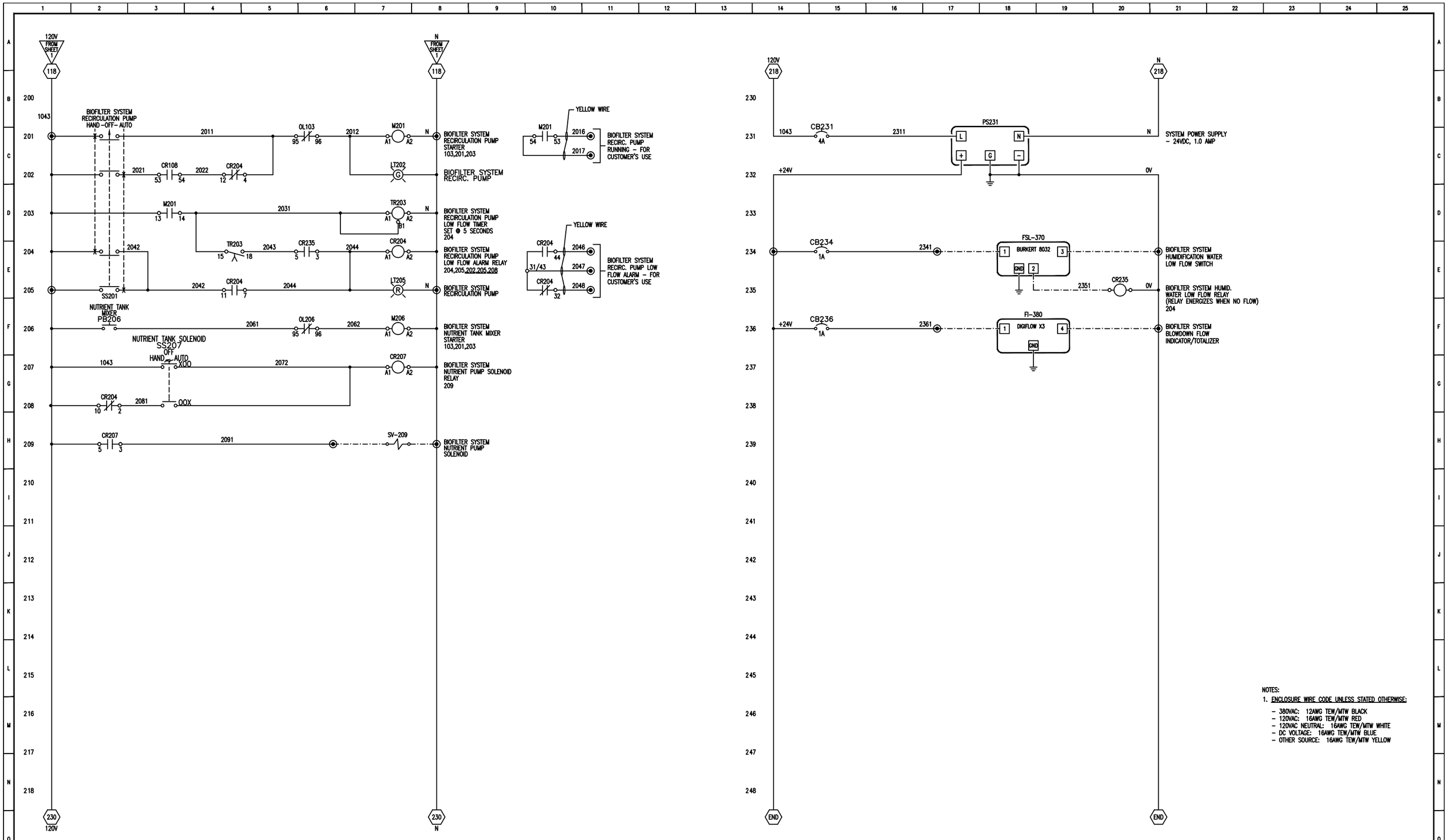
JOB #: ####X

SCALE: N.T.S.

SIZE: D

DRAWING NUMBER: SK250_450-E-001 Sh: 1 of 4

REV: A



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1. ENCLOSURE WIRE CODE UNLESS STATED OTHERWISE:
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   - 120VAC: 16AWG TEW/MTW RED
   - 120VAC NEUTRAL: 16AWG TEW/MTW WHITE
   - DC VOLTAGE: 16AWG TEW/MTW BLUE
   - OTHER SOURCE: 16AWG TEW/MTW YELLOW

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ANGLES ±1/2°

CUSTOMER: SK-450 THERMA-FLITE

TITLE: U500 ODOUR CONTROL SYSTEM ELECTRICAL WIRING DIAGRAM

JOB #: ####X

SCALE: N.T.S.

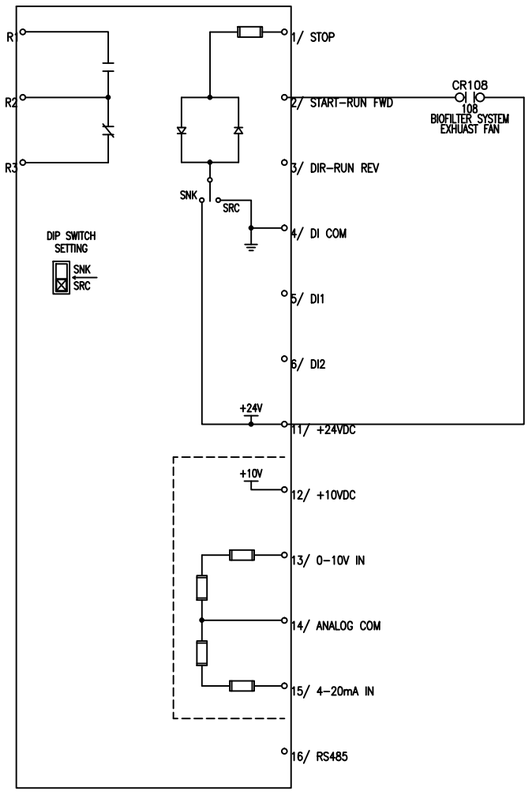
SIZE: D

DRAWING NUMBER: ####X-E-002

SH: 2 of 4

RDN: A

Control System Electrical Wiring Diagram, BIOREM Dwg. No.: SK250_450-E-001 S 3 of 4



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FRACTIONS ± 1/32
2 PLACE DEC. ±.030
3 PLACE DEC. ±.010
ANGLES ±1/2°

SCALE: N.T.S.

CUSTOMER: SK-450 THERMA-FLITE

TITLE: U500 ODOUR CONTROL SYSTEM ELECTRICAL WIRING DIAGRAM

JOB #: ####X

SIZE: D | DRAWING NUMBER: ####X-E-003 | SH: 3 of 4 | REV: A

Control Panel Layout Diagram, BIOREM Dwg. No.: SK250_450-E-001 S 4 of 4

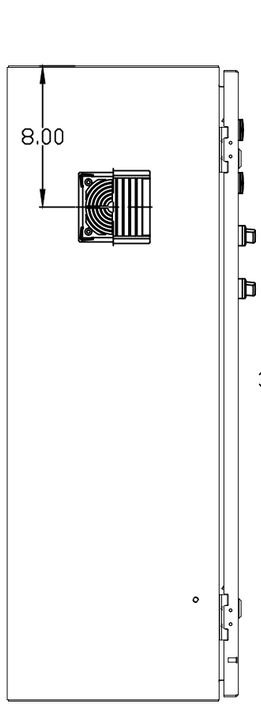
WARNING
DISCONNECT POWER
BEFORE ENTERING

CAUTION
VOLTAGE SUPPLIED FROM OTHER SOURCES
DISCONNECT POWER BEFORE ENTERING

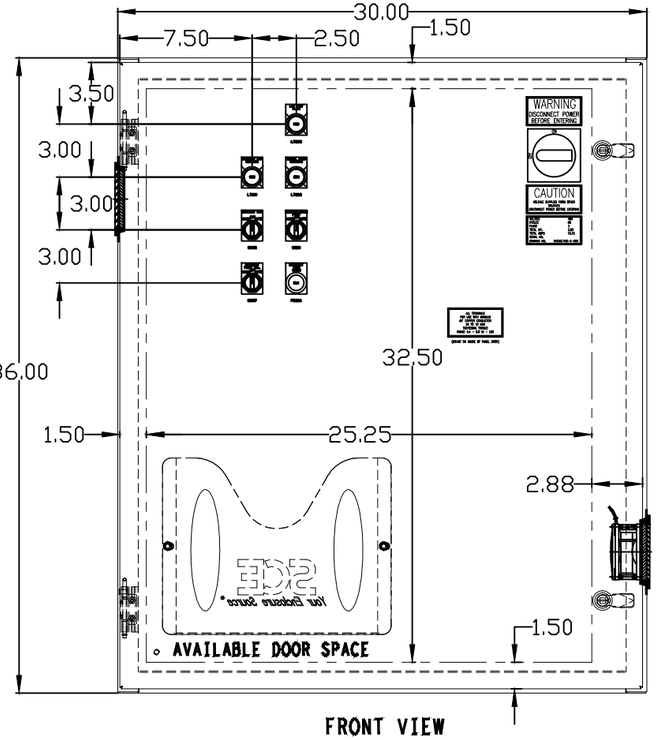
VOLTAGE	460
CYCLES	60
PHASE	3
TOTAL HP.	2.83
TOTAL AMPS	10.75
SERIAL NO.	
DRAWING NO.	SK250/450-E-00X

ALL TERMINALS
FOR USE WITH MINIMUM
60° COPPER CONDUCTOR
26 TO 10 AWG
TIGHTENING TORQUE
RANGE 4.4 – 8.8 IN – LBS

(MOUNT ON INSIDE OF PANEL DOOR)



LEFT SIDE VIEW



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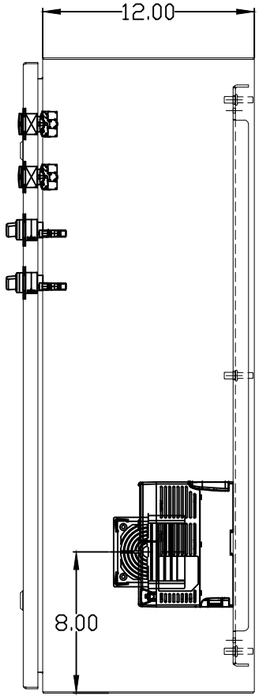

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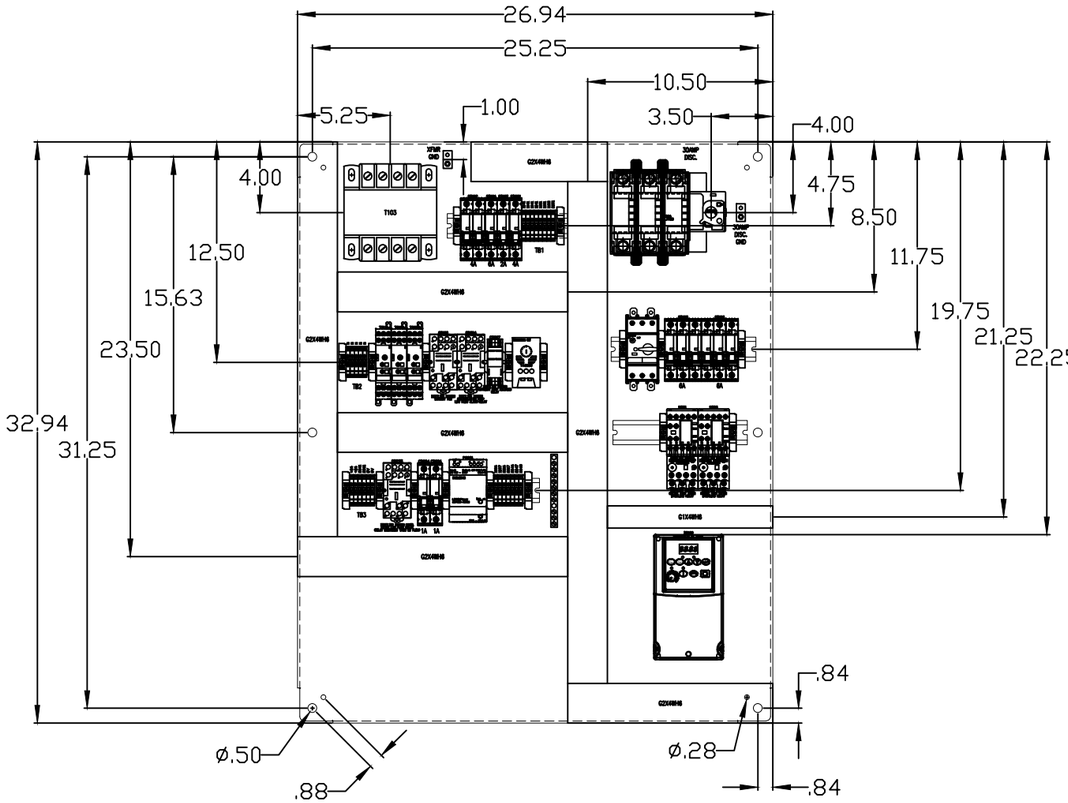
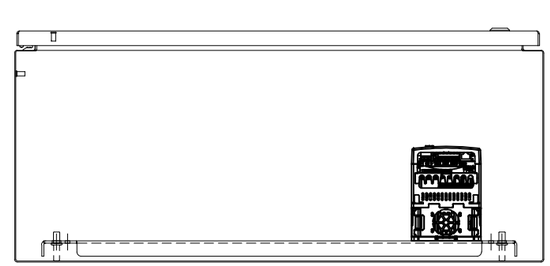
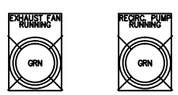




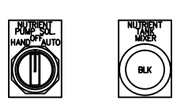
BOTTOM VIEW

LT205

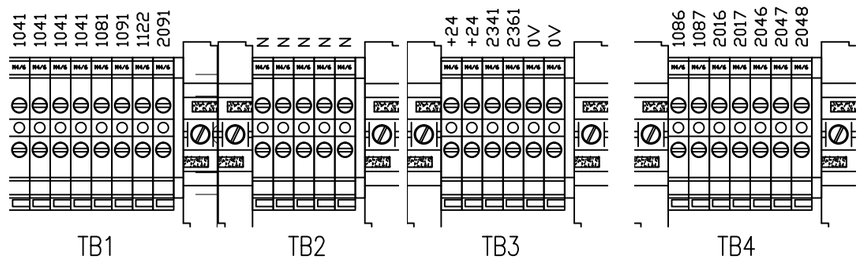


LT109 LT202

SS108 SS201



SS207 PB206



TB1 TB2 TB3 TB4

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2. TOLERANCES
FRACTIONS ± 1/32
1 PLACE DEC. ± .030
2 PLACE DEC. ±.010
ANGLES ±1.0°

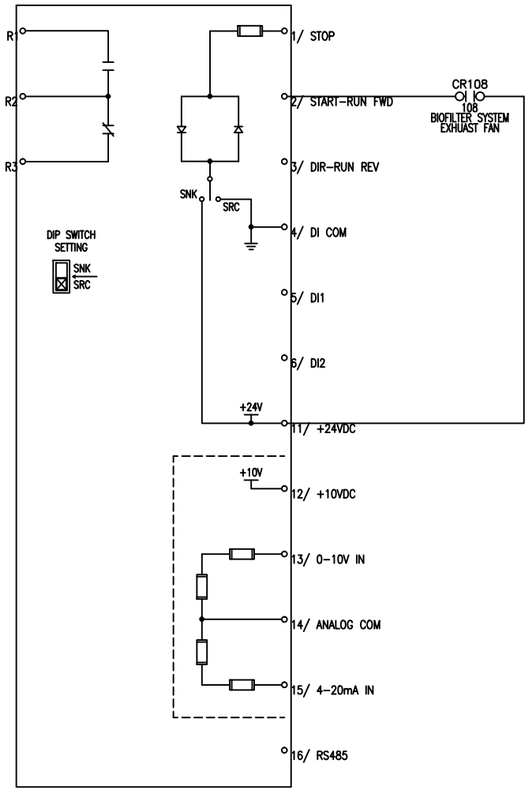
SCALE: N.T.S.

CUSTOMER: SK-450 THERMA-FLITE

TITLE: U500 ODOUR CONTROL SYSTEM CONTROL PANEL LAYOUT DIAGRAM

JOB #: ####X

SIZE: D | DRAWING NUMBER: ####X-E-004 | SH: 4 of 4 | REV: A



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CAD REF:

REV	DATE	DESCRIPTION
A	09JUL09	ISSUED FOR APPROVAL

REVISIONS

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DESIGNED BY:	M.H.	09JUL09
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APPROVED BY:		

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2. TOLERANCES
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2 PLACE DEC. ±.030
3 PLACE DEC. ±.010
ANGLES ±1/2°

SCALE: N.T.S.

CUSTOMER: SK-450 THERMA-FLITE

TITLE: U500 ODOUR CONTROL SYSTEM ELECTRICAL WIRING DIAGRAM

JOB #: ####X

SIZE: D | DRAWING NUMBER: ####X-E-003 | SH: 3 of 4 | REV: A

BIOREM SK450 General Arrangement Drawings

- BIOREM Dwg. No.: SK450-GA-000 S 1 of 7
- BIOREM Dwg. No.: SK450-GA-000 S 2 of 7
- BIOREM Dwg. No.: SK450-GA-000 S 3 of 7

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CONSTRUCTION

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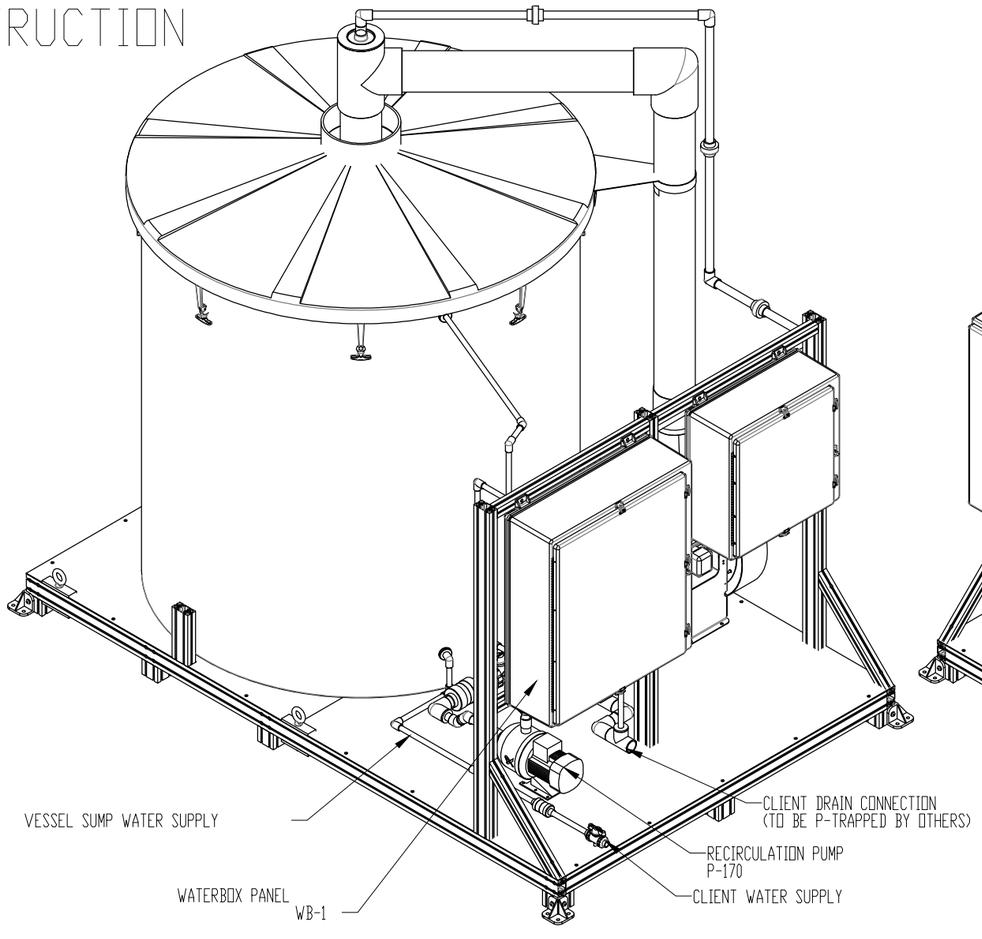
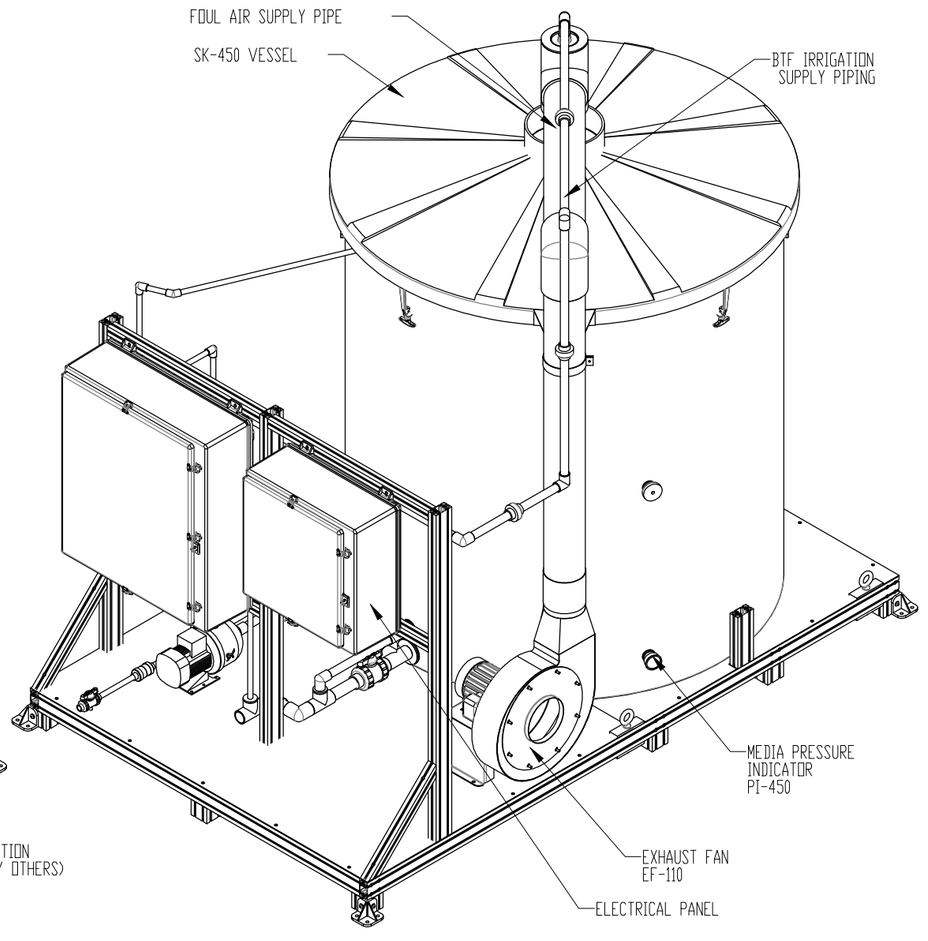
REV.	DATE	DESCRIPTION	BY
00	12/11/2009	FOR REVIEW AND APPROVAL	BAD





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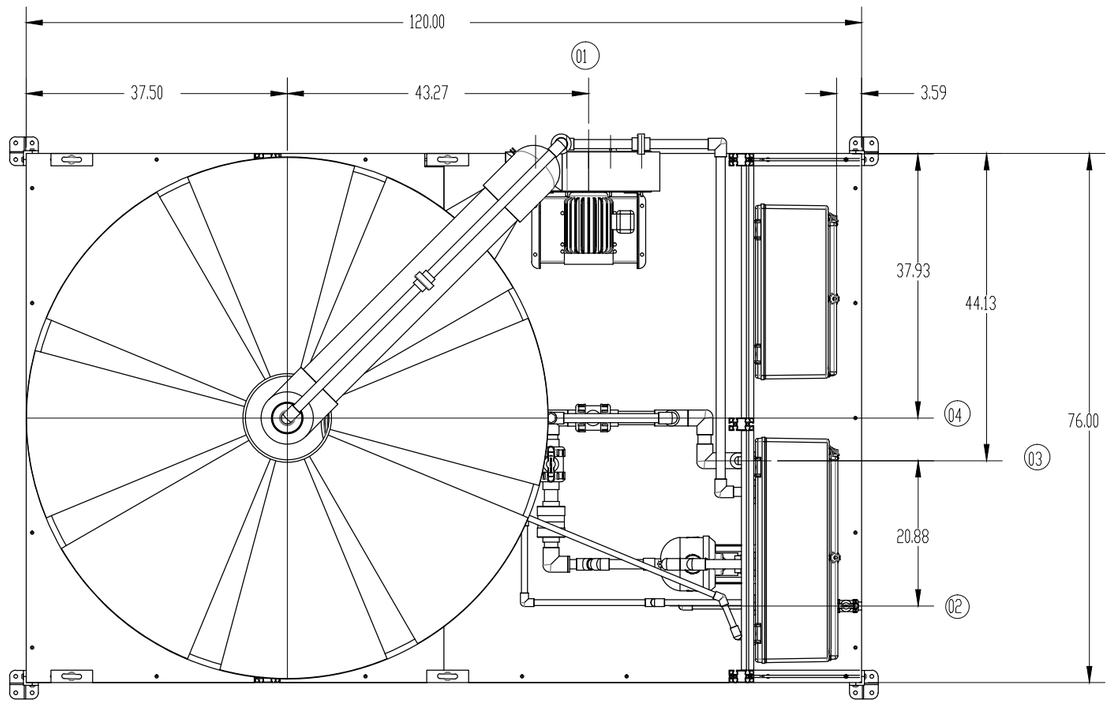
SCALE: 1:20

CLIENT: SK-450

TITLE: SK-450 GENERAL ARRANGEMENT

PROJECT: XXXXF

SIZE: B | DRAWING NUMBER: SK450-GA-000 | SHT 1 OF 7 | REV: 00



T.P.	SIZE	TYPE	DESCRIPTION
01	8"	FLG	FAN INLET
02	0.5"	SOC	CLIENT WATER SUPPLY
03	1.5"	SOC	TO CLIENT DRAIN
04	12"	N/A	VESSEL EXHAUST

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   3 PLACE DEC. ±.010
   ANGLES ±1.0°

CLIENT: SK-450

TITLE: SK-450 GENERAL ARRANGEMENT

PROJECT: XXXXF

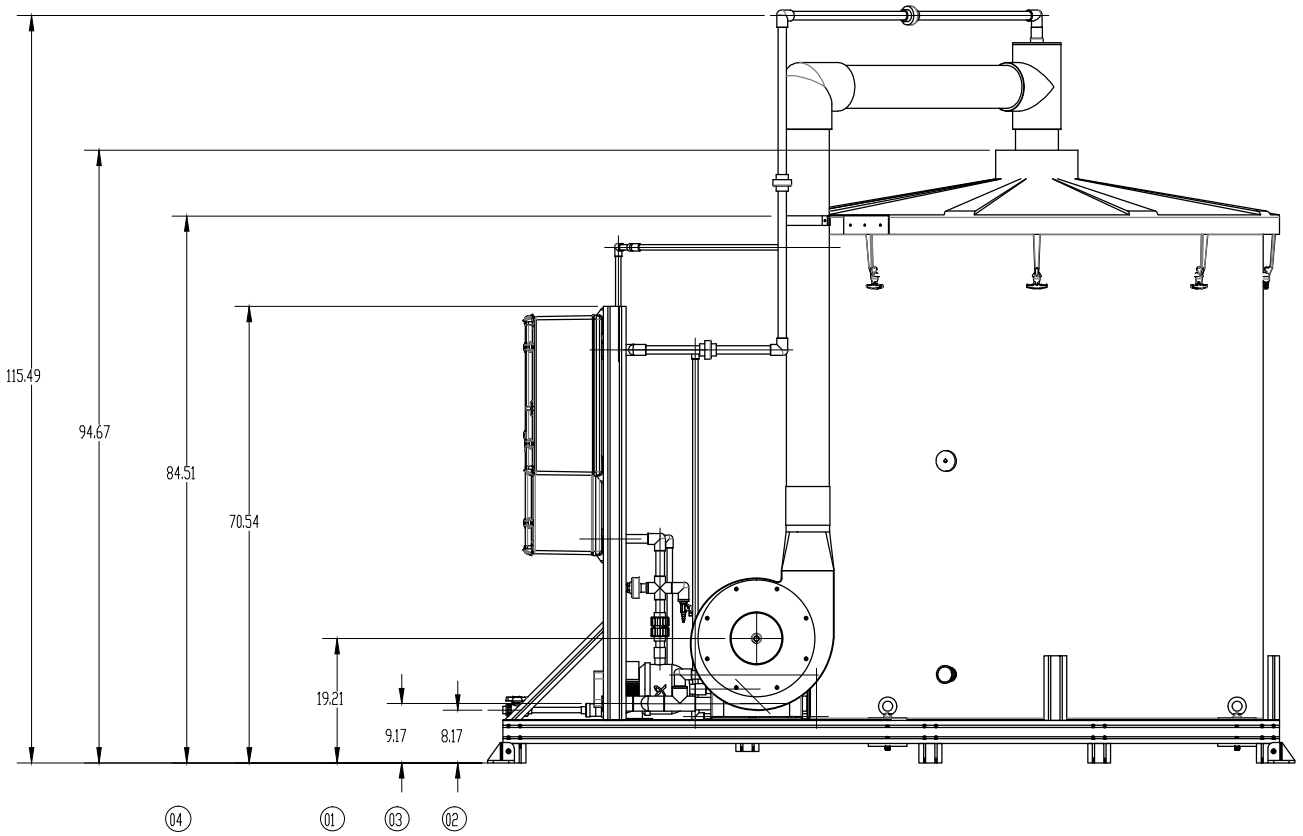
SCALE: 1:18

SIZE: B

DRAWING NUMBER: SK450-GA-000

SHT 2 OF 7

REV: 00



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SCALE: 1:18

CLIENT: SK-450

TITLE: SK-450 GENERAL ARRANGEMENT

PROJECT: XXXXF

SIZE: B | DRAWING NUMBER: SK450-GA-000 | SHT 3 OF 7 | REV: 00

J. Electrical

- TFL 5412 BGMU Control Narrative
- Electrical Load List: TFL 5412 Electrical Requirements
- Therma-Flite TFL 5412 Instrument Index
- TFL 5412 Control Panel Amtec Drawings
    - Amtec Drawing No.:21309-F-001 S 1 of 2, PLC/VFD Panel, Enclosure Layout Details
    - Amtec Drawing No.:21309-F-001 S 2 of 2, PLC/VFD Panel, Bill of Materials
    - Amtec Drawing No.:21309-F-002 S 1 of 2, PLC/VFD Panel, Enclosure Layout & Arrangement Details
    - Amtec Drawing No.:21309-F-002 S 2 of 2, PLC/VFD Panel, Enclosure Layout & Arrangement Details
    - Amtec Drawing No.:21309-F-003 S 2 of 2, Flex I/O Junction Box, Enclosure Bill of Materials
    - Amtec Drawing No.:21309-D-001 S 1 of 7, PLC/VFD Panel, Electrical Power Distribution Diagram
    - Amtec Drawing No.:21309-D-001 S 2 of 7, PLC/VFD Panel, Electrical Power Distribution Diagram
    - Amtec Drawing No.:21309-D-001 S 3 of 7, PLC/VFD Panel, PLC Communications Block Diagram
    - Amtec Drawing No.:21309-D-001 S 4 of 7, PLC/VFD Panel, Analog Input Wiring Diagram
    - Amtec Drawing No.:21309-D-001 S 5 of 7, PLC/VFD Panel, Analog Input Wiring Diagram
    - Amtec Drawing No.:21309-D-001 S 6 of 7, PLC/VFD Panel, Digital Input Wiring Diagram
    - Amtec Drawing No.:21309-D-001 S 7of 7, PLC/VFD Panel, Relay Output Wiring Diagram
    - Amtec Drawing No.:21309-D-002 S 1 of 8, Flex I/O Junction Box, Electrical Power Distribution Diagram
    - Amtec Drawing No.:21309-D-002 S 2 of 8, Flex I/O Junction Box, Analog Input Module Wiring Diagram
    - Amtec Drawing No.:21309-D-002 S 3of 8, Flex I/O Junction Box, DC Input Module Wiring Diagram
    - Amtec Drawing No.:21309-D-002 S 4 of 8, Flex I/O Junction Box, DC Input Module Wiring Diagram
    - Amtec Drawing No.:21309-D-002 S 5 of 8, Flex I/O Junction Box, Thermocouple Module Wiring Diagram
    - Amtec Drawing No.:21309-D-002 S 6 of 8, Flex I/O Junction Box, Thermocouple Module Wiring Diagram
    - Amtec Drawing No.:21309-D-002 S 7 of 8, Flex I/O Junction Box, 120V AC Input Module Wiring Diagram
    - Amtec Drawing No.:21309-D-002 S 8 of 8, Flex I/O Junction Box, Flex I/O Junction Box, 120V AC Input Module Wiring Diagram

[MODIFY SECTION LETTER]. Electrical Continued

- Control Panel Electrical Component Specifications
  - Hoffman Enclosure, 72" x 34 ¼" x 18", Flange Disconnect, NEMA Type 4X
  - Hoffman Inner Panel, 60" x 27 ¾"
  - Main Circuit Breaker, Allen Bradley 140U-J2D3-D12
  - Flange Mount Disconnect Kit w/ 6' Cable, Allen Bradley, 140U-J-FCS06
  - Variable Frequency Drive 480VAC 3-Phase, 7.5HP 12A, 5.5kW, Allen-Bradley, 22B-D012N104
  - Variable Frequency Drive 480VAC 3-Phase, 3HP 6A, 2.2kW, Allen-Bradley, 22B-D6P0N104
  - HMI, Allen Bradley Panelview 12" 2711P-T12C4A2
  - PLC, Allen Bradley
    - I/O Chassis, 7 Slot, 1756-A7
    - Power Supply, 1756-PA72
    - Control Logic Processor, 1756-L61
    - Ethernet Module, 1756-ENBT
    - Analog Input Module, 1756-IF8
    - Analog Output Module, 1756-OFC6I
    - AC Input Module, 1756-IA16
    - Relay Output Module, 16-PT, 1756-OW161
  - Motor Circuit Protector, 140M-D8E-C20
  - Motor Circuit Protector, 140M-C2E-C10
  - Circuit Breaker, 1-Pole, 10A, 1489-A1C100
  - Fused Terminal w/ Neon Indicator (120VAC), 1492-H4
  - Fused Terminal w/ Neon Indicator (120VAC), 1492-H5
  - RFI Filter, Corcom, 20V56
  - Ethernet Switch, BB Electronics, EIR308
  - Power Supply, PULS, CS5-241
  - Power Distribution Block Safety Cover, Ferraz Shawmut, 08570
  - Control Transformer, Hammond PH1500MQMJ
  - Fluorescent Light, Hoffman ALF16D24R
  - Fuse Holder, Ferraz Shawmut, USCC21
  - Fuse, Ferraz Shawmut, ATDR2

TFL 5412 BGMU Control Narrative

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THERMA-FLITE SLUDGE DRYING CONTROL SYSTEM DESCRIPTION

TFL5412 Bowling Green Municipal Utilities

IC10,000 Biosolids Drying System

Table of Contents

A) Touchscreens 2
B) Auto Mode 4
C) Setup Mode 6
D) Manual Mode 8
E) Shutdown Mode 9
F) Control Calculations 10
G) Compliance Recording 12

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THERMA-FLITE SLUDGE DRYING CONTROL SYSTEM DESCRIPTION

A) Touchscreens

A1) HMI Touchscreens – Navigation buttons are located along bottom of each screen.

1) Process Overview
2) Dehydration Chamber
3) Thermal Fluid Heater
4) Hopper / Feed System
5) Condenser / BioFilter
6) Cooling Screw
7) Manual
8) Setup
9) Active Alarms
10) Historical Alarms
11) Contact

All of the conveyor speeds except the Wet Infeed are preset from the HMI. All of the temperature set points, dwell times, and Wet Infeed speed prior to Normal Startup Sequence Complete, are programmable from the HMI.

The high and low limits for the pressure transducer and all of the thermocouples are programmable from the HMI.

MENU

The MENU key changes the screen back to the MAIN screen from any other screen. On the MAIN screen is a graphic representation of the Dryer and adjacent components. Displayed are all the thermocouples associated with the Dryer, the Wet Infeed speed, the on/off conditions of all components, and a Contact button. Touching the Contact button will change the screen to one that has the contact information for Therma-Flite, Inc.

In most circumstances, the system can be operated from the MAIN screen. In the event that information is desired regarding a specific component, touching the graphic representation of that component will change the screen from the MAIN screen to one with a graphic of that component, and will have displayed any information about that component. To return to the MAIN screen, press the MENU key.

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A) Touchscreens (cont.)

ALARM SILENCE
If a fault occurs an audible alarm will activate, the ALARM SILENCE key will silence that alarm for a preset amount of time, up to 60 minutes, to allow time for the alarm/fault to be cleared without the sound annoyance. The amount of time that the alarm will be silenced is programmable from the HMI.

FAULT RESET
Pressing the Fault Reset key resets all faults/alarms that exist in the system. Note that all of the faults have to be cleared and accepted on the Alarm Screen or they will immediately reappear.

ALARM SCREEN
When a Fault/Alarm occurs, the HMI screen will flash. Pressing the Alarm Screen key will change from whatever screen you are on to the Alarm Screen. On this screen will be displayed all of the alarms, time stamped, and in red if they are current/active alarms. In order to clear them, touch the PREV or NEXT buttons at the bottom of the screen to cursor over the desired selection, then touch the ACCEPT button. When all alarms have been accepted, press the Fault Reset key and if no alarms reappear the system should be able to resume operations.

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B) Auto Mode

Resuming the Auto mode startup sequence as quickly as possible saves the time that it takes for the system to come back to temperature. If the system is still at temperature, the only lost time will be the time that it takes to go back through the startup sequence.

No conveyor will start unless all of the following conditions have been satisfied:

B1) Entering Auto Mode Startup Conditions –

1) All alarms must be clear.
2) It is not necessary to allow the system to cool down after an alarm.
3) Accessed from either Manual Mode or Shutdown Mode.
4) All actuator status determined by Auto Mode (even if previously energized in Manual Mode).
5) No Faults – Faults force system to enter Shutdown Mode.
6) All permissive signals are available from external sources.

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B) Auto Mode (cont.)

B2) Auto Mode Startup Sequence - The temperature of the thermal fluid as reported by thermocouple (TE108) is used for the Startup Temperatures.

1) Thermal Fluid Heater circulation pump starts.
2) Nitrogen Purge is open to the Dehydration Chamber for X minutes then closed.
3) Ramp the Thermal Fluid Heater temperature to Setpoint #1 at 15 degrees F per minute.
4) When Startup Temperature Setpoint #1 is achieved, the Condenser and BioFilter is started.
5) Ramp the Thermal Fluid Heater Temperature to Setpoint #2.
6) When Startup Temperature SP2 is achieved, the Cooling Conveyors are started.
7) Dwell time.
8) The Dehydration Conveyor is started and water spray is open to the chamber.
9) The Thermal Fluid Heater Temperature is ramped to Setpoint #3 (Final Operating Temperature).
10) Start the Wet Infeed after a second dwell time.
11) Dwell time.
12) The water spray is closed to the chamber.
13) Final dwell time.
14) Wet Infeed speed is calculated by the PLC, based on the temperature reported by Thermocouple (TE101).
15) Normal Startup Sequence is complete.

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C) Setup Mode – (password access required)

Pressing the System Setup key will move you to multiple pages that allow the setting of system parameters. Navigating to all pages is accomplished via the buttons at the bottom of the screens. Touching the numeric input display of the parameter that you are trying to set will bring up a numerical keypad that allows you to change the value.

Control System Variables

1) Alarm Silence Timer PRE 60 Minutes Max - The number of minutes that the audible alarm is silenced during an alarm.
2) Auto Speed Op Delay PRE Minutes - The number of minutes from when the normal startup is complete until the Wet Infeed speed is automatically determined by the temperature of thermocouple (TE100). Before this delay is reached the Wet Infeed will operate at minimum speed.
3) Dehyd Cnvyr Start Delay PRE Seconds - The number of seconds from when the Cooling Conveyor starts until the Dehydration Conveyor starts.
4) Cooling Conveyor Shutdown Del PRE Seconds - The number of seconds from when the Dehydration Conveyor shuts down until the Cooling Conveyor shuts down.
5) Infeed Start Del PRE Seconds - The number of second from when the Dehydration Conveyor starts and the Wet Infeed starts.
6) PE100 Spec Min (in. WC) - The specification minimum (in. WC) for the pressure transducer. 4mA=?
7) PE100 Spec Max (in. WC) - The specification maximum (in. WC) for the pressure transducer. 20mA=?
8) PE100 Lo Lim (in. WC) - The (in. WC) low limit alarm set point for the pressure transducer.
9) PE100 Hi Lim (in. WC) - The (in. WC) high limit alarm set point for the pressure transducer.
10) Startup Temp SP1 - The degrees F at which the Condenser / BioFilter Motor energizes at startup.
11) Startup Temp SP2 - The degrees F at which the Cooling Conveyor energizes at startup.
12) Startup Temp SP3 - The degrees F at which the Thermal Fluid Temperature shall be maintained during normal operations in the AUTO mode.

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13) Shutdown Temp SP1 - The degrees F at which the Dehydration Conveyor de-energizes and water spray solenoid valve is open at shutdown.
14) Shutdown Temp SP2 - The degrees F at which the water spray solenoid valve closes at shutdown.
15) Shutdown Temp SP3 - The degrees F at which the Condenser / Biofilter Motor de-energizes at shutdown.

C) Setup Mode (cont.)

All thermocouples shall have a Lo Lim SP, which means low limit set point and is used as an alarm set point and Hi Lim SP, which means high limit set point, and is also used as an alarm set point. The low limit alarm set points are only examined while the system is in the AUTO mode and normal system startup is complete. The high limit set points are always active.

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D) Manual Mode – (password access required)

Places the system into the MANUAL mode and changes the screen from the Main screen to the Manual screen. The MANUAL mode can be accessed from either the AUTO or SHUTDOWN mode. Whatever was energized while the system was in the AUTO or SHUTDOWN modes remains energized. The Wet Infeed speed is now controlled by the manual setting entered into "INFEED IN MANUAL", touching that box will bring up a numerical pad where the Infeed Manual speed can be set or changed.

On this screen is a stop and start button each for the Thermal Fluid Heater Circulation Pump, Thermal Fluid Heater Burner, Wet Infeed, Dehydration Conveyor, Cooling Conveyor, Transfer Conveyor (if required), and the Condenser / BioFilter Fan. Under the Stop button for each component is the manual setpoint value for each component, touching that box will bring up a numerical pad where the value can be set or changed.

IMPORTANT: THE MANUAL MODE PROVIDES UNLIMITED CONTROL ACCESS FOR MAINTENANCE PURPOSES. THERE ARE NO INTERLOCKS WHILE IN THE MANUAL MODE. IT IS POSSIBLE TO START A CONVEYOR WITHOUT THE SUBSEQUENT CONVEYOR(S) RUNNING, OR TO HAVE MATERIAL IN THE DRYER WITHOUT THE CONDENSER RUNNING.
ONLY QUALIFIED PERSONNEL SHOULD HAVE ACCESS TO MANUAL MODE.

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E) Shutdown Mode

The SHUTDOWN mode can be accessed from either AUTO or MANUAL mode.

If any component of the system that is supposed to be energized fails to report back that it is energized, or if the pressure transducer or any of the thermocouples are out of their high limit or low limit alarm set points, a fault condition is triggered and the system automatically goes into the SHUTDOWN mode.

SHUTDOWN mode sequence:

1) The Thermal Fluid Heater Burner and the Wet Infeed are immediately shut off (The Thermal Fluid Circulation Pump remains running).
2) The temperature of the thermal fluid as reported by thermocouple (TE108) is used for the Shutdown Temperatures.
3) When Shutdown Temperature SP1 is achieved, the Dehydration Conveyor is shut off and water spray is open to the chamber.
4) Dwell time.
5) The Cooling Conveyor is shut off.
6) When Shutdown Temperature SP2 is achieved, the water spray is closed to the chamber and the Nitrogen is open for X minutes then closed.
7) When Shutdown Temperature SP3 is achieved, the Condenser /BioFilter is shut down and the Thermal Fluid Circulation Pump is shut down.
8) The Shutdown sequence is now complete. All of the temperature set points and dwell times are programmable from the HMI.

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F) Control Calculations

F1) Wet Infeed Speed PID Loop:

SP: Desired Value of BSDTE-5412-1
PV: (BSDTE-5412-1) Inlet Temperature Setpoint
CV: Wet Infeed VFD Speed
LCV low limit: Lower Limit for Wet Infeed VFD Speed
HCV high limit: High Limit for Wet Infeed VFD Speed
E=PV-SP: Increased Inlet Temperature results in increased Infeed Speed.

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F) Control Calculations

F3) Dehydration Chamber Drive Control

Description:
The two screws in the dehydration chamber are driven by two independent drive systems with independent VFD speed controls and grey-scale absolute encoders (to detect the absolute position of the screws). There is no mechanical gearing between the two screws. The relative positions of the screws must be maintained because the angled screw fins mesh and cannot touch as they rotate without resulting in damage to the screws.

Control Scheme:
The screws are initially aligned by bumping the position of screw #2 relative to the position of screw #1 (in Setup Mode) until there is a maximum gap between the meshing fins of the two screws. At the maximum fin mesh gap the relative screw position error is set = zero. The relative screw position error must be less than +/-5 angular degrees before Auto Mode can be entered. If the relative screw position error exceeds +/-20 angular degrees a fault is generated and the machine controls are shut down. The relative screw position error is maintained by controlling the speed of screw #2.

Notes:
The eight most-significant bits of the absolute encoder are connected to a group of eight digital inputs and converted to angular degrees by the controller resulting in a resolution of 1.4 angular degrees per bit change.

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G) Compliance Recording Requirements

Compliance with 40 CFR 503 Rules to Produce Class A Biosolids

(1) Date, (2) Time, (3) Residence time, (4) temperature will be recorded to hard disk every 15 seconds to satisfy the compliance requirements. The data file will be in csv file format. Each column will have a title and each row will be the recorded data separated by commas.

The screw conveyor can be considered a positive displacement pump and the residence time is known from the RPM feedback from the VFD drive and the "Pitch" of the rotor. BSDTE-5412-4 will be recorded as the initial temperature measurement point and BSDTE-5412-7 will be recorded to show the final temperature. If a moisture sensor is integrated into the system, a constant stream of moisture can be used for compliance.

Electrical Load List: TFL 5412 Electrical Requirements

Therma-Flite
The Screw Heat Exchanger Company

ELECTRICAL LOAD LIST

JOB #: TFL5412

REV	TAG NUMBER	DESCRIPTION	P&ID No.	NOMINAL VOLTAGE	PHASE	MOTOR					OTHER LOADS	SOURCE	REMARKS
						RATED POWER (Hp)	FULL LOAD AMPS	EFFICIENCY	POWER FACTOR	SERVICE FACTOR	KW / Service		
O	BSDCP-730	BIOSOLIDS DRYER CONTROL PANEL	TFL5412-PID	480VAC	3						100A	BGMU SUPPLY	
O	BSDJP-730	BIOSOLIDS DRYER JUNCTION PANEL	TFL5412-PID	120VAC	1						15A	BSDCP-730	
O	BSD-7401	RH Rotor Drive Motor _ DRYER	TFL5412-PID	480VAC	3	7.5	11	91.7	81	1.15		BSDCP-730	
O	BSD-7402	LH Rotor Drive Motor _ DRYER	TFL5412-PID	480VAC	3	7.5	11	91.7	81	1.15		BSDCP-730	
O	BSD-7410	Cooling Screw Drive Motor _ COOLER	TFL5412-PID	480VAC	3	2	2.8	88.5	75	1.15		BSDCP-730	
O	BSOC-7700	SK450 BIOREM BIOFILER	TFL5412-PID	480VAC	3						20A	BSDCP-730	
O	BSD-7440	FULTON Thermal Fluid Heater	TFL5412-PID	480VAC	3						200A	BGMU SUPPLY	
O	BSDPE-5412	DWYER, PRESSURE TRANSDUCER	TFL5412-PID	24VDC	1							BSDCP-730	
O	BSDAE-5412-1	BEI, ABSOLUTE ENCODER	TFL5412-PID	24VDC	1		120mA					BSDCP-730	
O	BSDAE-5412-2	BEI, ABSOLUTE ENCODER	TFL5412-PID	24VDC	1		120mA					BSDCP-730	
O	BSDLS-5412-1	BINDICATOR LEVEL SWITCH	TFL5412-PID	120VAC	1						5VA	BSDCP-730	
O	BSDLS-5412-2	BINDICATOR LEVEL SWITCH	TFL5412-PID	120VAC	1						5VA	BSDCP-730	
O	BSDSV-5412-1	Solenoid Valve Start-up and Shutdown Spray Water	TFL5412-PID	120VAC	1						16VA	BSDCP-730	
O	BSDSV-5412-2	Solenoid Valve Nitrogen Purge	TFL5412-PID	120VAC	1						16VA	BSDCP-730	

Therma-Flite
The Screw Heat Exchanger Company

ELECTRICAL LOAD LIST

JOB #: TFL5412

REV	TAG NUMBER	DESCRIPTION	P&ID No.	NOMINAL VOLTAGE	PHASE	MOTOR					OTHER LOADS	SOURCE	REMARKS
						RATED POWER (Hp)	FULL LOAD AMPS	EFFICIENCY	POWER FACTOR	SERVICE FACTOR	KW / Service		

TFL 5412 Control Panel Amtec Drawings

- Drawing No.:21309-F-001 S 1 of 2, PLC/VFD Panel, Enclosure Layout Details
- Drawing No.:21309-F-001 S 2 of 2, PLC/VFD Panel, Bill of Materials

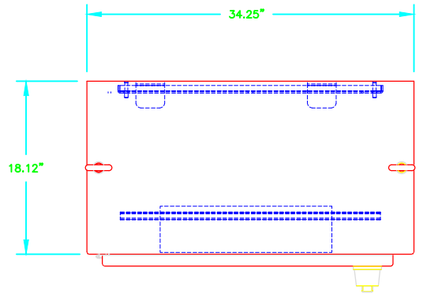
- Drawing No.:21309-F-002 S 1 of 2, PLC/VFD Panel, Enclosure Layout & Arrangement Details
- Drawing No.:21309-F-002 S 2 of 2, PLC/VFD Panel, Enclosure Layout & Arrangement Details

- Drawing No.:21309-F-003 S 2 of 2, Flex I/O Junction Box, Enclosure Bill of Materials

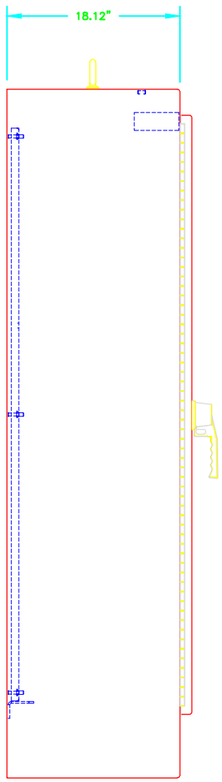
- Drawing No.:21309-D-001 S 1 of 7, PLC/VFD Panel, Electrical Power Distribution Diagram
- Drawing No.:21309-D-001 S 2 of 7, PLC/VFD Panel, Electrical Power Distribution Diagram
- Drawing No.:21309-D-001 S 3 of 7, PLC/VFD Panel, PLC Communications Block Diagram
- Drawing No.:21309-D-001 S 4 of 7, PLC/VFD Panel, Analog Input Wiring Diagram
- Drawing No.:21309-D-001 S 5 of 7, PLC/VFD Panel, Analog Input Wiring Diagram
- Drawing No.:21309-D-001 S 6 of 7, PLC/VFD Panel, Digital Input Wiring Diagram
- Drawing No.:21309-D-001 S 7of 7, PLC/VFD Panel, Relay Output Wiring Diagram

- Drawing No.:21309-D-002 S 1 of 8, Flex I/O Junction Box, Electrical Power Distribution Diagram
- Drawing No.:21309-D-002 S 2 of 8, Flex I/O Junction Box, Analog Input Module Wiring Diagram
- Drawing No.:21309-D-002 S 3of 8, Flex I/O Junction Box, DC Input Module Wiring Diagram
- Drawing No.:21309-D-002 S 4 of 8, Flex I/O Junction Box, DC Input Module Wiring Diagram
- Drawing No.:21309-D-002 S 5 of 8, Flex I/O Junction Box, Thermocouple Module Wiring Diagram
- Drawing No.:21309-D-002 S 6 of 8, Flex I/O Junction Box, Thermocouple Module Wiring Diagram
- Drawing No.:21309-D-002 S 7 of 8, Flex I/O Junction Box, 120V AC Input Module Wiring Diagram
- Drawing No.:21309-D-002 S 8 of 8, Flex I/O Junction Box, Flex I/O Junction Box, 120V AC Input Module Wiring Diagram

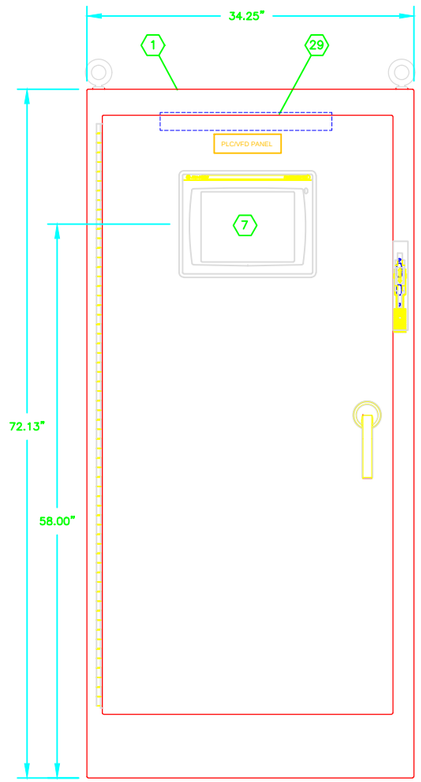
Drawing No.:21309-F-001 S 1 of 2, PLC/VFD Panel, Enclosure Layout Details



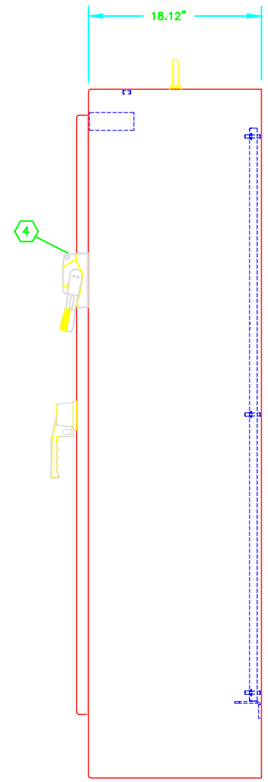
TOP VIEW



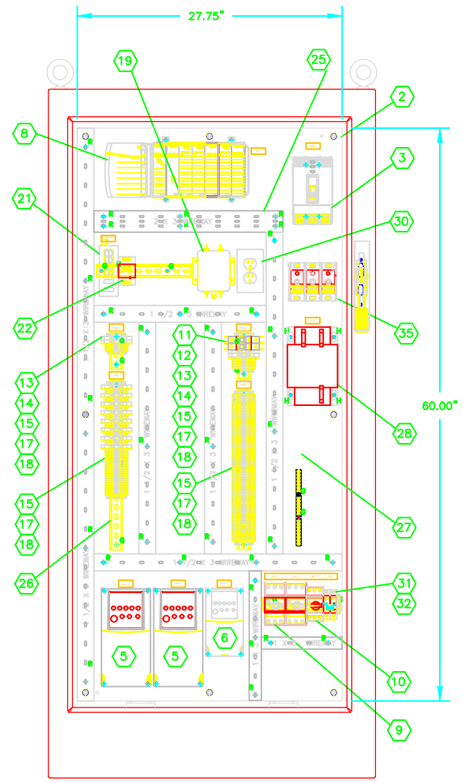
LEFT SIDE VIEW



FRONT VIEW



RIGHT SIDE VIEW



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REV.	DESCRIPTION	BY	CHK'D	APPVD	DATE
0	ISSUED FOR CONSTRUCTION	RE	DG	JS	03/23/10
1	REVISED PER ENGINEER'S COMMENTS	RE	X	X	04/22/10

REV.	DESCRIPTION	BY	CHK'D	APPVD	DATE

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MACHINED SURFACES DEBURR & BREAK SHARP EDGES
MATERIAL
FINISH

DWG. FILE No. N/A		
SCALE: 1/16" = 1"		
	BY	DATE
DESIGNED	DG	03/23/10
DRAWN	RE	03/23/10
CHECKED	DG	03/23/10
APPROVED	JS	03/23/10
CLIENT APPV'L		
CLIENT APPV'L		

PROJECT: 21309 PLC/VFD PANEL

ENGINEER

CLIENT:

AMtec INDUSTRIES, INC.
2501 INDUSTRIAL PARKWAY WEST
HAYWARD, CA. 94545
(510)687-2289

TITLE: ENCLOSURE LAYOUT DETAILS

DRAWING No. 21309-F-001 | SHEET 1 OF 2 | REVISION 1

Drawing No.:21309-F-001 S 2 of 2, PLC/VFD Panel, Bill of Materials

BILL OF MATERIALS

ITEM	QTY	DESCRIPTION	MFG	PART NO.
1	1	ENCLOSURE, 72"x 34 1/4"x 18", FLANGE DISCONNECT, NEMA TYPE 4X	HOFFMAN	A72XM3418SSN4/316SS
2	1	INNER PANEL, 60" X 27 3/4"	HOFFMAN	A72PM34
3	1	MAIN CIRCUIT BREAKER, 480V, 50Hz, 125A	ALLEN BRADLEY	140U-J2D3-D12
4	1	FLANGE MOUNT DISCONNECT KIT W/6FT CABLE	ALLEN BRADLEY	140U-J-FCS06
5	2	VARIABLE FREQUENCY DRIVE, 480V AC, 3-PHASE, 7.5 HP, 12A, 5.5kW	ALLEN BRADLEY	22B-D012N104
6	1	VARIABLE FREQUENCY DRIVE, 480V AC, 3-PHASE, 3 HP 6A, 2.2kW	ALLEN BRADLEY	22B-D6P0N104
7	1	PANELVIEW, HMI, 12 INCH	ALLEN BRADLEY	2711P-T12C4A2
8	1 1 1 1 1 1 1 1 1	I/O CHASSIS, 7-SLOT POWER SUPPLY CONTROL LOGIC PPROCESSOR ETHERNET MODULE ANALOG INPUT MODULE ANALOG OUTPUT MODULE AC INPUT MODULE RELAY OUTPUT MODULE, 16-PT	ALLEN BRADLEY ALLEN BRADLEY ALLEN BRADLEY ALLEN BRADLEY ALLEN BRADLEY ALLEN BRADLEY ALLEN BRADLEY ALLEN BRADLEY	1756-A7 1756-PA72 1756-L61 1756-ENBT 1756-IF8 1756-OF6CI 1756-IA16 1756-OW16I
9	2	MOTOR CIRCUIT PROTECTOR, 480V, 60Hz, 14.5-20A, 5 kA	ALLEN BRADLEY	140M-D8E-C20
10	1	MOTOR CIRCUIT PROTECTOR, 480V, 60Hz, 6.3-10A, 5 kA	ALLEN BRADLEY	140M-C2E-C10
11	2	CIRCUIT BREAKER, 1-POLE, 10A	ALLEN BRADLEY	1489-A1C100
12	2	FUSED TERMINAL W/NEON INDICATOR (120V AC)	ALLEN BRADLEY	1492-H4
13	2	FUSED TERMINAL W/LED INDICATOR (24V DC)	ALLEN BRADLEY	1492-H5
14	10	FUSED TERMINAL END COVER	ALLEN BRADLEY	1492-N37
15	106	TERMINAL BLOCK	ALLEN BRADLEY	1492-J4
16	15	GROUND TERMINAL BLOCK	ALLEN BRADLEY	1492-JG4
17	3	TERMINAL END COVER	ALLEN BRADLEY	1492-EB3
18	10	TERMINAL END CLAMP	ALLEN BRADLEY	1492-EBJ3
19	1	RFI FILTER	CORCOM	20VS6
20		(N O T U S E D)		
21	1	ETHERNET SWITCH, 8-PORT	BB ELECTRONICS	EIR308
22	1	POWER SUPPLY, 24V DC OUTPUT	PULS	CS5-241
23	1	POWER DISTRIBUTION BLOCK, PRI. 2/0 AWG-#4 / SEC. #2-#14	FERRAZ SHAWMUT	67563
24	3	POWER DISTRIBUTION SAFETY COVER	FERRAZ SHAWMUT	08570
25	A/R	WIREWAY (SIZED AS SHOWN)	PANDUIT	TYPE-E
26	A/R	DIN RAIL TRACK	(STOCK)	- - - -
27	1	GROUND BUS BAR	CUTLER HAMMER	CH9GP21
28	1	CONTROL TRANSFORMER, 480V/120V, 1500 VA	HAMMOND	PH1500MQMJ
29	1	FLUORESCENT LIGHT	HOFFMAN	ALF16D24R
30	1	DUPLEX RECEPTACLE	- - - -	- - - -
31	1	FUSE HOLDER, 2-POLE	FERRAZ SHAWMUT	USCC2I
32	2	FUSE	FERRAZ SHAWMUT	ATDR2

REV.	DESCRIPTION	BY	CHK'D	APPVD	DATE
0	ISSUED FOR CONSTRUCTION	RE	DG	JS	02/18/09
1	REVISED PER ENGINEER'S COMMENTS	RE	X	X	04/22/10

REV.	DESCRIPTION	BY	CHK'D	APPVD	DATE

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MACHINED SURFACES DEBURR & BREAK SHARP EDGES
MATERIAL
FINISH

DWG. FILE No. N/A
SCALE: NONE

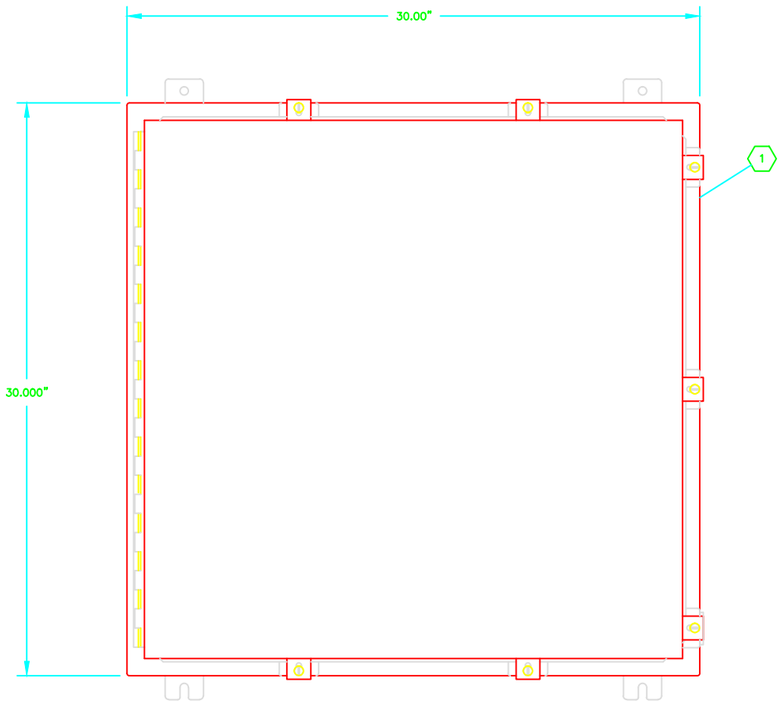
	BY	DATE
DESIGNED	DG	03/23/10
DRAWN	RE	03/23/10
CHECKED	DG	03/23/10
APPROVED	JS	03/23/10
CLIENT APPV'L		

PROJECT: 21309 PLC/VFD PANEL
ENGINEER
CLIENT:

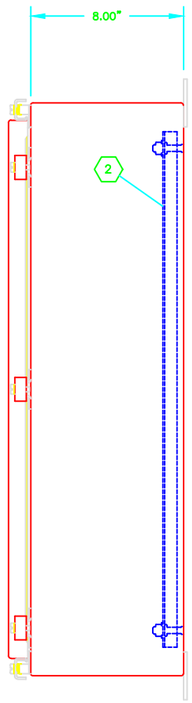
AMtec INDUSTRIES, INC.
2501 INDUSTRIAL PARKWAY WEST
HAYWARD, CA. 94545
(510)887-2289

TITLE: BILL OF MATERIALS
DRAWING No. 21309-F-001
SHEET 2 OF 2
REVISION 1

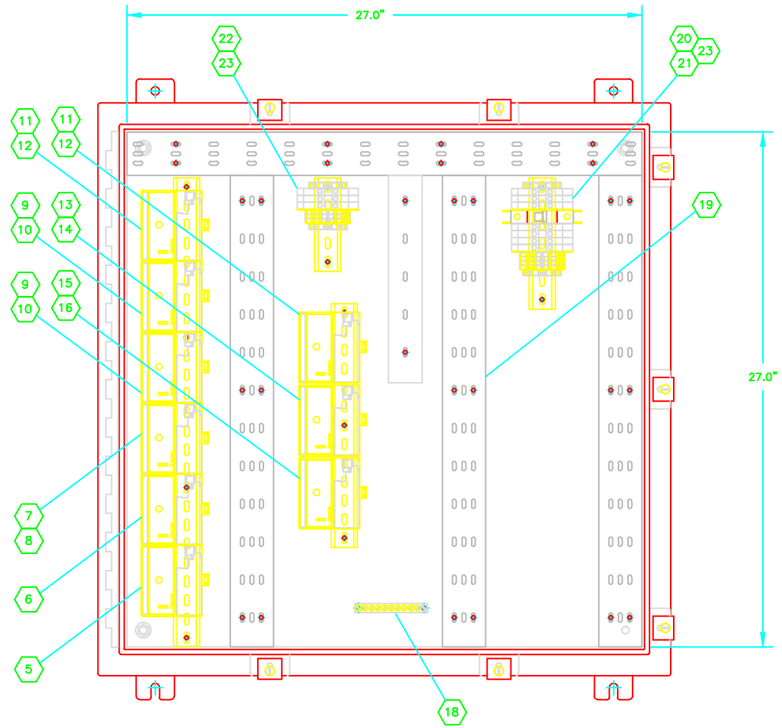
Drawing No.:21309-F-002 S 1 of 2, PLC/VFD Panel, Enclosure Layout & Arrangement Details



FRONT VIEW



SIDE VIEW



FRONT VIEW W/DOOR REMOVED

REV.	DESCRIPTION	BY	CHK'D	APPVD	DATE
0	ISSUED FOR CONSTRUCTION	RE	DG	JS	03/24/10
1	REVISED PER ENGINEER'S COMMENTS	RE	X	X	04/21/10

REV.	DESCRIPTION	BY	CHK'D	APPVD	DATE

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MACHINED SURFACES DEBURR & BREAK SHARP EDGES
MATERIAL
FINISH

DWG. FILE No. N/A
SCALE: 1/8" = 1"

	BY	DATE
DESIGNED	RE	03/24/10
DRAWN	RE	03/24/10
CHECKED	DG	03/24/10
APPROVED	JS	03/24/10
CLIENT APPV'L		
CLIENT APPV'L		

PROJECT: 21309 FILEX I/O JUNCTION BOX
ENGINEER
CLIENT:

AMtec INDUSTRIES, INC.
2501 INDUSTRIAL PARKWAY WEST
HAYWARD, CA. 94545
(510)887-2289

TITLE: ENCLOSURE LAYOUT & ARRANGEMENT DETAILS
DRAWING No. 21309-F-002
SHEET 1 OF 2
REVISION 1

Drawing No.:21309-F-002 S 2 of 2, PLC/VFD Panel, Enclosure Layout & Arrangement Details

BILL OF MATERIALS

ITEM	QTY	DESCRIPTION	MFG	PART NO.
1	1	ENCLOSURE, 30"x30"x8", NEMA TYPE 4X, 316 S.S.	HOFFMAN	A30H3008SS6LP
2	1	MOUNTING PANEL, 27"x27"	HOFFMAN	A30P30
3				
4				
5	1	FLEX I/O POWER SUPPLY	ALLEN BRADLEY	1794-PS3
6	1	FLEX I/O COMMUNICATION MODULE	ALLEN BRADLEY	1794-AENT
7	1	FLEX I/O 4-CHANNEL ANALOG INPUT MODULE	ALLEN BRADLEY	1794-IF4I
8	1	ANALOG INPUT MODULE TERMINAL BASE	ALLEN BRADLEY	1794-TB3
9	2	FLEX I/O 24VDC, 16-CHANNEL DIGITAL INPUT MODULE	ALLEN BRADLEY	1794-IF4I
10	2	DC INPUT MODULE TERMINAL BASE	ALLEN BRADLEY	1794-TB32
11	2	FLEX I/O 8-CHANNEL THERMOCOUPLE MODULE	ALLEN BRADLEY	1794-IT8
12	2	THERMOCOUPLE MODULE TERMINAL BASE	ALLEN BRADLEY	1794-TB3T
13	1	FLEX I/O 120VAC, 8-CHANNEL INPUT MODULE	ALLEN BRADLEY	1794-IA8
14	1	120VAC INPUT MODULE TERMINAL BASE	ALLEN BRADLEY	1794-AENT
15	1	120VAC 8-CHANNEL OUTPUT MODULE	ALLEN BRADLEY	1794-OA8
16	1	OUTPUT MODULE TERMINAL BASE	ALLEN BRADLEY	1794-TBNF
17	1	EXTENDER CABLE, 3 FT.	ALLEN BRADLEY	1794-CE3
18	1	GROUND BUS BAR	CUTLER HAMMER	CH9GP21
19	A/R	WIREWAY W/COVER (SIZED AS REQ'D)	PANDUIT	TYPE-F
20	1	CIRCUIT BREAKER, 5A	ALLEN BRADLEY	1489-A1C050
21	4	FUSE BLOCK, NEON, 120VAC	ALLEN BRADLEY	1492-H4
22	3	FUSE BLOCK, LED, 24VDC	ALLEN BRADLEY	1492-H5
23	10	TERMINAL BLOCK	ALLEN BRADLEY	1492-H5
24	2	FUSE BLOCK END COVER	ALLEN BRADLEY	1492-N37
25	3	TERMINAL END COVER	ALLEN BRADLEY	1492-EB3
26	4	TERMINAL END CLAMP	ALLEN BRADLEY	1492-EBJ3

REV.	DESCRIPTION	BY	CHK'D	APPVD	DATE
0	ISSUED FOR CONSTRUCTION	RE	X	X	03/24/10
1	REVISED PER ENGINEER'S COMMENTS	RE	X	X	04/21/10

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MACHINED SURFACES DEBURR & BREAK SHARP EDGES
MATERIAL
FINISH

DWG. FILE No. N/A		
SCALE: NONE		
	BY	DATE
DESIGNED	RE	03/24/10
DRAWN	RE	03/24/10
CHECKED	DG	03/24/10
APPROVED	JS	03/24/10
CLIENT APPV'L		
CLIENT APPV'L		

PROJECT: 21309 FLEX I/O JUNCTION BOX
ENGINEER
CLIENT:

AMtec INDUSTRIES, INC.
2501 INDUSTRIAL PARKWAY WEST
HAYWARD, CA. 94545
(510)887-2289

TITLE: ENCLOSURE BILL OF MATERIALS
DRAWING No. 21309-F-003
SHEET 2 OF 2
REVISION 1

1 REVISED PER ENGINEER'S COMMENTS RE X X 04/21/10

Drawing No.:21309-F-003 S 2 of 2, Flex I/O Junction Box, Enclosure Bill of Materials

Drawing No.:21309-D-001 S 1 of 7, PLC/VFD Panel, Electrical Power Distribution Diagram

480V, 3Ph, 60Hz

L1 L2 L3

MCB
125A
(AB #140U-J2D3-D12)

T1 T2 T3

2 AWG (BLK)

POWER DISTRIBUTION BLOCK
(FERRAZ-SHAWMUT #67563)

L1 L2 L3

10 AWG (BLK)

MCP1-L3 MCP1-L2 MCP1-L1

MCP1
(AB #140M-D8E-C20

T3 6 T2 4 T1 2

10 AWG (BLK)

VFD1-L3 VFD1-L2 VFD1-L1

VFD1
(AB #22B-D017N104

7.5 HP
FLA 17 AMP

10 AWG (BLK)

MCP2-L3 MCP2-L2 MCP2-L1

MCP2
(AB #140M-D8E-C20

10 AWG (BLK)

VFD2-L3 VFD2-L2 VFD2-L1

VFD2
(AB #22B-D017N104

7.5 HP
FLA 17 AMP

12 AWG (BLK)

MCP3-L3 MCP3-L2 MCP3-L1

MCP3
(AB #140M-C2E-C10

12 AWG (BLK)

VFD3-L3 VFD3-L2 VFD3-L1

VFD3
(AB #22B-D6PN104

3 HP
FLA 6 AMP

FUX
XA

M

CONDENSER WATER
CONTROL VALVE
460V, 0.008 HP
FLC: 0.032 AMPS
LOCKED ROTOR: 1.16A

BSD
7431

12 AWG (BLK)

2L1 2L2

FU1
5A

FU2
5A

CCT
(HAMMOND #PH1500MQMJ)

FU3
20A

14 AWG (WHT)

14 AWG (RED)

FU3

N

TO POWER DISTRIBUTION
DWG. 21309-D-001-R0
SHT. 2 OF 7

REV.	DESCRIPTION	BY	CHK'D	APPVD	DATE
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1	REVISED PER ENGINEER'S COMMENTS	RE	X	X	04/21/10

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MACHINED SURFACES DEBURR & BREAK SHARP EDGES
MATERIAL
FINISH

DWG. FILE No. N/A
SCALE: NONE

	BY	DATE
DESIGNED	DG	03/23/10
DRAWN	RE	03/23/10
CHECKED	DG	03/23/10
APPROVED	JS	03/23/10
CLIENT APPV'L		
CLIENT APPV'L		

PROJECT: 21309 PLC/VFD PANEL

ENGINEER

CLIENT:

AMtec INDUSTRIES, INC.
2501 INDUSTRIAL PARKWAY WEST
HAYWARD, CA. 94545
(510)887-2289

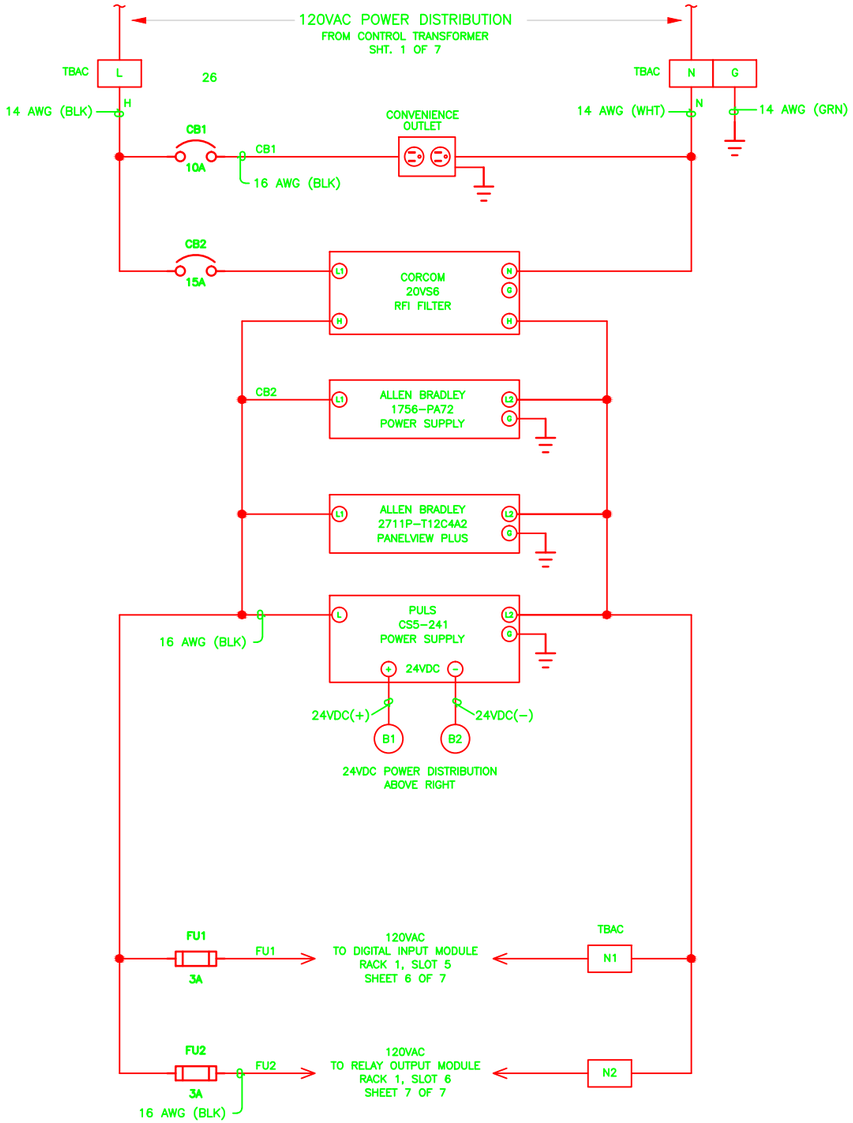
TITLE: ELECTRICAL POWER DISTRIBUTION DIAGRAM

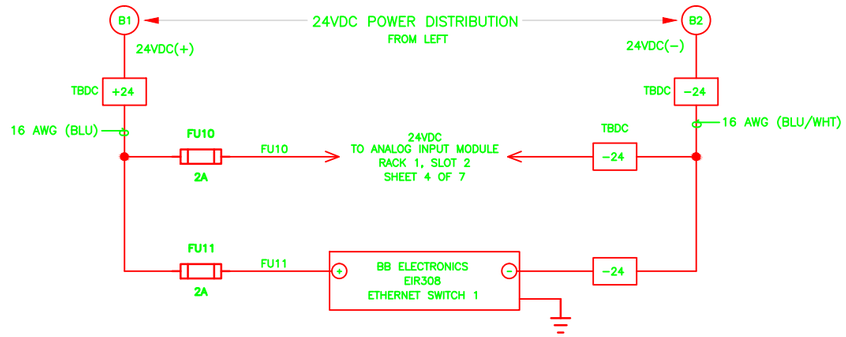
DRAWING No. 21309-D-001

SHEET 1 OF 7

REVISION 1

Drawing No.:21309-D-001 S 2 of 7, PLC/VFD Panel, Electrical Power Distribution Diagram





REV.	DESCRIPTION	BY	CHK'D	APPVD	DATE
0	ISSUED FOR APPROVAL	RE	X	X	03/23/10
1	REVISED PER ENGINEER'S COMMENTS	RE	X	X	04/21/10

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MATERIAL
FINISH

DWG. FILE No. N/A	BY	DATE
SCALE: NONE		
DESIGNED	DG	03/23/10
DRAWN	RE	03/23/10
CHECKED	DG	03/23/10
APPROVED	JS	03/23/10
CLIENT APPV'L		
CLIENT APPV'L		

PROJECT: 21309 PLC/VFD PANEL

ENGINEER

CLIENT:

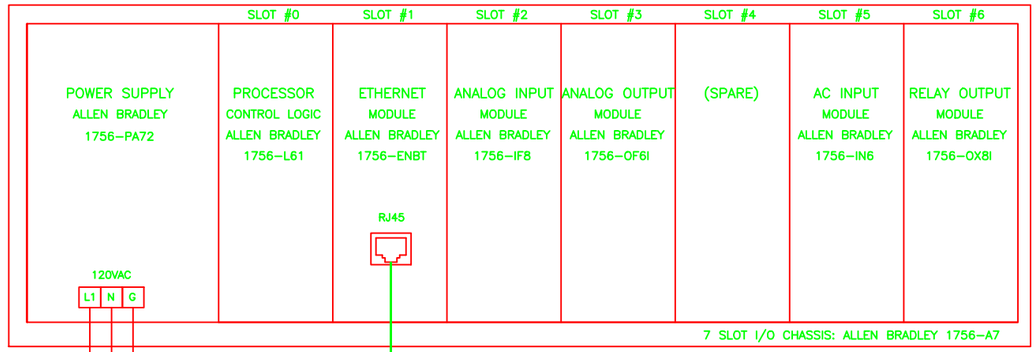
AMtec INDUSTRIES, INC.
2501 INDUSTRIAL PARKWAY WEST
HAYWARD, CA. 94545
(510)887-2289

TITLE: ELECTRICAL POWER DISTRIBUTION DIAGRAM

DRAWING No. 21309-D-001 | SHEET 2 OF 7 | REVISION 1

Drawing No.:21309-D-001 S 3 of 7, PLC/VFD Panel, PLC Communications Block Diagram

PLC I/O RACK



120VAC
SHT. 2 OF 7

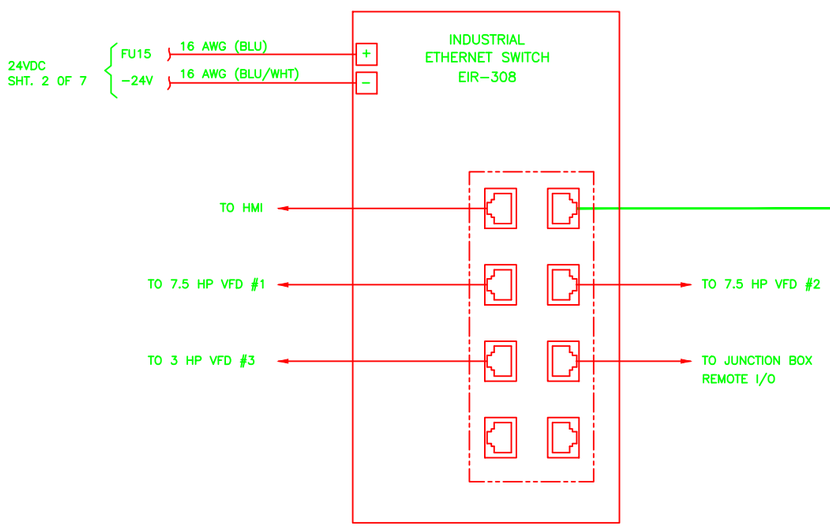
CB2 — 16 AWG (BLK)

N — 16 AWG (WHT)

16 AWG (GRN)

CAT 5/5e/6 PATCH CABLE

ETHERNET SWITCH



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1	REVISED PER ENGINEER'S COMMENTS	RE	X	X	04/21/10

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MACHINED SURFACES DEBURR & BREAK SHARP EDGES
MATERIAL
FINISH

DWG. FILE No. N/A
SCALE: NONE

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DRAWN	RE	03/23/10
CHECKED	DG	03/23/10
APPROVED	JS	03/23/10
CLIENT APPV'L		
CLIENT APPV'L		

PROJECT: 21309 PLC/VFD PANEL

ENGINEER

CLIENT:

AMtec INDUSTRIES, INC.
2501 INDUSTRIAL PARKWAY WEST
HAYWARD, CA. 94545
(510)887-2289

TITLE: PLC COMMUNICATIONS BLOCK DIAGRAM

DRAWING No. 21309-D-001

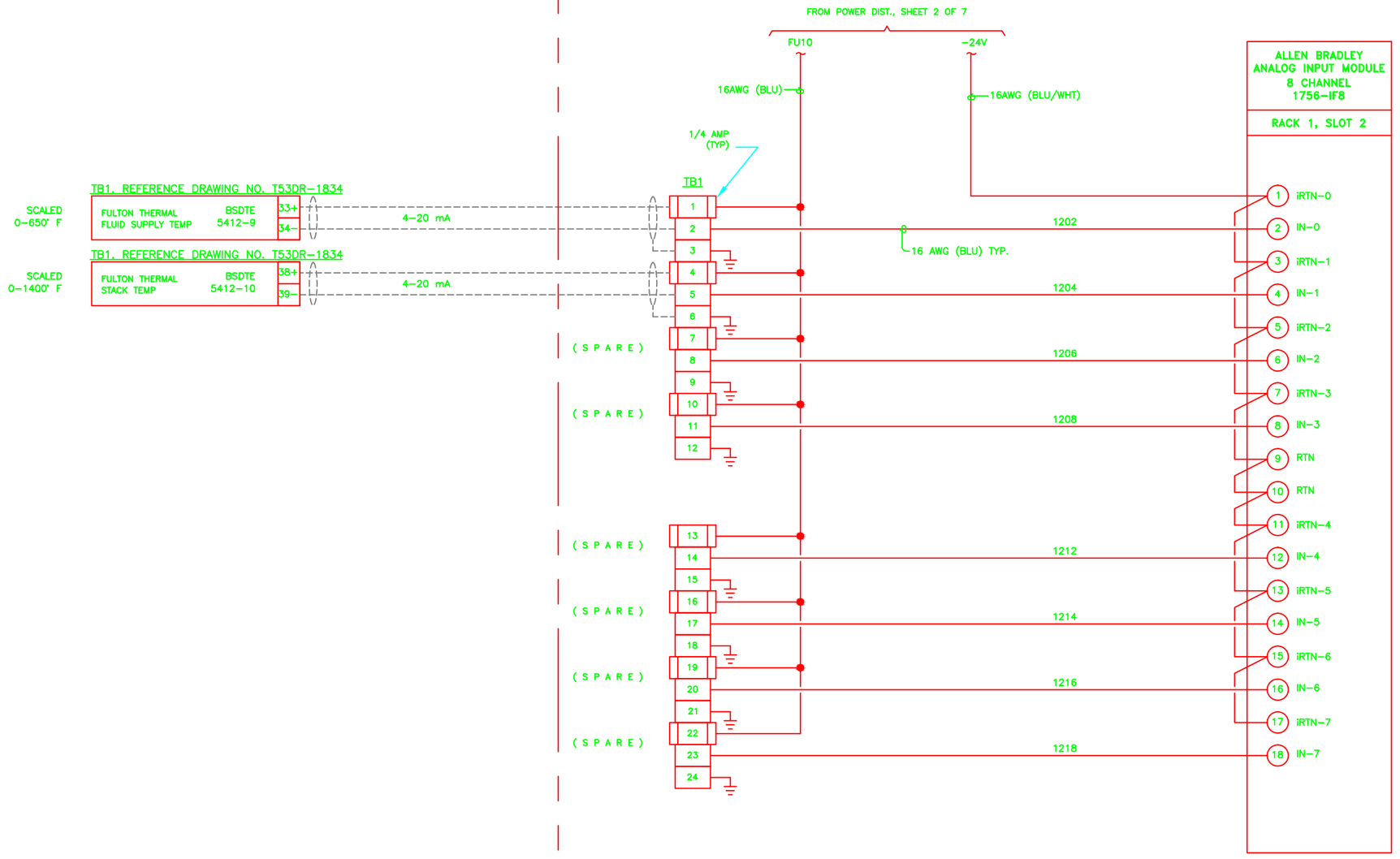
SHEET 3 OF 7

REVISION 1

Drawing No.:21309-D-001 S 4 of 7, PLC/VFD Panel, Analog Input Wiring Diagram

FIELD

PLC/VFD PANEL



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MATERIAL
FINISH

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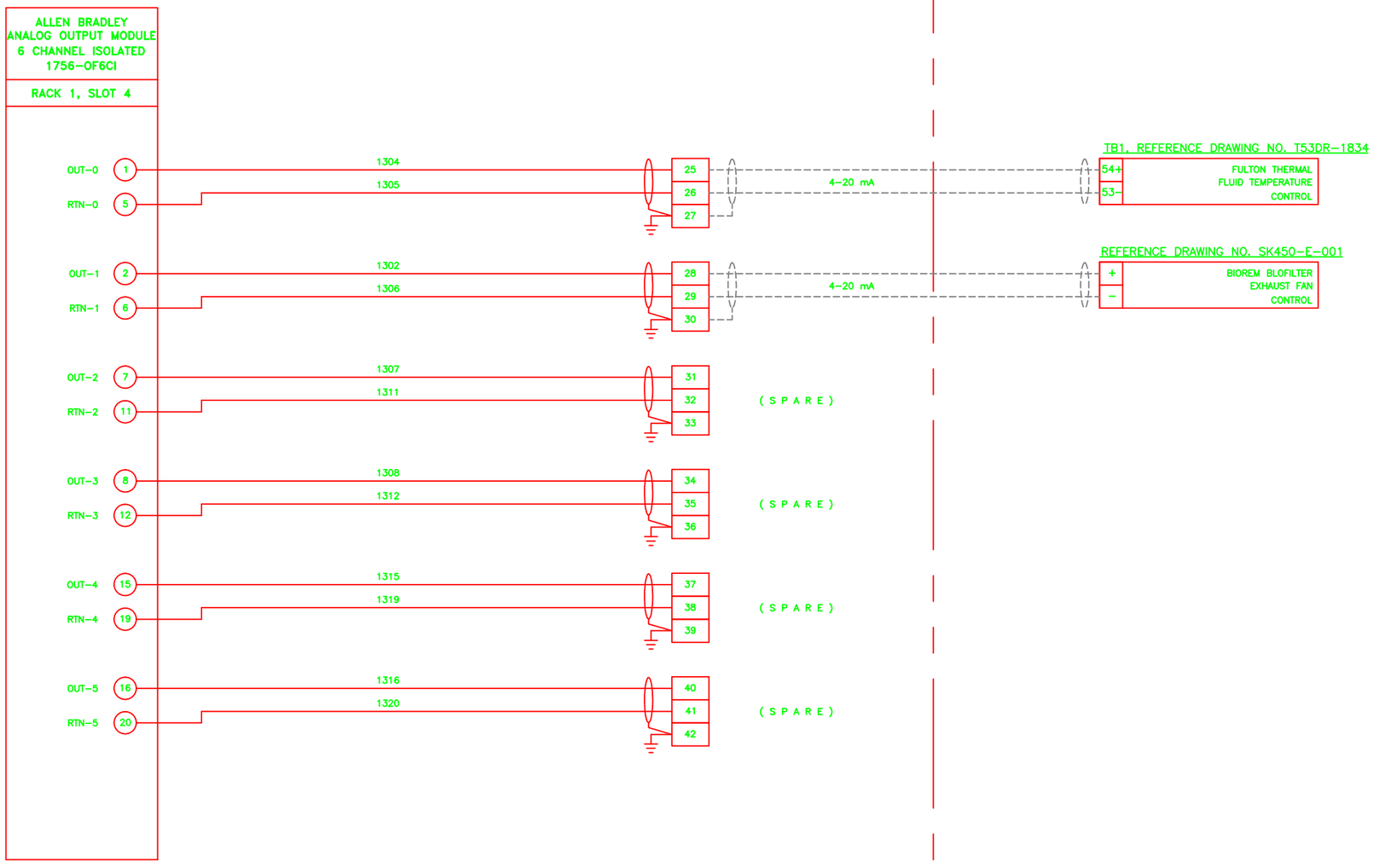
CLIENT APPV'L		
CLIENT APPV'L		

PROJECT: 21309 PLC/VFD PANEL
ENGINEER
CLIENT:

AMtec INDUSTRIES, INC.
2501 INDUSTRIAL PARKWAY WEST
HAYWARD, CA. 94545
(510)887-2289

TITLE: ANALOG INPUT WIRING DIAGRAM
DRAWING No. 21309-D-001
SHEET 4 OF 7
REVISION 1

Drawing No.:21309-D-001 S 5 of 7, PLC/VFD Panel, Analog Input Wiring Diagram



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CLIENT APPV'L		
CLIENT APPV'L		

PROJECT: 21309 PLC/VFD PANEL

ENGINEER

CLIENT:

AMtec INDUSTRIES, INC.
2501 INDUSTRIAL PARKWAY WEST
HAYWARD, CA. 94545
(510)887-2289

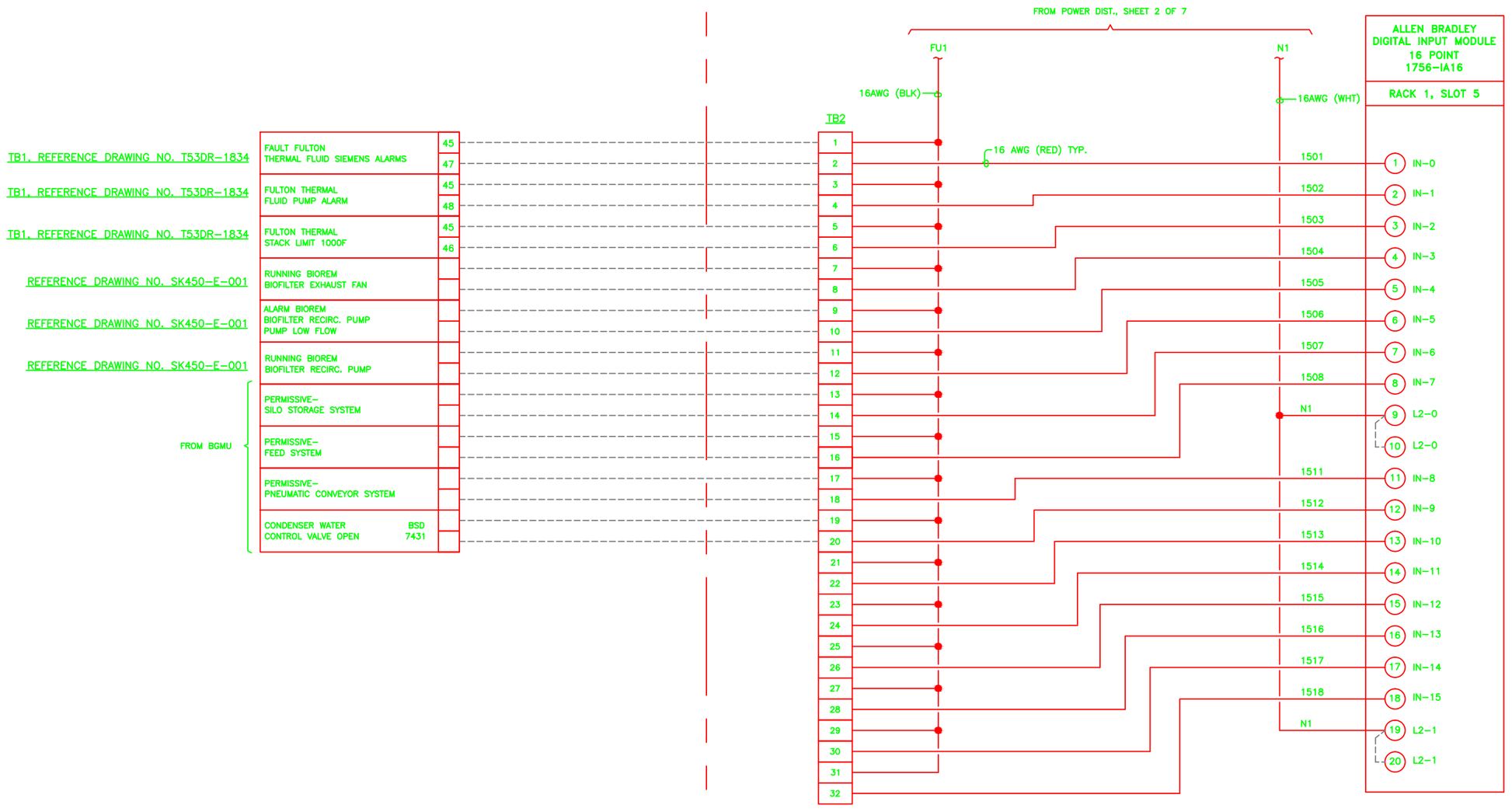
TITLE: ANALOG OUTPUT WIRING DIAGRAM

DRAWING No. 21309-D-001

SHEET 5 OF 7

REVISION 1

Drawing No.:21309-D-001 S 6 of 7, PLC/VFD Panel, Digital Input Wiring Diagram



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SCALE: NONE

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CHECKED	DG	03/23/10
APPROVED	JS	03/23/10
CLIENT APPV'L		
CLIENT APPV'L		

PROJECT: 21309 PLC/VFD PANEL
ENGINEER
CLIENT:

AMtec INDUSTRIES, INC.
2501 INDUSTRIAL PARKWAY WEST
HAYWARD, CA. 94545
(510)887-2289

TITLE: DIGITAL INPUT WIRING DIAGRAM
DRAWING No. 21309-D-001
SHEET 6 OF 7
REVISION 1

Drawing No.:21309-D-001 S 7of 7, PLC/VFD Panel, Relay Output Wiring Diagram

PLC PANEL

FIELD

ALLEN BRADLEY
RELAY OUTPUT MODULE
16-POINT
1756-OW16I

RACK 1, SLOT 6

FROM POWER DISTRIBUTION
SHT. 2 OF 7

FU2 — 16AWG (BLK)

N2 — 16AWG (WHT)

TB2

OUT-0	1	1601	16AWG (RED)	33	34	49 / 52	REMOTE START FULTON THERMAL FLUID PUMP (120V) — TB1, REFERENCE DRAWING NO. T53DR-1834
L1-0	2						
OUT-1	3	1603		35	36	50 / 52	FULTON THERMAL SYSTEM STSRT/STOP (120V) — TB1, REFERENCE DRAWING NO. T53DR-1834
L1-1	4						
OUT-2	5	1605		37	38	51 / 52	REMOTE START FULTON THERMAL BURNER MNGT. (120V) — TB1, REFERENCE DRAWING NO. T53DR-1834
L1-2	6						
OUT-3	7	1607		39	40	H / 35	FULTON THERMAL SYSTEM REMOTE E-STOP (120V) — TB1, REFERENCE DRAWING NO. T53DR-1834
L1-3	8						
OUT-4	9	1609		41	42		REMOTE START BIOREM BIOFILTER SYSTEM (120V) — REFERENCE DRAWING NO. SK450-E-001
L1-4	10						
OUT-5	11	1611		43	44	BSDSV 17411	COOLING CONVEYOR WATER CONTROL VALVE (120V)
L1-5	12						
OUT-6	13	1613		45	46	BSDC 7710	ODOR CONTROL WATER CONTROL VALVE (120V)
L1-6	14						
OUT-7	15	1615		47	48	BSD 7431	CONDENSER WATER CONTROL VALVE OPEN (120V)
L1-7	16						
OUT-8	17	1617		49	50	BSD 7431	CONDENSER WATER CONTROL VALVE CLOSED (120V)
L1-8	18						
OUT-9	19	1619		51	52	BSD 7431	CONDENSER WATER CONTROL VALVE STOP (120V)
L1-9	20						
OUT-10	21	1621		53	54	(S P A R E)	
L1-10	22						
OUT-11	23	1623		55	56	(S P A R E)	
L1-11	24						
OUT-12	25	1624		57	58	(S P A R E)	
L1-12	26						
OUT-13	27	1625		59	60	(S P A R E)	
L1-13	28						
OUT-14	29	1629		61	62	(S P A R E)	
L1-14	30						
OUT-15	31	1631		63	64	(S P A R E)	
L1-15	32						
NOT USED	33						
L1-15	34						
NOT USED	35						
NOT USED	36						

FROM BGMU

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MATERIAL
FINISH

DWG. FILE No. N/A
SCALE: NONE

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CHECKED	DG	03/23/10
APPROVED	JS	03/23/10
CLIENT APPV'L		
CLIENT APPV'L		

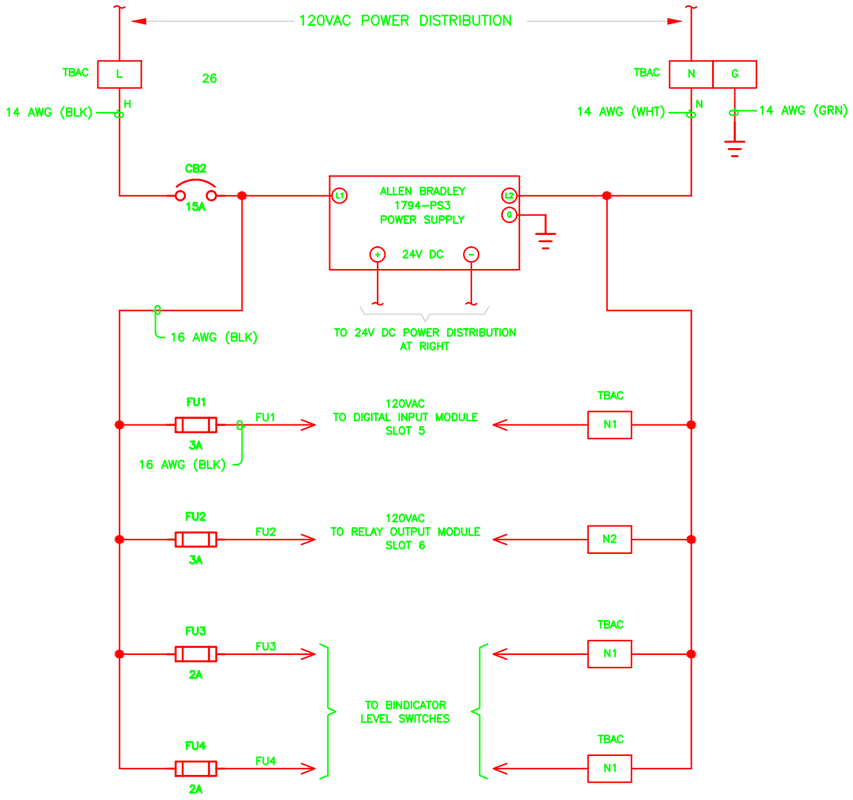
PROJECT: 21309 PLC/VFD PANEL
ENGINEER
CLIENT:

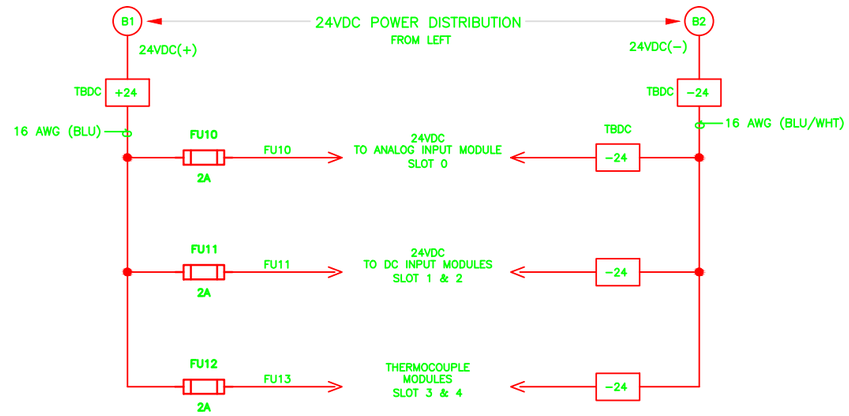
AMtec INDUSTRIES, INC.
2501 INDUSTRIAL PARKWAY WEST
HAYWARD, CA. 94545
(510)887-2289

TITLE: RELAY OUTPUT WIRING DIAGRAM

DRAWING No. 21309-D-001 | SHEET 7 OF 7 | REVISION 1

Drawing No.:21309-D-002 S 1 of 8, Flex I/O Junction Box, Electrical Power Distribution Diagram





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DRAWN	RE	03/23/10
CHECKED	DG	03/23/10
APPROVED	JS	03/23/10
CLIENT APPV'L		
CLIENT APPV'L		

PROJECT: 21309 FLEX I/O JUNCTION BOX

ENGINEER

CLIENT:

AMtec INDUSTRIES, INC.
2501 INDUSTRIAL PARKWAY WEST
HAYWARD, CA. 94545
(510)887-2289

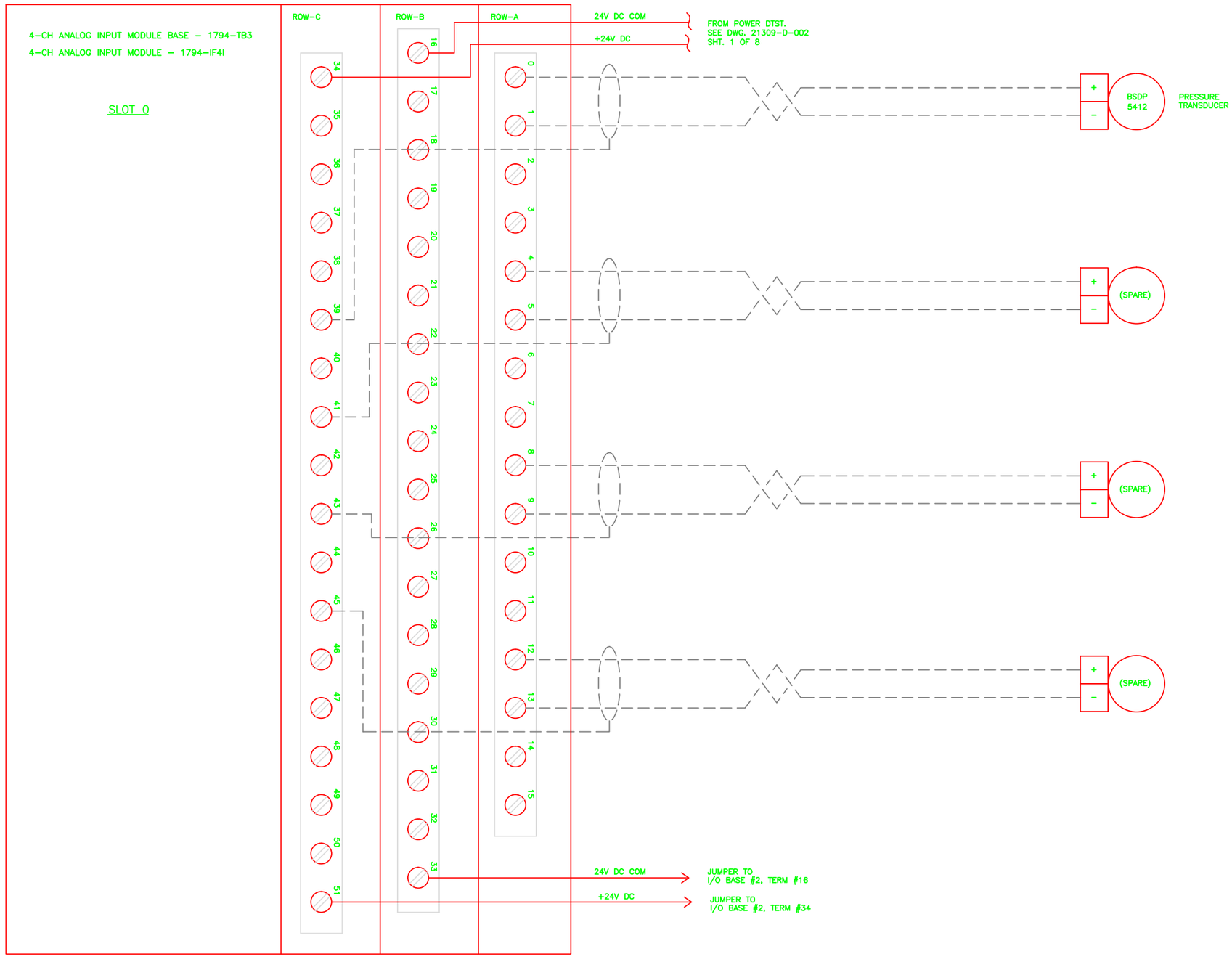
TITLE: ELECTRICAL POWER DISTRIBUTION DIAGRAM

DRAWING No. 21309-D-002

SHEET 1 OF 8

REVISION 1

Drawing No.:21309-D-002 S 2 of 8, Flex I/O Junction Box, Analog Input Module Wiring Diagram



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CLIENT APPV'L		
CLIENT APPV'L		

PROJECT: 21309 FLEX I/O JUNCTION BOX
ENGINEER
CLIENT:

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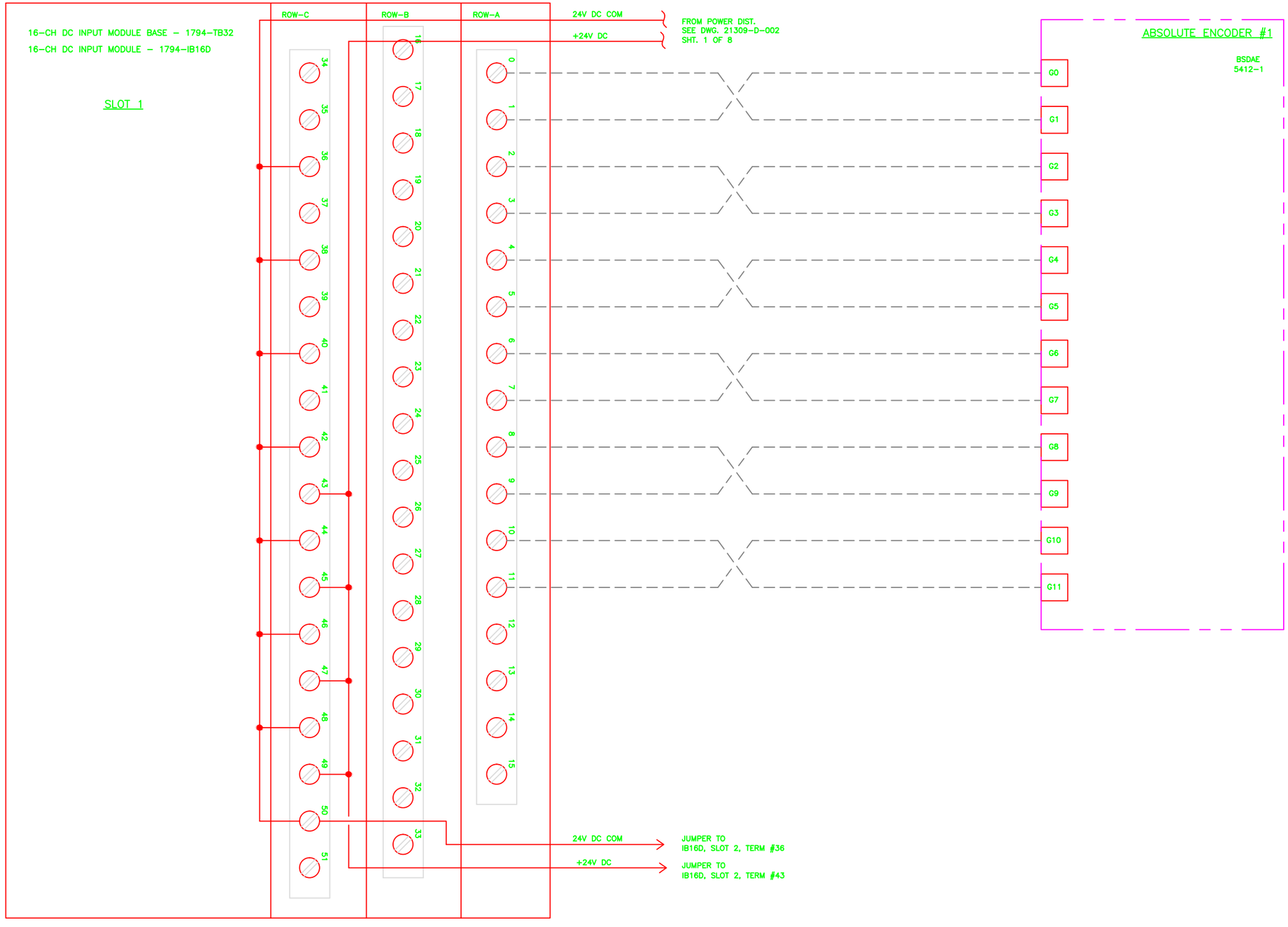
2501 INDUSTRIAL PARKWAY WEST
HAYWARD, CA. 94545
(510)887-2289

TITLE: ANALOG INPUT MODULE WIRING DIAGRAM
DRAWING No. 21309-D-002
SHEET 2 OF 8
REVISION 1

Drawing No.:21309-D-002 S 3of 8, Flex I/O Junction Box, DC Input Module Wiring Diagram

16-CH DC INPUT MODULE BASE - 1794-TB32
16-CH DC INPUT MODULE - 1794-IB16D

SLOT 1



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APPROVED	JS	03/23/10
CLIENT APPV'L		
CLIENT APPV'L		

PROJECT: 21309 FLEX I/O JUNCTION BOX
ENGINEER
CLIENT:

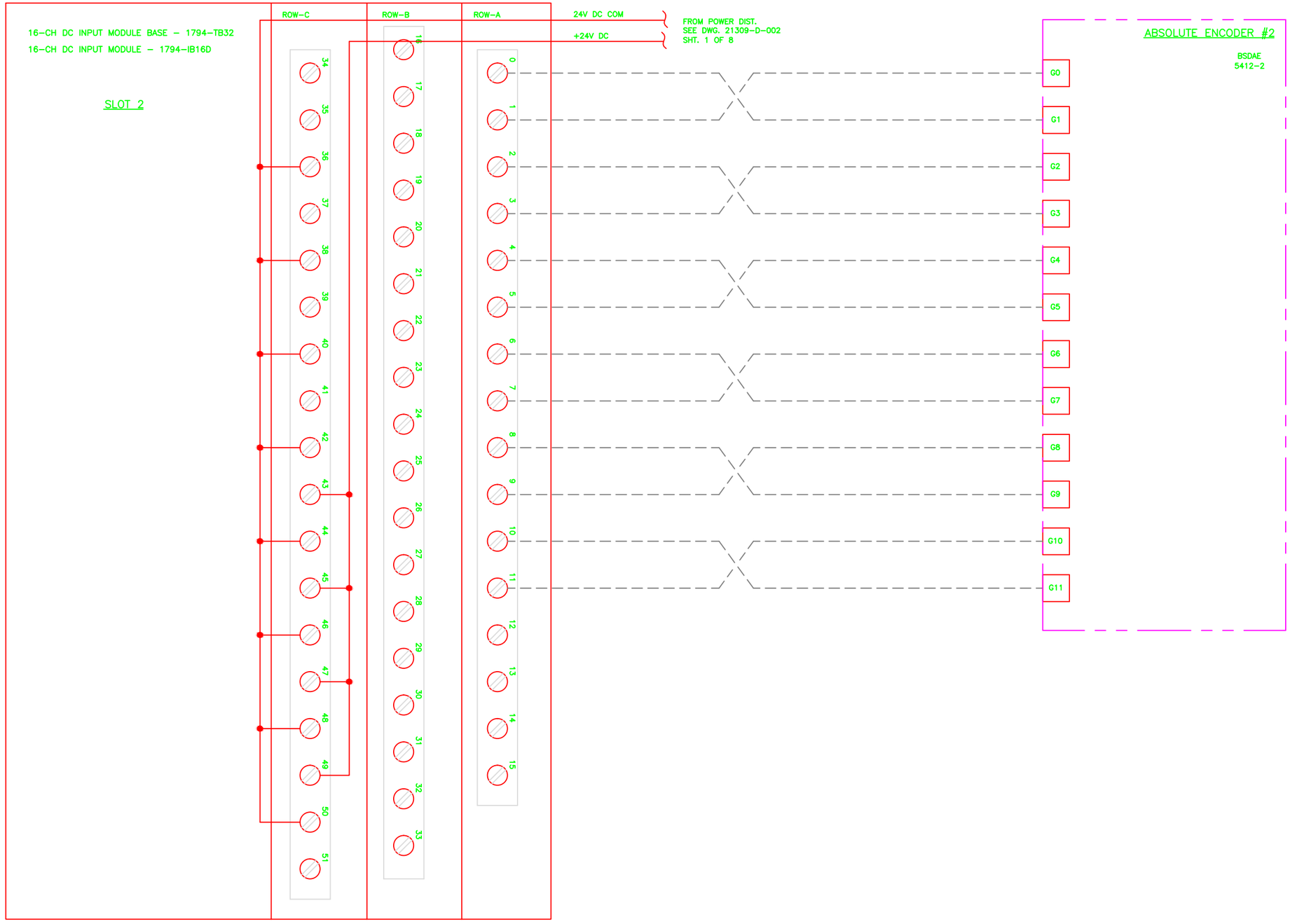
AMtec INDUSTRIES, INC.
2501 INDUSTRIAL PARKWAY WEST
HAYWARD, CA. 94545
(510)687-2289

TITLE: DC INPUT MODULE WIRING DIAGRAM
DRAWING No. 21309-D-002
SHEET 3 OF 8
REVISION 1

Drawing No.:21309-D-002 S 4 of 8, Flex I/O Junction Box, DC Input Module Wiring Diagram

16-CH DC INPUT MODULE BASE - 1794-TB32
16-CH DC INPUT MODULE - 1794-IB16D

SLOT 2



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CLIENT APPV'L		
CLIENT APPV'L		

PROJECT: 21309 FLEX I/O JUNCTION BOX
ENGINEER
CLIENT:

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2501 INDUSTRIAL PARKWAY WEST
HAYWARD, CA. 94545
(510)687-2289

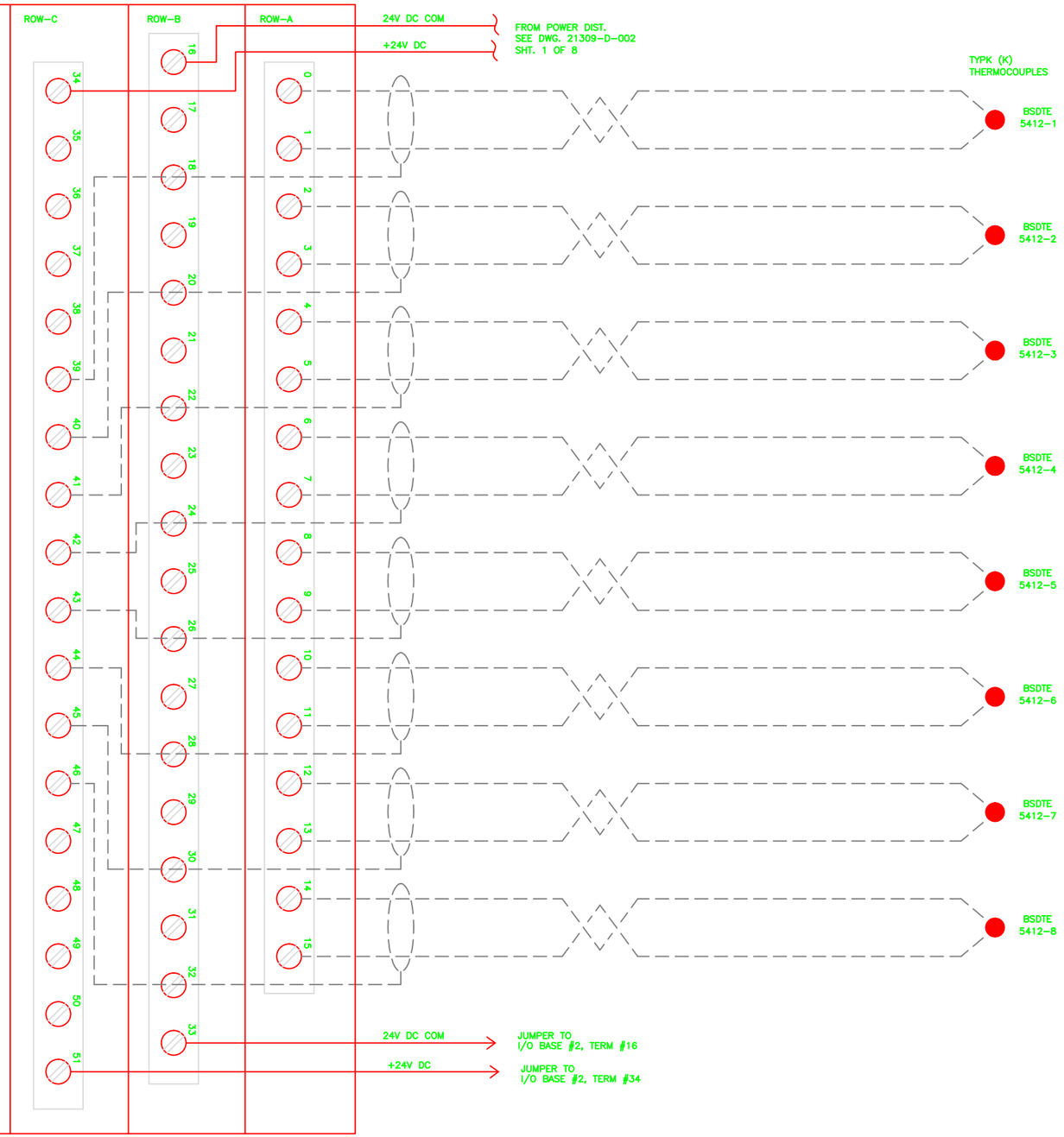
TITLE: DC INPUT MODULE WIRING DIAGRAM
DRAWING No. 21309-D-002
SHEET 4 OF 8
REVISION 1

Drawing No.:21309-D-002 S 5 of 8, Flex I/O Junction Box, Thermocouple Module Wiring Diagram

THERMOCOUPLE MODULE BASE – 1794–TB3T

THERMOCOUPLE MODULE – 1794–IT8

SLOT 3



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CLIENT APPV'L		
CLIENT APPV'L		

PROJECT: 21309 FLEX I/O JUNCTION BOX

ENGINEER

CLIENT:

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2501 INDUSTRIAL PARKWAY WEST
HAYWARD, CA. 94545
(510)887–2289

TITLE: THERMOCOUPLE MODULE WIRING DIAGRAM

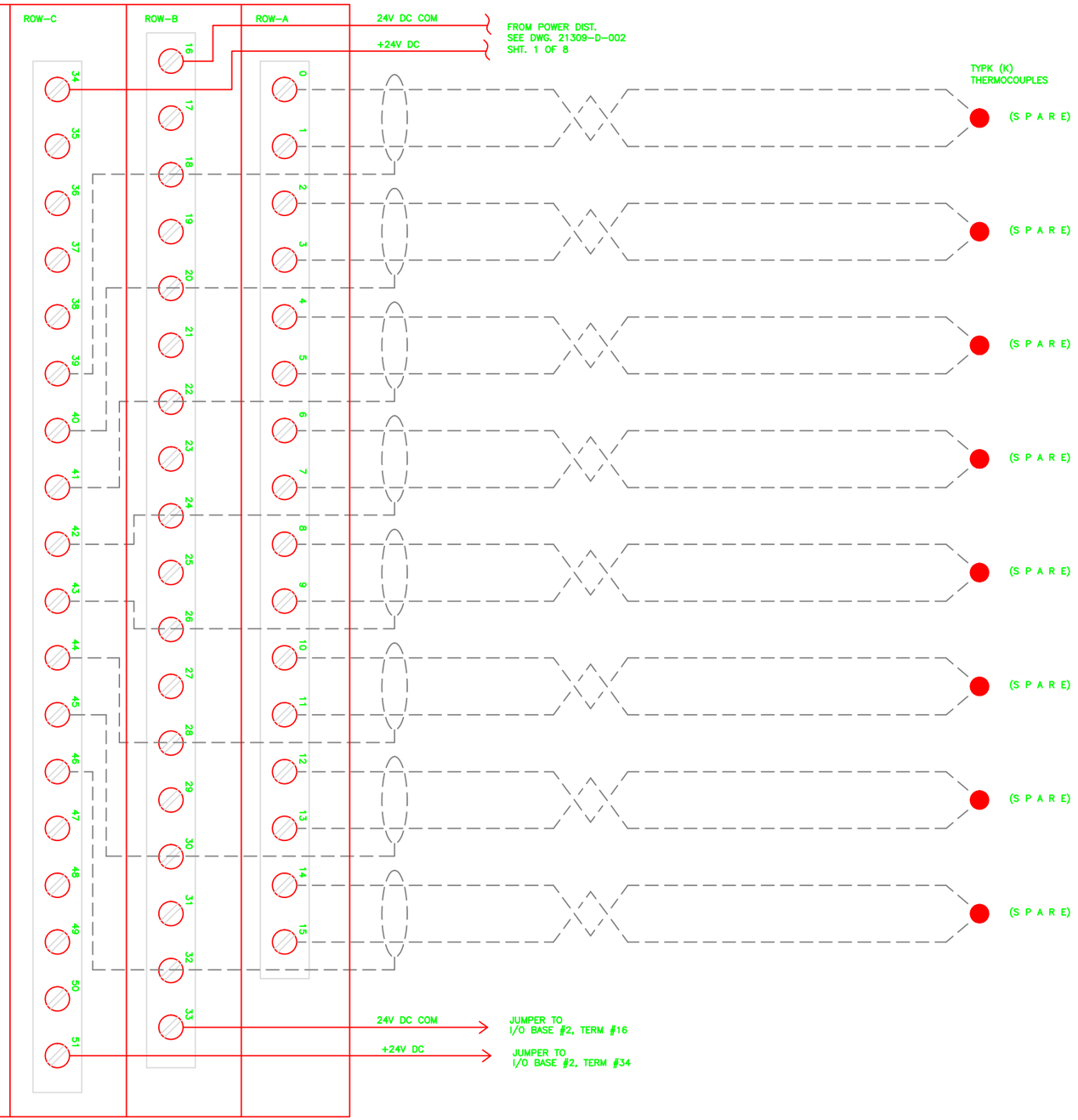
DRAWING No. 21309–D–002 | SHEET 5 OF 8 | REVISION 1

Drawing No.:21309-D-002 S 6 of 8, Flex I/O Junction Box, Thermocouple Module Wiring Diagram

THERMOCOUPLE MODULE BASE – 1794–TB3T

THERMOCOUPLE MODULE – 1794–IT8

SLOT 4



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CLIENT APPV'L		
CLIENT APPV'L		

PROJECT: 21309 FLEX I/O JUNCTION BOX

ENGINEER

CLIENT:

AMtec INDUSTRIES, INC.
2501 INDUSTRIAL PARKWAY WEST
HAYWARD, CA. 94545
(510)887–2289

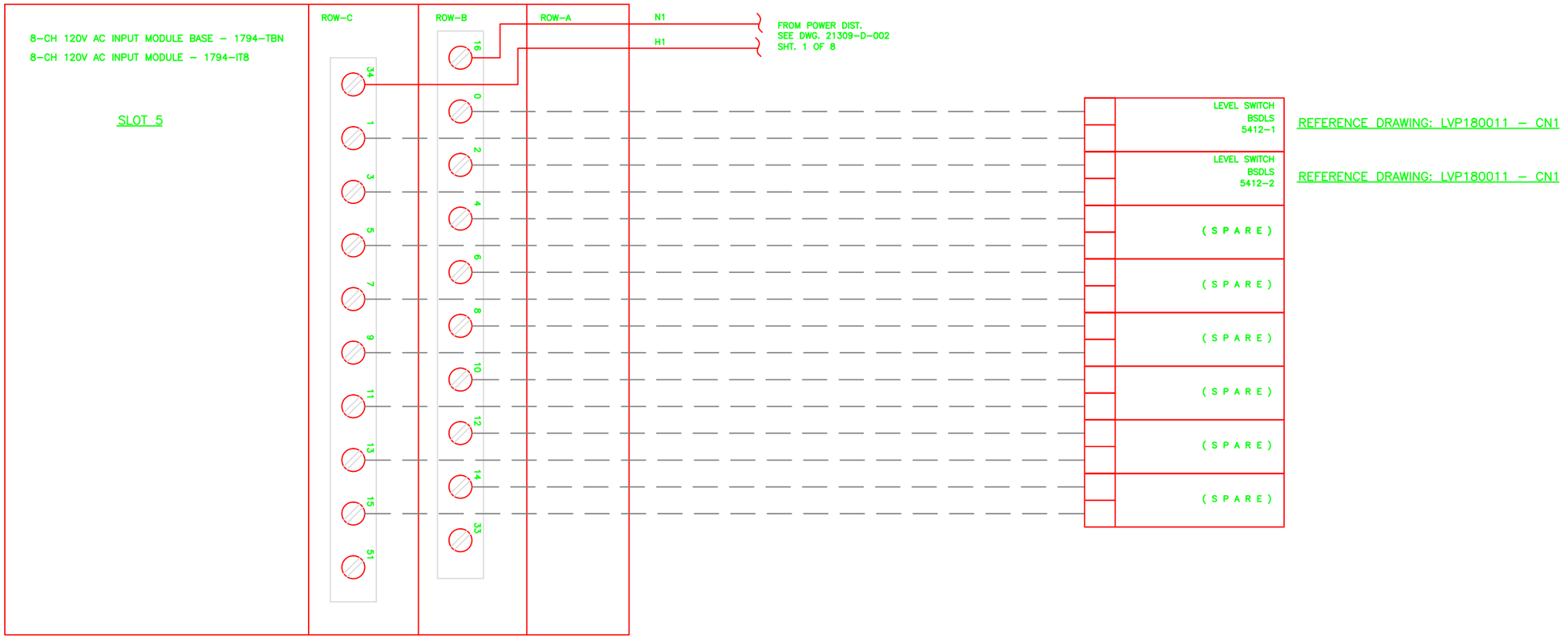
TITLE: THERMOCOUPLE MODULE WIRING DIAGRAM

DRAWING No. 21309–D–002 | SHEET 6 OF 8 | REVISION 1

Drawing No.:21309-D-002 S 7 of 8, Flex I/O Junction Box, 120V AC Input Module Wiring Diagram

8-CH 120V AC INPUT MODULE BASE - 1794-TBN
8-CH 120V AC INPUT MODULE - 1794-IT8

SLOT 5



REFERENCE DRAWING: LVP180011 - CN1

REFERENCE DRAWING: LVP180011 - CN1

REV.	DESCRIPTION	BY	CHK'D	APPVD	DATE
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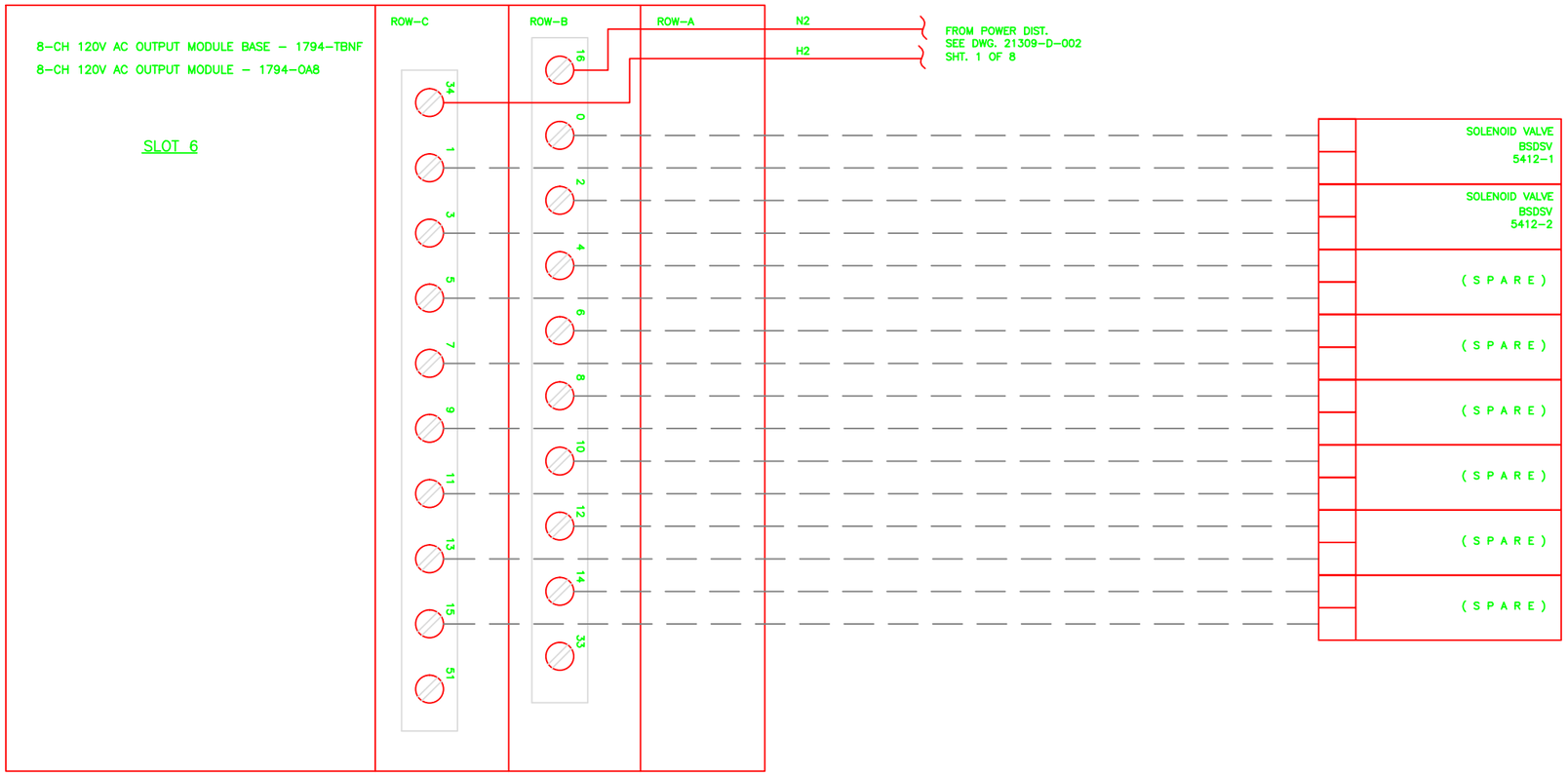
CLIENT APPV'L		
CLIENT APPV'L		

PROJECT: 21309 FLEX I/O JUNCTION BOX
ENGINEER
CLIENT:

AMtec INDUSTRIES, INC.
2501 INDUSTRIAL PARKWAY WEST
HAYWARD, CA. 94545
(510)887-2289

TITLE: 120V AC INPUT MODULE WIRING DIAGRAM
DRAWING No. 21309-D-002
SHEET 7 OF 8
REVISION 1

Drawing No.:21309-D-002 S 8 of 8, Flex I/O Junction Box, Flex I/O Junction Box, 120V AC Input Module Wiring Diagram



REV.	DESCRIPTION	BY	CHK'D	APPVD	DATE
0	ISSUED FOR APPROVAL	RE	X	X	03/23/10
1	REVISED PER ENGINEER'S COMMENTS	RE	X	X	04/21/10

REV.	DESCRIPTION	BY	CHK'D	APPVD	DATE

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UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
FRACTIONS ± 1/64 | DECIMALS .01 ± .015 ± | ANGLES ± 1°
MACHINED SURFACES DEBURR & BREAK SHARP EDGES
MATERIAL
FINISH

DWG. FILE No. N/A
SCALE: NONE

	BY	DATE
DESIGNED	DG	03/23/10
DRAWN	RE	03/23/10
CHECKED	DG	03/23/10
APPROVED	JS	03/23/10
CLIENT APPV'L		
CLIENT APPV'L		

PROJECT: 21309 FLEX I/O JUNCTION BOX
ENGINEER
CLIENT:

AMtec INDUSTRIES, INC.
2501 INDUSTRIAL PARKWAY WEST
HAYWARD, CA. 94545
(510)887-2289

TITLE: 120V AC INPUT MODULE WIRING DIAGRAM
DRAWING No. 21309-D-002
SHEET 8 OF 8
REVISION 1

K. Paint Specifications

- TFL5422Paint Specifications Data Sheet
- AUE 280 Skid & Structure Supports Primer
- HSP 1128 Skid & Structural Supports Paint

TFL5422Paint Specifications Data Sheet

Paint Specifications Data Sheet

Project: Bowling Green Municpal Utilities District, KY
Project No.: TFL 5412

		Polyurethane Primer	Polyurethane Enamel	Paint Color:
		HSP2128	AUE 280	
Skid & Support Structure				
	Skid	**X**	**X**	**Blue**
	Support Structure	**X**	**X**	**Blue**
	Safety Guards	**X**	**X**	**Yellow**

Commercial Performance Coatings

HSP-2128 (FOR USE WITH HSP-211 AND UA11)

CPC 53

2.1/2.8 VOC Tintable Polyurethane Primer

PRODUCT DESCRIPTION

HSP-2128 2.1/2.8 LOW VOC TINTABLE POLYURETHANE PRIMER Component A	HSP-211 CATALYST FOR HSP-2128 PRIMERS Component B	UA-11 URETHANE ACCELERATOR Component C

TYPE: Polyurethane

RECOMMENDED USE

HSP-2128 is a high performance polyurethane primer which conforms to 2.1 lbs/gal. VOC limits in acetone exempt regulated areas, and to 2.8 lbs /gal. VOC limits in non-acetone exempt regulated areas. HSP-2128 is heavy metal free, and has excellent adhesion over a wide variety of metal and other substrates HSP-2128 may be topcoated with all Commercial Coatings VOC compliant topcoats.

HSP-2128 is custom tinted by the distributor to any shade desired with the Commercial Coatings Color Accurate tint system. Tint ratio is 2 oz of tint to 100 oz. HSP-2128 primer base. HSP-2128 is particularly suited for application over sandblasted metals, or anywhere superior film build, fast dry and superior corrosion resistance are required Examples include castings hot rolled steel, and fabrications. HSP-2128 primer is sold in easy-to-mix kit form.

PHYSICAL CONSTANTS

WEIGHT PER U.S. GALLON (MIXED)
(varies by color) 11.4-11.6 lbs./gal.

PERCENT SOLIDS BY WEIGHT (MIXED)
(varies by color) 74.5-75.5

PERCENT SOLIDS BY VOLUME (MIXED)
(varies by color) 57.5-59.5

FLASH POINTS

HSP-2128	Pensky-Martens	1 F (-17°C)
HSP-211	Pensky-Martens	334 F (168°C)
UA-11	Pensky-Martens	96 F (36°C)

VOC (MIXED) <2.1 lbs /gal (acetone exempt areas)
<2.8 lbs./gal. (non-acetone exempt areas)

READY TO SPRAY VISCOSITY (varies by color) #3 Zahn 10-20 seconds #2 Zahn N/A

PERFORMANCE FEATURES

96 HOUR HUMIDITY RESISTANCE
Excellent

ADHESION
Excellent

IN SERVICE TEMPERATURE LIMITATIONS
300 F

CHEMICAL/SOLVENT RESISTANCE

10% SULFURIC ACID	Excellent	10%HYDROCHLORIC ACID	Excellent
10%AMMONIA	Very Good	10%SODIUM HYDROXIDE	Excellent
XYLENE	Excellent	ISOPROPYL ALCOHOL	Excellent
OIL	Excellent	GASOLINE	Excellent
500 HOURS SALT SPRAY	Excellent		

WATER RESISTANCE: Resistant to intermittent exposure. **Not recommended for immersion**

PPG

SURFACE PREPARATION

For optimum performance, surface to be coated should be sanded free of all contamination including dust dirt oil grease and oxidation.

Metal	Recommended Topcoat	Direct To Properly Treated Substrate
Cold Rolled Steel	AUE-280, AUE-300, AUE-350, AUE-400LG, AUE-280LG	Excellent
Hot Rolled Steel	AUE-280, AUE-300, AUE-350, AUE-400LG, AUE-280LG	Excellent
Galvanized	AUE-280, AUE-300, AUE-350, AUE-400LG, AUE-280LG	Excellent (See Note)
Galvaneal	AUE-280, AUE-300, AUE-350, AUE-400LG, AUE-280LG	Excellent
Aluminum	AUE-280, AUE-300, AUE-350, AUE-400LG, AUE-280LG	Excellent

Note: Galvanized surfaces will need chemical treatment or a conversion coat such a PLC-900 for exterior and/or harsh environments.

Plastic/Fiberglass	Surface should be free of all contamination Because of the variability of plastic/fiberglass substrates coating performance should be confirmed on the actual plastic/fiberglass substrate being used.

APPLICATION DATA

MIXING DIRECTIONS

Stir thoroughly before and occasionally during use

FOR A ONE-GALLON RTS KIT: To each gallon (102 oz net) of tinted HSP-2128 add the entire contents of a one quart (20 oz net) container of HSP-211 catalyst, and 6 oz. Of UA-11 accelerator

FOR 1 QUART RTS: Mix 25 5 oz. Tinted HSP-2128 to 5 oz. HSP-211 to 1 5 oz UA-11.

NOTE: Moisture contamination in components can result in poor properties of applied films or gelation of the material Do not open until ready to use. **DO NOT USE LACQUER THINNERS FOR CLEANING LINES.**

THINNING

For improved application properties and pot life thinning is recommended between 10% - 25% by volume with Acetone.

NOTE: TO REMAIN WITHIN STATED VOC LIMITS IN NON-ACETONE EXEMPT AREAS (2.8 LBS./GAL.), DO NOT EXCEED 10 oz ADDED ACETONE TO EACH RTS GALLON.

PPG DT series urethane reducers may be used up to 25% by volume in non-VOC regulated areas

POT LIFE

1 5-2 hours at 75 F thinned 10% by volume with Acetone. Additional acetone may be added for longer pot life. Do not exceed 25% acetone reduction by volume in non- VOC regulated areas Mix only enough material that can be used in two hours or less. **Note: Higher temperatures will shorten pot life.**

RECOMMENDED WET FILM BUILD (Mixed)

Spray Application: 3 5 to 4 5 mils

RECOMMENDED DRY FILM BUILD

2 0 to 2 5 mils

Film in excess or below these recommended film builds may cause problems such as poor adhesion solvent popping, runs sags, or extended dry times.

APPLICATION EQUIPMENT

Conventional Spray: 55-65 psi at the gun

DRYING TIME

3 5 to 4 5 mils wet at 77°F (25°C) and 50% relative humidity.

To Touch:	45 minutes
Handle: *	2 hours
Dry: **	8 hours
To Topcoat:	After 1 hour, before 4 days

* This condition does not mean that the paint film has reached full cure. It is a stage where handling can be achieved without loosening, wrinkling or otherwise marring the film under minimal pressure from fingers or hands Drying time listed may vary depending upon film build, color selection temperature humidity and degree of air movement

**Application of film thickness in excess of that recommended for this product will substantially extend dry time and lengthen the recoat window.

RECOMMENDED SPREADING RATE

922-954 sq ft. at 1.0 mil dry film per U.S gallon (varies by color). Spreading rate figures do not include losses due to thinning transfer application of coating or losses due to surface irregularities or porosity

CLEAN UP

PPG Urethane Reducer or Acetone. **Do not use Lacquer Thinner. Moisture and/or alcohol content of Lacquer Thinner may cause gelling or thickening of material remaining in lines and spray guns.**

APPLICATION PRECAUTIONS AND LIMITATIONS

Apply only when air, product or surface temperature is above 50°F (10°C) and when surface temperature is at least 5°F (3°C) above the dew point. Brush and roller application is not recommended

To the best of our knowledge, the technical information in this bulletin is accurate; however, since PPG Industries, Inc. is constantly improving its coatings and paint formulas the current technical data may vary somewhat from what was available when this bulletin was printed. Contact your PPG Distributor for the most up-to-date information

SAFETY

These materials are designed for application only by professional, trained personnel, using proper equipment under controlled conditions and are not intended for sale to the general public.
Safe application of paints and coatings requires knowledge of equipment materials and individual training. Directions and precautionary information on both equipment and products should be carefully read and strictly observed for personal safety and property protection. Consideration must be given to eliminate conditions, which may generate hazardous atmospheres during spray application or subject operators or bystanders to injury or illness. Special precautions must be taken when utilizing spray equipment, particularly airless equipment. High-pressure injection of coatings into the skin by airless equipment may cause serious injury requiring immediate medical attention at a hospital Treatment advice may also be obtained from Poison Centers. Air quality should be maintained with adequate ventilation; applicators can achieve additional protection by wearing respirators and other protective garments such as gloves and overalls. In all cases, wear protective eye equipment During the application of all coatings materials all flames welding and smoking must be prohibited Explosion proof equipment must be used when coating these materials in confined areas

PRECAUTIONARY INFORMATION

Before using the products listed herein, carefully read each product label and follow directions for its use Please read and observe all warnings and precautionary information on all product labels. Prevent all contact with skin and eyes and breathing of vapors and spray mist. Repeated inhalation of high vapor concentrations may cause a series of progressive effects including irritation of the respiratory system, permanent brain and nervous system damage and possible unconsciousness and death in poorly ventilated areas. Eye watering headaches nausea dizziness and loss of coordination are indications that solvent levels are too high. Intentional misuse by deliberately concentrating and inhaling the contents can be harmful or fatal

KEEP OUT OF THE REACH OF CHILDREN

MEDICAL RESPONSE :Emergency Medical or Spill Control Information (304) 843-1300. CANADA (514) 645 - 1320 Have label information available. **MATERIAL SAFETY DATA SHEET Material Safety Data Sheets for the PPG products mentioned in this publication are available through your PPG Distributor. FOR ADDITIONAL INFORMATION REGARDING THIS PRODUCT, SEE THE MSDS AND LABEL INFORMATION.**

PPG Industries
Commercial Coatings

We're Everywhere You Look

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Part No CPC 53 8/03

SURFACE PREPARATION

For optimum performance surface to be coated should be sanded free of all contamination including dust, dirt oil grease and oxidation.

Metal	Recommended Topcoat	Direct To Properly Treated Substrate
Cold Rolled Steel	AUE-280, AUE-300, AUE-350, AUE-400LG, AUE-280LG	Excellent
Hot Rolled Steel	AUE-280, AUE-300, AUE-350, AUE-400LG, AUE-280LG	Excellent
Galvanized	AUE-280, AUE-300, AUE-350, AUE-400LG, AUE-280LG	Excellent (See Note)
Galvaneal	AUE-280, AUE-300, AUE-350, AUE-400LG, AUE-280LG	Excellent
Aluminum	AUE-280, AUE-300, AUE-350, AUE-400LG, AUE-280LG	Excellent

Note: Galvanized surfaces will need chemical treatment or a conversion coat such a PLC-900 for exterior and/or harsh environments.

Plastic/Fiberglass	Surface should be free of all contamination. Because of the variability of plastic/fiberglass substrates, coating performance should be confirmed on the actual plastic/fiberglass substrate being used.

APPLICATION DATA

MIXING DIRECTIONS

Stir thoroughly before and occasionally during use.

FOR A ONE-GALLON RTS KIT: To each gallon (102 oz. net) of tinted HSP-2128 add the entire contents of a one quart (20 oz net) container of HSP-211 catalyst, and 6 oz. Of UA-11 accelerator

FOR 1 QUART RTS: Mix 25 5 oz Tinted HSP-2128 to 5 oz HSP-211 to 1.5 oz UA-11.

NOTE: Moisture contamination in components can result in poor properties of applied films or gelation of the material Do not open until ready to use. **DO NOT USE LACQUER THINNERS FOR CLEANING LINES.**

THINNING

For improved application properties and pot life, thinning is recommended between 10% - 25% by volume with Acetone.

NOTE: TO REMAIN WITHIN STATED VOC LIMITS IN NON-ACETONE EXEMPT AREAS (2.8 LBS./GAL.), DO NOT EXCEED 10 oz ADDED ACETONE TO EACH RTS GALLON.

PPG DT series urethane reducers may be used up to 25% by volume in non-VOC regulated areas.

POT LIFE

1 5-2 hours at 75 F thinned 10% by volume with Acetone. Additional acetone may be added for longer pot life. Do not exceed 25% acetone reduction by volume in non- VOC regulated areas Mix only enough material that can be used in two hours or less **Note: Higher temperatures will shorten pot life.**

RECOMMENDED WET FILM BUILD (Mixed)

Spray Application: 3.5 to 4.5 mils

RECOMMENDED DRY FILM BUILD

2.0 to 2 5 mils

Film in excess or below these recommended film builds may cause problems such as poor adhesion, solvent popping, runs, sags or extended dry times.

APPLICATION EQUIPMENT

Conventional Spray: 55-65 psi at the gun

DRYING TIME

3 5 to 4.5 mils wet at 77°F (25°C) and 50% relative humidity

To Touch:	45 minutes
Handle: *	2 hours
Dry: **	8 hours
To Topcoat:	After 1 hour before 4 days

* This condition does not mean that the paint film has reached full cure. It is a stage where handling can be achieved without loosening, wrinkling or otherwise marring the film under minimal pressure from fingers or hands. Drying time listed may vary, depending upon film build, color selection, temperature humidity and degree of air movement.

**Application of film thickness in excess of that recommended for this product will substantially extend dry time and lengthen the recoat window.

RECOMMENDED SPREADING RATE

922-954 sq ft at 1 0 mil dry film per U S gallon (varies by color). Spreading rate figures do not include losses due to thinning transfer, application of coating, or losses due to surface irregularities or porosity

CLEAN UP

PPG Urethane Reducer or Acetone **Do not use Lacquer Thinner. Moisture and/or alcohol content of Lacquer Thinner may cause gelling or thickening of material remaining in lines and spray guns.**

APPLICATION PRECAUTIONS AND LIMITATIONS

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Before using the products listed herein, carefully read each product label and follow directions for its use. Please read and observe all warnings and precautionary information on all product labels. Prevent all contact with skin and eyes and breathing of vapors and spray mist. Repeated inhalation of high vapor concentrations may cause a series of progressive effects including irritation of the respiratory system, permanent brain and nervous system damage and possible unconsciousness and death in poorly ventilated areas. Eye watering headaches nausea dizziness and loss of coordination are indications that solvent levels are too high. Intentional misuse by deliberately concentrating and inhaling the contents can be harmful or fatal.

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AUE 280 Skid & Structural Supports Paint

Commercial Performance Coatings

Ahn Pat

CPCPB211

2.8 VOC Polyurethane Enamel

AUE-280 / AUE-280LG

AUE-280 is a 2.8 VOC Polyurethane Enamel that is recommended for interior and exterior use on properly prepared and or primed metal surfaces. This product provides a wide balance of performance properties, including excellent flow and leveling, film hardness and good exterior durability.

This resin is available in high and low gloss bases that when combined, provide intermediate gloss levels. Suitable applications for the higher gloss include metal fabrication, castings, cabinets, machinery, and heavy equipment. For the lower gloss, AUE-280 is particularly suited for use on electronics components, metal furniture, and exterior signs and metalwork, as well as cabinets and machinery.

Features and benefits:

- Intermixable high and low gloss bases
- Excellent corrosion and chemical resistance
- Excellent gloss and color retention
- Fast dry for quick turnaround

Associated Products:

- AUE-280 2.8 VOC Polyurethane Enamel
- AUE-280LG 2.8 VOC Polyurethane Enamel – Low Gloss
- AUE-281 Hardener for AUE-280 & AUE-280LG
- UA-11 Polyurethane Accelerator
- UE-28 Polyurethane Extender
- AUE2-FP901, Factory-packaged Black
- AUE2-FP951, Factory-packaged White

Physical Constants: *All values are theoretical, depend on color and are Ready-to-Spray. Actual values could vary slightly due to manufacturing variability.*

	AUE-280 w/ tints	AUE-280 w/ tints : AUE-281 : UA-11 or UE-28	AUE-280LG w/ tints	AUE-280LG w/ tints : AUE-281
Percent solids (by weight)	61.6 – 74.2%	67.02 – 76.01%	35.8 – 51.3%	45.85 – 57.7%
Percent solids (by volume)	55.3 – 61.8%	61.28 – 66.02%	26.2 – 31.8%	36.75 – 41.51%
HAPs	≤ 0.1 lbs/gal	≤ 0.1 lbs/gal	≤ 0.1 lbs/gal	≤ 0.1 lbs/gal
Photo-chemically reactive	No	No	No	No

Flashpoint
AUE-280 = 109°F, AUE-280LG = 17°F
AUE-281 = 334°F

RTS Combinations:	AUE-280 w/ tints	AUE-280 w/ tints : AUE-281 : UA-11 or UE-28	AUE-280LG w/ tints	AUE-280LG w/ tints : AUE-281
Volume Ratio	As is	4 : 1 : 6 oz/RTS gal	As is	6 : 1
Applicable Use Category	Single-Stage Coating	Single-Stage Coating	Single-Stage Coating	Single-Stage Coating
VOC Actual	323 – 373 (g/L) 2.70 – 3.11 (lbs/gal)	292 – 331 (g/L) 2.44 – 2.76 (lbs/gal)	169 – 213 (g/L) 1.41 – 1.77 (lbs/gal)	145 – 182 (g/L) 1.21 – 1.52 (lbs/gal)
VOC Regulatory (less water less exempt)	323 – 373 (g/L) 2.70 – 3.11 (lbs/gal)	292 – 331 (g/L) 2.44 – 2.76 (lbs/gal)	334 – 419 (g/L) 2.79 – 3.50 (lbs/gal)	252 – 316 (g/L) 2.10 – 2.64 (lbs/gal)
Density	1003 – 1234 (g/L) 8.37 – 10.30 (lbs/gal)	1029 – 1230 (g/L) 8.59 – 10.26 (lbs/gal)	1028 – 1254 (g/L) 8.58 – 10.46 (lbs/gal)	1046 – 1239 (g/L) 8.73 – 10.34 (lbs/gal)
Volatiles wt. %	26.2 – 37.0	24.1 – 32.0	48.8 – 62.9	42.3 – 53.1
Water wt. %	0.0 – 0.2	0.0 – 0.1	0.0 – 0.2	0.0 – 0.1
Exempt wt. %	0.0	0.0	34.9 – 42.6	30.3 – 35.9
Water vol. %	0.0 – 0.2	0.0 – 0.1	0.0 – 0.2	0.0 – 0.1
Exempt vol. %	0.0	0.0	49.2	42.2

AUE-280 / AUE-280LG

Directions for Use

Substrate Preparation:

The surface to be coated must be sanded and free of all contamination (including dust, dirt, oil, grease, and oxidation). Chemical treatment and the use of a conversion coating will improve the performance properties of the coating system. We recommend that adhesion and system compatibility be checked prior to full application.

Metal	Direct to properly treated substrate
Cold Rolled Steel	Refer to CPCTB01 for approved primers.
Hot Rolled Steel	Refer to CPCTB01 for approved primers.
Galvaneal	Refer to CPCTB01 for approved primers.
Galvanized	Refer to CPCTB01 for approved primers.
Aluminum	Refer to CPCTB01 for approved primers.
Plastic / Fiberglass	Surface should be free of all contamination. Because of the variability of plastic/ fiberglass substrates, coating performance should be confirmed on the actual plastic/fiberglass substrate being used

Note: *For improved performance between this topcoat and CPC primers please see the CPC Primer/Topcoat compatibility chart (CPCTB01)*

Mix Directions:

Mix Directions: Stir thoroughly before and occasionally during use.

Thinning: AUE-280 can be thinned with Q50 (Aromatic 100), or Q80 (Xylene) but these solvents will raise the VOC above 2.8 lbs/gal. AUE-280LG should not be thinned.

Blend Ratio:	AUE-280			AUE-280LG*		
	AUE-280	: AUE-281	+ UA-11 or UE-28	AUE-280LG	: AUE-281	
	4	: 1	+ 6 oz/RTS gal	6	: 1	
Pot Life @ 77°F (25°C):	1 hour with UA-11 1 ½ – 2 hours with UE-28			3 – 4 hours		
Spray Viscosity Range:	#3 Zahn 15 – 25 seconds			#3 Zahn 10 – 20 seconds		
Unopened Shelf Life: (each component)	4 years			2 years		

* *Intermediate gloss levels can be achieved. See "Miscellaneous" section for details*

Application Equipment:

Conventional:	1.0 – 1.4 mm needle/nozzle on pressure pot 1.4 – 1.6 mm needle/nozzle without pot; 50 – 70 psi at the gun
HVLP:	1.0 – 1.4 mm needle/nozzle on pressure pot 1.4 – 1.6 mm needle/nozzle without pot; 10 psi output at the tip
Airless:	No recommendation
Air-Assisted Airless:	No recommendation
Brush or Roll:	Not recommended
Electrostatic:	No recommendation

Application:

Apply: 1 – 2 medium coats with a 10 – 15 minute flash. Apply only when air, product and surface temperature are above 50°F (10°C) and when surface temperature is at least 5°F (3°C) above the dew point

	AUE-280 w/AUE-281	AUE-280LG w/AUE-281
Recommended Wet Film Build:	2.6 – 3.6 mils	3.6 – 6.8 mils
Recommended Dry Film Build:	1.7 – 2.2 mils	1.5 – 2.5 mils
Square Foot Coverage @ 1 mil no loss:	983 – 1,059	589 – 665

Dry Times:

Air Dry @ 77°F 50% RH:

	AUE-280 w/AUE-281 + UA-11	AUE-280 w/AUE-281 +UE-28	AUE-280LG w/ AUE-281
To Touch	30 -45 minutes	45 minutes – 1 hour	20 – 30 minutes
To Handle	2 – 2 ½ hours	2 ½ - 3 ½ hours	1 – 1 ½ hours
Recoat	Up to 3 days	Up to 3 days	Up to 3 days
Force Dry	20 minutes @ 140°F after 10 minute air dry		N/A

* *Paint film is not fully cured for 7 days. Drying time listed may vary, depending upon film build, color selection, temperature, humidity and degree of air movement.*

AUE-280 / AUE-280LG

Technical Data*

Performance Properties:

Test	ASTM Method	Results	
		AUE-280	AUE-280LG
Gloss @ 60° Angle*	D523	85 – 90	10 – 20
Pencil Hardness	D3363	F	HB – H
Gravelometer	D3170	7 – 8	7 – 8
Adhesion	D3359	5B	5B
In Service Temperature Limit**		300°F	

*** As you approach 300°F depending on the pigmentation the color may change, but the film integrity will be maintained up to 300°F.*

Chemical Resistance:

Chemical	ASTM Methd	Results	
		AUE-280	AUE-280LG
MEK	D1308	Ring	Ring
10% NaOH (Sodium Hydroxide)	D1308	Pass	Pass
10% HCl (Hydrochloric acid)	D1308	Pass	Pass
10% H_2SO_4 (Sulphuric acid)	D1308	Pass	Pass
Gasoline	D1308	Ring/discolor	Ring/discolor
Water†	D1308	Pass	Pass

† *Although resistant to intermittent exposure, not recommended for immersion.*

Weather Resistance:

	ASTM Method	Results	
		AUE-280	AUE-280LG
System Tested:			
Bonderite 1000			
W43181A			
AUE-280 or AUE-280LG			
Salt Spray – 500 hours	B117		
Corrosion Creep	D1654	9A	9A
Scribe Blisters	D714	8MD, 2M	None
Face Blisters	D714	None	None
Humidity – 1000 hours	D2247		
5 Minute Recovery Adhesion	D3359	4B – 5B	4B – 5B
1 Hour Recovery Adhesion	D3359	4B – 5B	4B – 5B
24 Hour Recovery Adhesion	D3359	4B – 5B	4B – 5B
QUV-UVA: 60° angle	D4587		
200 hour retention	D523	95 – 100%	85 – 95%
500 hour retention	D523	95 – 100%	85 – 95%
QUV-UVB: 60° angle	D4587		
200 hour retention	D523	90 – 95%	75 – 90%
500 hour retention	D523	85 – 90%	50 – 75%

All tests results assume proper cure and preparation of test substrates Unless otherwise stated, all results were obtained spraying product direct to metal on Bonderite 1000

* The application and performance property data above are believed to be reliable based on laboratory findings It is for the buyer to satisfy itself on the suitability of the product for its particular use Variation in environment, procedures of use, or extrapolation of data may cause unsatisfactory results.

Miscellaneous:

Intermediate Gloss Levels

Description	60° gloss	AUE-280LG parts (by vol)	AUE-280 parts (by vol)
Matte / Eggshell	10 – 20	1	0
Satin	20 – 40	4	1
Semi-Gloss	40 – 60	2	1

Please note that if AUE-280LG is present in the color mix at any level, the mix ratio of 6:1 must be used

Supplement #1

Therma-Flite
The Screw Heat Exchanger Company

P.O. Box 847
849 Jackson St.
Benicia, CA 94510
P (707) 747-5949
F (707) 747-5951
www.therma-flite.com

DOCUMENT TRANSMITTAL

Number: TFL5412-6

Date: June 28, 2010

Company: Bowling Green / BGMU

Attention: **Kristi Schnell, P.E.**

Project: TFL5412 IC10,000 "Bio-Scru"

Description	File Name	Sheet	Date	Rev.	Issued For
List of Questions & Answers regarding IC 10,000 Nitrogen Systems	TFL 5412 Response to Nitrogen Systems Questions R0.pdf		6-28-10	0	FI
TFL 5412 Utility Requirements Spreadsheet R0	TFL5412_Utility Requirements R0.pdf		6-28-10	0	FI
Procedure for Adding Nitrogen Blanket Components to a Fulton Thermal Fluid Heater System	Adding Nitrogen Blanket Components to a Fulton Thermal Fluid Heater System.pdf		6-28-10	0	FI
Fulton Drawing No.: T40DR-0784	0784_A Nitrogen Blanket P&ID.pdf		6-28-10	0	FI
Fulton Nitrogen Requirements	Fulton Nitrogen Requirements.pdf		6-28-10	0	FI

Legend:

FA **For Approval**
FI **For Information**
FC **Certified for Construction**
AB **As Built**

Submitted By: *Robert D. Nickerson*

Robert D. Nickerson
Therma-Flite, Inc.

Therma-Flite Project: TFL 5412 - Bowling Green Municipal Utilities
Subject: Response to Questions in 6/28/10 GS&P email Rev 0
Therma-Flite Transmittal TFL5412-6

Item	Kristi Schnell, GS&P Email 6/28/10	TFL Response 6/14/10
1	Quantity of nitrogen used by Thermal Fluid Heater expansion tank.	Please see attached TFL 5412 Utility Requirements Spreadsheet.
2	Thermal Fluid Heater nitrogen line size.	Please refer to attached Fulton Drawing T40DR-0784
3	Thermal Fluid Heater Nitrogen Blanket Kit Installation Instructions and method of connection	Please refer to attached Fulton Jun 25,2004 "Adding Nitrogen Blanket Components".
4	IC 10,000 Biosolids Dryer Nitrogen supply connection location	For IC 10,000 Nitrogen supply connection location please refer to Therma-Flite's BGMU Submittal Package Part 1 of 2, page 30, Therma-Flite Drawing No. TFL5412-00000 Sheet 2 of 2 R2, General Arrangement Drawing, View B-B, Item J. Connection type as defined in Therma-Flite Drawing TFL5412-PID R0, Submittal package page 23.

Utility Requirements Spreadsheet
Therma-Flite Project No.: 5412
IC 10,000 Biosolids Dryer
Bowling Green Municipal Utilities

Rev.	P&ID	Service Description	Type of Device	Instrument Tags	Continuous / Intermittent	Consumption each device	Qty	Total Consumption Cont.	Total Consumption Inter.	Basis: Actual/ Estimate	Comments
		INSTRUMENT AIR				(SCFM)					
				CONTINUOUS TOTAL				**0**	0		
		SERVICE AIR				(SCFM)					
				CONTINUOUS TOTAL				**0**	0		
		SERVICE WATER				GPM					
				CONTINUOUS TOTAL				**0**	0		
		COOLING WATER				GPM					
0	TFL5412-PID	COOLING WATER	COOLING SCREW	BSD-7410	CONTINUOUS	30	1	30		ACTUAL	
0	TFL5412-PID	COOLING WATER	SCRUBBER/CONDENSER	BSD-7430	CONTINUOUS	420	1	420		ACTUAL	
				CONTINUOUS TOTAL				**450**			
		THERMAL FLUID				GPM					
0	TFL5412-PID	PARATHERM NF	BIOSOLIDS DRYER	BSD-7400	CONTINUOUS	800	1	800		ACTUAL	
				CONTINUOUS TOTAL				**800**			
		AUXILIARY STEAM				LB/HR					
				CONTINUOUS TOTAL				**0**	0		
		NITROGEN (INERT GAS)				(SCFM)					
0	TFL5412-PID	START UP AUTOMATIC PURGE (25 MIN.)	BIOSOLIDS DRYER	BSD-7400	INTERMITTENT	30	1		30	ACTUAL	750 CUFT PER STARTUP CONSUMPTION
0	TFL5412-PID	SHUTDOWN AUTOMATIC PURGE <215F (25 MIN.)	BIOSOLIDS DRYER	BSD-7400	INTERMITTENT	30	1		30	ACTUAL	750 CUFT PER SHUTDOWN CONSUMPTION
0	TFL5412-PID	EMERGENCY / HIGH TEMP CONDITION	BIOSOLIDS DRYER	BSD-7400	INTERMITTENT	30	1		30	ACTUAL	OPEN CONSUMPTION (TIMED SEQUENCE OR UNTIL TEMP <)
0	TFL5412-PID	THERMAL FLUID EXPANSION TANK	THERMAL FLUID HEATER	BSD-7440	INTERMITTENT	5	1		5	ESTIMATE	40 CUFT PER HEATUP CYCLE CONSUMPTION
				CONTINUOUS TOTAL				**0**	**95**		

Procedure for Adding Nitrogen Blanket Components to a Fulton Thermal Fluid Heater System

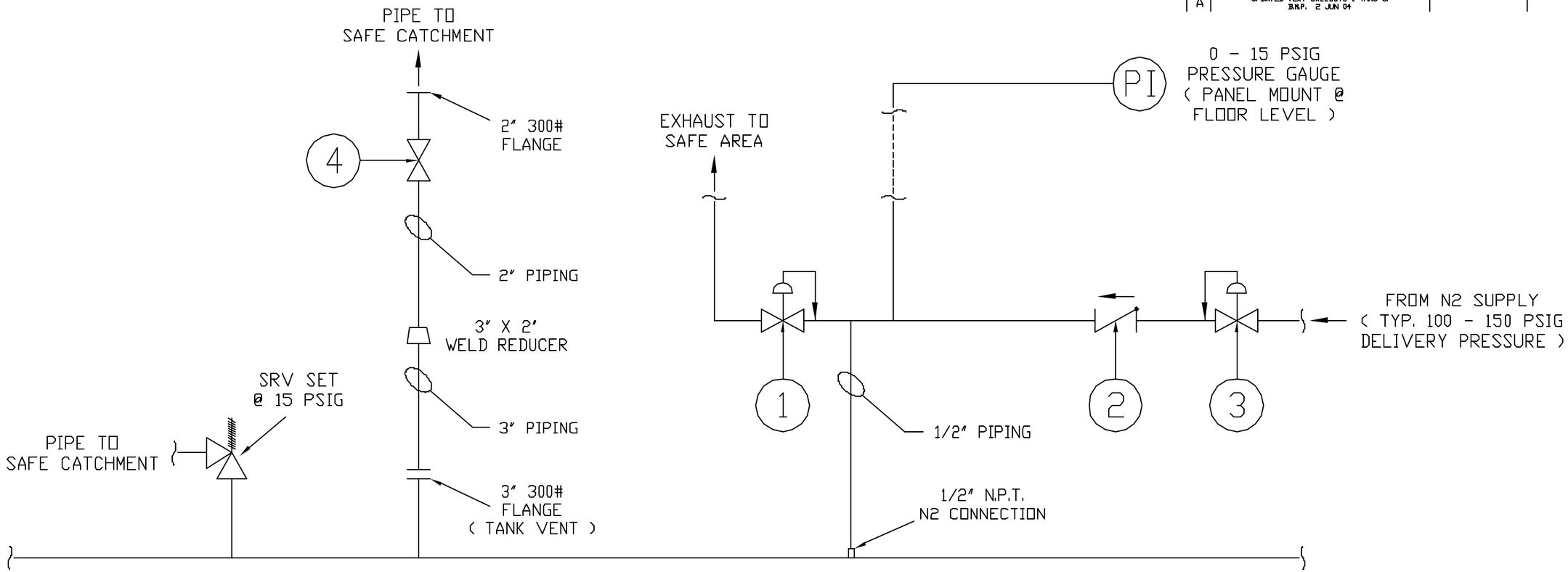
June 25, 2004

1. A nitrogen blanket is recommended if any of the following conditions exist:
    a. The DA tank is located outdoors (required).
    b. The inlet to the DA tank is not equal to or above the system high point.
    c. The vapor pressure of the thermal fluid at operating temperature exceeds atmospheric pressure.
2. Determine if the tank is equipped with the appropriate ports for the N2 regulator and Safety Relief Valve (SRV).
3. If the ports are not on the tank, contact Fulton for a custom adaptor assembly for the tank.
4. Determine the set pressure of the nitrogen.
    a. If the DA tank is located outdoors, a pressure of 1-2 psi is sufficient.
    b. If the inlet to the tank is not the high point, then the tank must be pressurized enough to overcome the weight of the fluid above it. Divide the height of the fluid (in feet) above the inlet to the DA tank by 2.31 ft/psig. The pressure in the tank must exceed this pressure.
    c. If the vapor pressure of the thermal fluid at operating temperature exceeds atmospheric pressure, the pressure in the tank must exceed the vapor pressure of the fluid at all times.
5. Remarks on the set pressure of the nitrogen:
    a. If more than one condition is present, the higher pressure must be used.
    b. A non-code tank cannot be pressurized over 15 psig.
    c. A safety relief valve is required whenever a nitrogen blanked is used (15 psig set pressure for non-code tanks).
    d. Either a 3-way N2 regulator or 2-way n2 regulator with back pressure valve may be used. The 3-way regulator is a relieving regulator meaning that it maintains the set pressure in the tank by continually allowing N2 in or out. If conservation of nitrogen is a concern, the 2-way regulator and back pressure valve are recommended.
    e. If vapor pressure of the thermal fluid at operating temperature exceeds atmospheric pressure a low pressure switch is recommended on the tank.
6. Components required:
    a. SRV (15 psig max for non-code tanks).
    b. Class VI bubble tight socket weld ball valve for the vent line. Note: Vent line may be reduced to 2".
    c. 3-way N2 regulator or 2-way N2 regulator with back pressure valve and check valve
    d. Pressure indicator
    e. N2 bottles or other N2 source.
7. Installation:

a. Connections on the Fulton tank are threaded. Do not weld these connections.
b. Install SRV using appropriate thread sealant. Pipe outlet of SRV to safe catchment.
c. Install N2 regulator assembly using ½" carbon steel pipe welded wherever possible to minimize potential leaks. Regulators should be located near floor level for ease of adjustment.
d. Install a pressure indicator at eye level. Choose a range appropriate for the set pressure of nitrogen.
e. Vent the regulator to a safe area.
f. Leak test all joints.

8. Warnings:
    a. High temperature thermal fluid, steam or combustible vapors may be vented from the SRV or regulator.
    b. If installing the components on a system already filled with thermal fluid:
        i. Turn off the heater
        ii. Turn off the circulating pump
        iii. Cool the system down.
        iv. Add a flanged spool piece to the vent line containing the ball valve, weld reducer (if required) and mating flange to the DA vent connection. Do not weld near the DA tank.
        v. Leak test all joints.
    c. Consult the MSDS for the thermal fluid for warnings and flammability information.
    d. Thermal fluid vapors may be present at vent connections in the thermal fluid system and may be flammable.
    e. If the system is already filled with thermal fluid, any modifications to the tank or piping requires purging of the work area to prevent ignition of potentially flammable vapors.
    f. Consult factory prior to beginning this procedure.

REVISIONS			
LTR	DESCRIPTION	CHECKED / DATE	APPROVAL / DATE
A	UPDATED TEXT CALLOUTS 1 THRU 3. B.M.P. 2 JUN 04		



D/A TANK - EXPANSION TANK SECTION

1. BACKPRESSURE REGULATING VALVE (1/2") - FISHER MODEL 98L OR EQUAL
2. CHECK VALVE (600°F MIN. TEMP. RATING) (1/2") - RP&C MODEL F90D OR EQUAL
3. PRESSURE REGULATING VALVE (1/2") - FISHER MODEL 95L OR EQUAL
4. 2" BALL VALVE (SOCKET WELD) - SVF R8 SERIES W/ PTFE SEATS OR EQUAL

The item shown in this drawing may be covered by one or more patents of the Fulton Companies. This design and drawing are proprietary and are the exclusive property of The Fulton Companies. The corporation doesn't permit their use except with prior written consent.

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCE ON:
FRACTIONS ± 1/4
TWO PLACE DECIMALS ± .01
THREE PLACE DECIMALS ± .005
ANGLES ± 2 DEG
SURFACE FINISH 250 MICROINCHES

ENG'GN	B.M.P.	24 MAR 2004
CHECKED	K.R.H.	24 MAR 2004
APPROVED	M.W.	24 MAR 2004

Fulton Thermal Corp.
972 Centerville road
Pulaski, New York, USA 13142

N2 SYSTEM W/
2-WAY REGULATOR

SIZE	DWG NO	REV.
D	T40DR-0784	A

SCALE	SHEET NO.
1 / 1	1 OF 1

Nitrogen Requirements for Thermal Systems Higher than DA Inlet

lbs. Nitrogen	Feet Above Inlet
1	2.3
2	4.6
3	6.9
4	9.2
5	11.6
6	13.9
7	16.2
8	18.5
9	20.8
10	23.1
11	25.4
12	27.7
13	30.0
14	32.3
15	34.7
16	37.0
17	39.3
18	41.6
19	43.9
20	46.2
21	48.5
22	50.8
23	53.1
24	55.4
25	57.8
26	60.1
27	62.4
28	64.7
29	67.0
30	69.3

Note: 1 PSI of nitrogen will raise thermal fluid with a specific gravity of 1, 2.307 feet.

AJB: 6/28/2010

Nitrogen Requirements for Thermal Systems Higher than DA Inlet

lbs. Nitrogen	Feet Above Inlet
31	71.6
32	73.9
33	76.2
34	78.5
35	80.9
36	83.2
37	85.5
38	87.8
39	90.1
40	92.4
41	94.7
42	97.0
43	99.3
44	101.6
45	104.0
46	106.3
47	108.6
48	110.9
49	113.2
50	115.5
51	117.8
52	120.1
53	122.4
54	124.7
55	127.1
56	129.4
57	131.7
58	134.0
59	136.3
60	138.6

AJB: 6/28/2010

Supplement #2

Therma-Flite
The Screw Heat Exchanger Company

P.O. Box 847
849 Jackson St.
Benicia, CA 94510
P (707) 747-5949
F (707) 747-5951
www.therma-flite.com

DOCUMENT TRANSMITTAL

Number: TFL5412-8

Date: July 2, 2010

Company: Bowling Green / BGMU

Attention: **Kristi Schnell, P.E.**

Project: TFL5412 IC10,000 "Bio-Scru"

Description	File Name	Sheet	Date	Rev.	Issued For
List of Questions & Answers in Response to Kristi Schnell's 6/30/10 email to Therma-Flite	TFL 5412 Response to 6-30-10 Questions R0.pdf		7-2-10	0	FI
TFL 5412 Instrumentation Index Rev 1, including Fulton Expansion Tank Pressure Relief Valve	TFL5412_Instrument Index-R1.pdf		7-2-10	0	FI
TFL 5412 Utility Requirements Spreadsheet Rev 1, including Dryer Chamber "Saturation Cycle" quantity	TFL5412_Utility Requirements R1.pdf		7-2-10	0	FI
Revised TFL 5412 P&ID Drawing, Including Changes for Fulton Expansion Tank Nitrogen Kit	TFL5412_PID_R1.pdf		7-2-10	0	FI
Fulton Drawing T91DR-0565	FT-1200-C WITH EXOTHERMICS TUBULAR HEAT EXCHANGER.pdf		7-2-10	0	FI

Legend:

FA **For Approval**
FI **For Information**
FC **Certified for Construction**
AB **As Built**

Submitted By: *Robert D. Nickerson*

Robert D. Nickerson
Therma-Flite, Inc.

Therma-Flite Project: TFL 5412 - Bowling Green Municipal Utilities
Subject: Response to Questions in 6/30/10 GS&P email Rev 0
Therma-Flite Transmittal TFL5412-7

Item	Kristi Schnell, GS&P Email 6/30/10	TFL Response 7/4/10
1	There seems to be some discrepancies between the P&ID drawing from Fulton (Drawing T40DR-0784) and your drawing (TFL5412-PID) in the submittal. Please confirm which pieces Fulton is providing versus those that will need to be provided by the Contractor	Please refer to revised P&ID Drawing TFL5412-PID R1. Fulton will provide Valves 1,2,3,4 referred to in Fulton Drawing. T40DR-0784 RA with Nitrogen Kit. Nitrogen kit shipped loose as shown in Item 7 of Fulton Drawing T99DR-1530, TFL 5412 Submittal Package Page 444
2	does the Contractor only provide the N2 supply (at the 100-150 psi)	Please refer to Fulton drawing T40DR-0784. All items for nitrogen kit provided by Fulton to be shipped loose, to be mounted per instructions on Fulton drawing T40DR-0784. GC responsible for piping to and from Nitrogen Kit.
3	and then #3 (pressure regulating valve) and #2 (check valve) are provided by Fulton?	Correct
4	Also is Fulton providing #1 (backpressure regulating valve)?	Correct
5	For the other two pipes coming from the De-aerator Tank, can you confirm that the 3" to vent is the same as the 3" shown on your P&ID drawing in the submittal?	Please refer to attached revised P&ID Drawing TFL5412-PID R1.
6	Also does the Contractor's scope start with the 3"x2" reducer?	Please refer to attached revised P&ID Drawing TFL5412-PID R1.
7	On your P&ID drawing you show a 3" vent to the catchment tank and do not show the pipe reducing to a 2" with the #4 (ball valve), so is Fulton providing them?	Please refer to attached revised P&ID Drawing TFL5412-PID R1.
8	And lastly, the third pipe shown on the P&ID drawing shows a "SRV at 15 psi" is this the same as the high and low level lines shown on your P&ID drawing in the submittal?	No. Please refer to attached revised P&ID Drawing TFL5412-PID R1.

Item	Kristi Schnell, GS&P Email 6/30/10	TFL Response 7/4/10
9	Regarding the quantity of nitrogen listed in "TFL5412_Utility Requirements R0.xls" it lists 750 cu.ft. at startup and shutdown. This differs from the information we received on February 18, 2010 stating 500 cu.ft. Please confirm which quantity is correct so we can size the nitrogen system correctly.	Revision 0 is correct.
10	Also please confirm the pressure required by the dryer and expansion tank. In the same February 18, 2010 correspondence, 35 psi was stated as the pressure required for the dryer. However based on the P&ID provided by Fulton it says the Contractor is to provide 100-150 psi nitrogen supply, so which is correct?	35 psi to Dryer. 100-150 psi to Thermal Fluid Heater Expansion Tank.
11	Is Fulton/Therma-Flite providing the regulator(s) to reduce the pressure to the required amount, or is that part of the Contractor's scope (for both the dryer and expansion tank)?	Fulton is supplying Pressure Regulator for expansion tank. GC is to supply Pressure Regulator to dryer.
12	Additionally, on "TFL5412_Utility Requirements R0.xls" it lists the water requirements for the cooling screw and scrubber/condenser. However, it does not list the quantity for the saturation cycle. Can you please confirm that the "5 to 6 GPM to be flashed to steam" given on May 4, 2010 is still correct? Or does the saturation cycle require more/less water? This water requirement also is not listed on page 12 of the submittal where the other two requirements are listed.	Please refer to Revised Utility Spreadsheet TFL5412_Utility Requirements R1.pdf
13	Additionally on page 12 of the submittal, you do not list the return temperature for the scrubber/condenser. Can you confirm the 130 deg. F given on February 9, 2010, or is the return temperature different?	130°F is the scrubber/condenser water return temperature

Item	Kristi Schnell, GS&P Email 6/30/10	TFL Response 7/4/10
14	On general arrangement drawing TFL5412-00000 (sheet 1 of 2) it shows where section "D-D" is cut for where the nitrogen connection is (drawing TFL5412-00000, sheet 2 of 2), however can you provide a distance so we can run the nitrogen piping to the correct location. We had originally assumed the nitrogen connection would be near the inlet, however it appears it is more in the middle of the dryer at the top. Please confirm and provide a distance from either the inlet or cooling screw so we can locate.	Dryer Nitrogen connection is just below the center of the control panel, about 9'-3" from the tail end of the skid, and at an elevation of approximately 6'-9" above the finished floor
15	Additionally, it appears that section F3 is missing from the table of contents. However, there is a cover sheet within the submittal that lists a drawing of the cooling screw should be there, but nothing is after the cover page. Is this just a typo or was this section not submitted? Same situation with Section G3, it has a cover sheet but no drawing. And the same for Section J5, it has a cover sheet stating instrumentation index but nothing following the cover sheet. Please submit these missing pieces.	For Cover sheet J-5, please see attached Revised Instrumentation Index TFL5412_Instrument Index R1.pdf. Cover sheet for section G-3 is followed by Fulton Drawing T1DR-0565, BGMU Submittal Package Part 1 of 2 page 247. Cooling Screw drawing to be sent next week.

Therma-Flite
The Screw Heat Exchanger Company

INSTRUMENT INDEX

JOB #: TFL5412

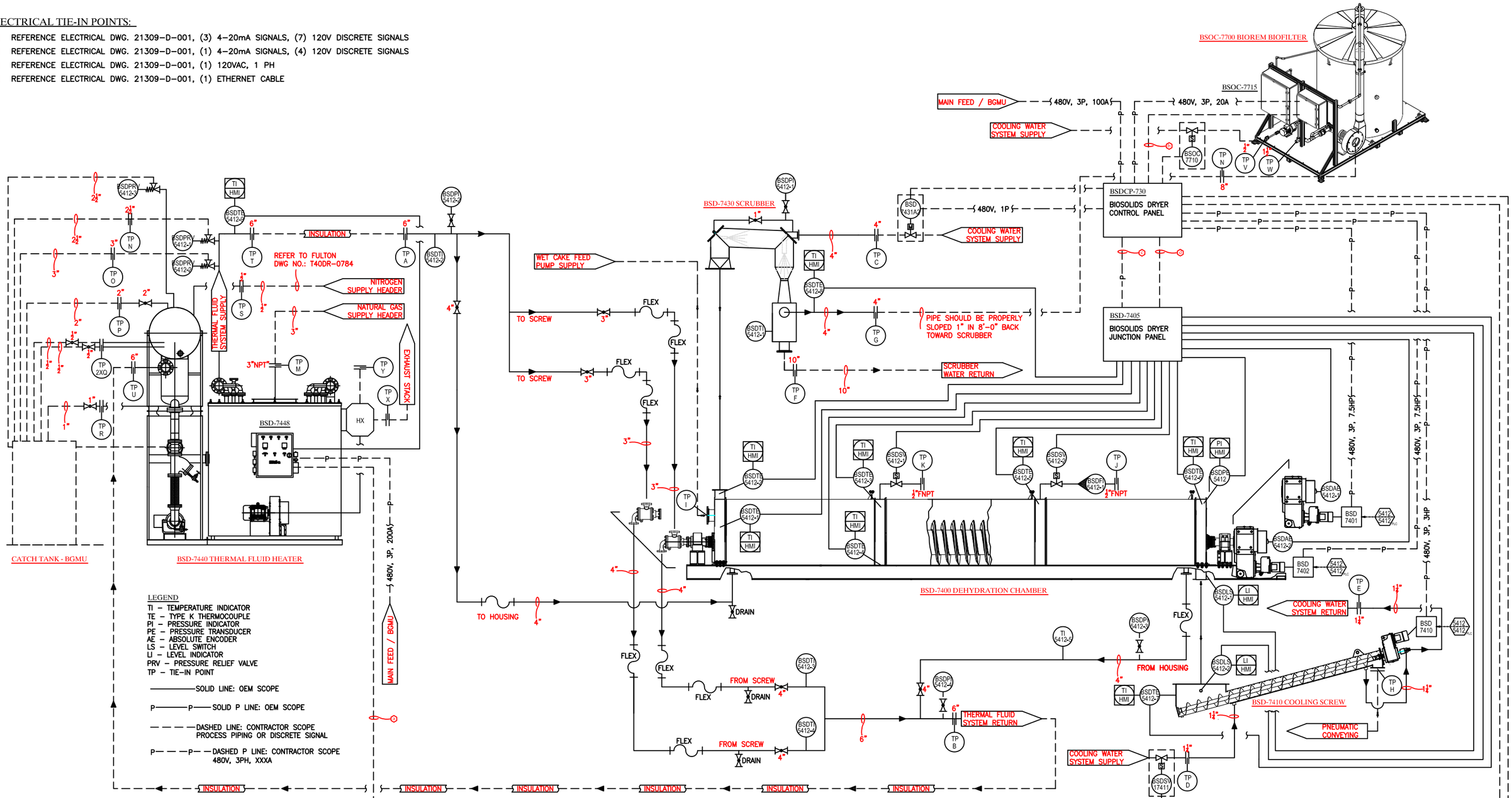
REV	TAG NUMBER	SERVICE DESCRIPTION	P&ID No.	DEVICE TYPE	MANUFACTURER	MODEL NO.	CALIBRATED RANGE	LOCATION DWG.	REMARKS
O	BSDTE-5412-1	PROCESS VENT TO SCRUBBER	TFL5412-PID	TE	OMEGA ENG.	NB1-CASS-14U-XX	TYPE K	TFL5412-00000	
O	BSDTE-5412-2	PRODUCT INLET ZONE TEMPERATURE	TFL5412-PID	TE	OMEGA ENG.	NB1-CASS-14U-XX	TYPE K	TFL5412-00000	
O	BSDTE-5412-3	PROCESS VAPOR ZONE 2 TEMPERATURE	TFL5412-PID	TE	OMEGA ENG.	NB1-CASS-14U-XX	TYPE K	TFL5412-00000	
O	BSDTE-5412-4	MATERIAL TEMP ZONE 2 TEMPERATURE	TFL5412-PID	TE	OMEGA ENG.	NB1-CASS-14U-XX	TYPE K	TFL5412-00000	
O	BSDTE-5412-5	PROCESS VAPOR ZONE 3 TEMPERATURE	TFL5412-PID	TE	OMEGA ENG.	NB1-CASS-14U-XX	TYPE K	TFL5412-00000	
O	BSDTE-5412-6	PROCESS VAPOR DISCHARGE TEMPERATURE	TFL5412-PID	TE	OMEGA ENG.	NB1-CASS-14U-XX	TYPE K	TFL5412-00000	
O	BSDTE-5412-7	MATERIAL DISCHARGE TEMPERATURE	TFL5412-PID	TE	OMEGA ENG.	NB1-CASS-14U-XX	TYPE K	TFL5412-00000	
O	BSDTE-5412-8	PROCESS VENT FROM SCRUBBER	TFL5412-PID	TE	OMEGA ENG.	NB1-CASS-14U-XX	TYPE K	TFL5412-00000	
O	BSDPE-5412	PRODUCT CHAMBER PRESSURE	TFL5412-PID	PE	DWYER	645-10	-0.5 TO 0.5 PSI	TFL5412-00000	
O	BSDAE-5412-1	DRYER LH ROTOR POSITION	TFL5412-PID	AE	BEI INDUSTRIES	HS35F-100-R2-SS	NA	TFL5412-00000	
O	BSDAE-5412-2	DRYER RH ROTOR POSITION	TFL5412-PID	AE	BEI INDUSTRIES	HS35F-100-R2-SS	NA	TFL5412-00000	
O	BSDLS-5412-1	MATERIAL SEAL LEVEL LOW	TFL5412-PID	LS	BINDICATOR	LP3-1-A-1-G-A-10-0	SPDT	TFL5412-00000	
O	BSDLS-5412-2	MATERIAL SEAL LEVEL CONTROL	TFL5412-PID	LS	BINDICATOR	LP3-1-A-1-G-A-10-0	SPDT	TFL5412-00000	
O	BSDSV-5412-1	SOLENOID VALVE - STARTUP AND SHUTDOWN WATER SPRAY	TFL5412-PID	SV	ASCO	EF8210GO94MO	-----	TFL5412-00000	
O	BSDSV-5412-2	SOLENOID VALVE - NITROGEN PURGE	TFL5412-PID	SV	ASCO	EF8210GO94MO	-----	TFL5412-00000	
O	BSDTI-5412-1	SCRUBBER WATER RETURN TEMPERATURE	TFL5412-PID	TI	ASHCROFT	30-CI-60-R-040-0/200F	0/200F	TFL5412-00000	
O	BSDTI-5412-2	THERMAL FLUID SUPPLY HEADER TEMPERATURE	TFL5412-PID	TI	ASHCROFT	30-CI-60-L-040-50/550F	50/550F	TFL5412-00000	
O	BSDTI-5412-3	RH ROTOR THERMAL FLUID RETURN TEMPERATURE	TFL5412-PID	TI	ASHCROFT	30-CI-60-L-040-50/550F	50/550F	TFL5412-00000	
O	BSDTI-5412-4	LH ROTOR THERMAL FLUID RETURN TEMPERATURE	TFL5412-PID	TI	ASHCROFT	30-CI-60-L-040-50/550F	50/550F	TFL5412-00000	
O	BSDTI-5412-5	HOUSING THERMAL FLUID RETURN TEMPERATURE	TFL5412-PID	TI	ASHCROFT	30-CI-60-L-040-50/550F	50/550F	TFL5412-00000	
O	BSDPI-5412-1	SCRUBBER CONDENSER SUPERHEAT NOZZLE PRESSURE	TFL5412-PID	PI	WEKSLER	BA43YPE4LW	0-60 PSI	TFL5412-00000	
O	BSDPI-5412-2	THERMAL FLUID SUPPLY PRESSURE	TFL5412-PID	PI	WEKSLER	BA43YPE4LW	0-60 PSI	TFL5412-00000	
O	BSDPI-5412-3	THERMAL FLUID RETURN HEADER PRESSURE	TFL5412-PID	PI	WEKSLER	BA43YPE4LW	0-60 PSI	TFL5412-00000	
O	BSDPRV-5412-1	PRESSURE RELIEF VALVE - THERMAL FLUID SUPPLY	TFL5412-PID	PRV	-----	------	-----	T99DR-1530	
O	BSDPRV-5412-2	PRESSURE RELIEF VALVE - THERMAL FLUID SUPPLY	TFL5412-PID	PRV	------	--------	-----	T99DR-1530	
1	BSDPRV-5412-3	PRESSURE RELIEF VALVE - THERMAL FLUID EXPANSION TANK	TFL5412-PID	PRV	------	--------	-----	T99DR-1530	
O	BSDFI-5412-1	NITROGEN ROTOMETER - FLOW INDICATOR	TFL5412-PID	FI	DWYER	RMC-108-CPF	180 1800 CFH	TFL5412-00000	

Utility Requirements Spreadsheet
Therma-Flite Project No.: 5412
IC 10,000 Biosolids Dryer
Bowling Green Municipal Utilities

Rev.	P&ID	Service Description	Type of Device	Instrument Tags	Continuous / Intermittent	Consumption each device	Qty	Total Consumption Cont.	Total Consumption Inter.	Basis: Actual/ Estimate	Comments
		INSTRUMENT AIR				(SCFM)					
				CONTINUOUS TOTAL				**0**	0		
		SERVICE AIR				(SCFM)					
				CONTINUOUS TOTAL				**0**	0		
		SERVICE WATER				GPM					
				CONTINUOUS TOTAL				**0**	0		
		COOLING WATER				GPM					
0	TFL5412-PID	COOLING WATER	COOLING SCREW	BSD-7410	CONTINUOUS	30	1	30		ACTUAL	
0	TFL5412-PID	COOLING WATER	SCRUBBER/CONDENSER	BSD-7430	CONTINUOUS	420	1	420		ACTUAL	
1	TFL5412-PID	COOLING WATER	DRYER SPRAY NOZZLE SATURATION CYCLE	BSD-7430	INTERMITTENT	6	1		6.0	ACTUAL	
				CONTINUOUS TOTAL				**450**			
		THERMAL FLUID				GPM					
0	TFL5412-PID	PARATHERM NF	BIOSOLIDS DRYER	BSD-7400	CONTINUOUS	800	1	800		ACTUAL	
				CONTINUOUS TOTAL				**800**			
		AUXILIARY STEAM				LB/HR					
				CONTINUOUS TOTAL				**0**	0		
		NITROGEN (INERT GAS)				(SCFM)					
0	TFL5412-PID	START UP AUTOMATIC PURGE (25 MIN.)	BIOSOLIDS DRYER	BSD-7400	INTERMITTENT	30	1		30	ACTUAL	750 CUFT PER STARTUP CONSUMPTION
0	TFL5412-PID	SHUTDOWN AUTOMATIC PURGE <215F (25 MIN.)	BIOSOLIDS DRYER	BSD-7400	INTERMITTENT	30	1		30	ACTUAL	750 CUFT PER SHUTDOWN CONSUMPTION
0	TFL5412-PID	EMERGENCY / HIGH TEMP CONDITION	BIOSOLIDS DRYER	BSD-7400	INTERMITTENT	30	1		30	ACTUAL	OPEN CONSUMPTION (TIMED SEQUENCE OR UNTIL TEMP <)
0	TFL5412-PID	THERMAL FLUID EXPANSION TANK	THERMAL FLUID HEATER	BSD-7440	INTERMITTENT	5	1		5	ESTIMATE	40 CUFT PER HEATUP CYCLE CONSUMPTION
				CONTINUOUS TOTAL				**0**	**95**		

ELECTRICAL TIE-IN POINTS:

- (a) REFERENCE ELECTRICAL DWG. 21309-D-001, (3) 4-20mA SIGNALS, (7) 120V DISCRETE SIGNALS
- (b) REFERENCE ELECTRICAL DWG. 21309-D-001, (1) 4-20mA SIGNALS, (4) 120V DISCRETE SIGNALS
- (c) REFERENCE ELECTRICAL DWG. 21309-D-001, (1) 120VAC, 1 PH
- (d) REFERENCE ELECTRICAL DWG. 21309-D-001, (1) ETHERNET CABLE



LEGEND

TI – TEMPERATURE INDICATOR
TE – TYPE K THERMOCOUPLE
PI – PRESSURE INDICATOR
PE – PRESSURE TRANSDUCER
AE – ABSOLUTE ENCODER
LS – LEVEL SWITCH
LI – LEVEL INDICATOR
PRV – PRESSURE RELIEF VALVE
TP – TIE-IN POINT

———— SOLID LINE: OEM SCOPE

P———P—— SOLID P LINE: OEM SCOPE

— — — — DASHED LINE: CONTRACTOR SCOPE
PROCESS PIPING OR DISCRETE SIGNAL

P— — —P— — DASHED P LINE: CONTRACTOR SCOPE
480V, 3PH, XXXA

UTILITY AND AUXILIARY TIE-IN POINTS:

- (A) 6" 300# FLANGE THERMAL FLUID SUPPLY
- (B) 6" 300# FLANGE THERMAL FLUID RETURN
- (C) 4" 150# FLANGE COOLING WATER SUPPLY TO SCRUBBER / CONDENSER
- (D) 1 1/4" FNPT COOLING WATER SUPPLY TO COOLING SCREW
- (E) 1 1/4" FNPT COOLING WATER RETURN TO COOLING SCREW
- (F) 10" 150# FLANGE CONDENSATE RETURN FROM SCRUBBER / CONDENSER
- (G) 4" 150# FLANGE VENT LINE TO BIO-FILTER
- (H) 12" X 12" CUSTOM FLANGE FROM COOLING SCREW
- (I) 12" 150# FLANGE WET CAKE INLET
- (J) 1/2" FNPT NITROGEN PURGE CONNECTION
- (K) 1/2" FNPT WATER SPRAY CONNECTION
- (L) JUNCTION – 30"X30"X8", NEMA 4X, STAINLESS
- (M) 3" MPNT NATURAL GAS SUPPLY
- (N) 2 1/2" 150# FLANGE PRESSURE RELIEF
- (O) 3" 150# FLANGE PRESSURE RELIEF
- (P) 2" 300# FLANGE VENT
- (Q) 1/2" MNPT HIGH/LOW CHECK
- (R) 1" 150# DRAIN
- (S) 1/2" FNPT NITROGEN PURGE
- (T) 6" 300# FLANGE THERMAL FLUID SUPPLY
- (U) 6" 300# FLANGE THERMAL FLUID RETURN
- (V) 1/2" SOC WATER SUPPLY
- (W) 1 1/2" DRAIN (P-TRAP REQUIRED)
- (X) 26" DIA. VERTICAL STACK CONNECTION
- (Y) 13 1/8" X 33 1/4" AIR INLET CONN.

REFERENCES

DRAWING NUMBER	TITLE

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REVISIONS

No.	MADE BY	CHECKED BY	DATE	DESCRIPTION
A	CJ	RDN	01/11/10	APPROVAL SUBMITTAL

JOB No.:	TFL5412
DRAWN BY:	RDN
TRACED BY:	
CHECKED BY:	
APPROVED BY:	BRB
DATE	01/11/10

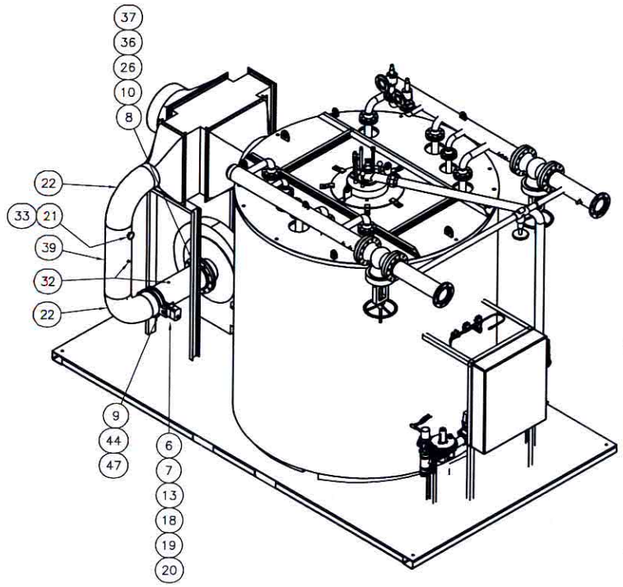
PROCESS AND INSTRUMENT DIAGRAM
IC10,000
"BIO-SCRU" DRYER
FOR
BGMU – WWTP

CUSTOMER: BGMU – WWTP

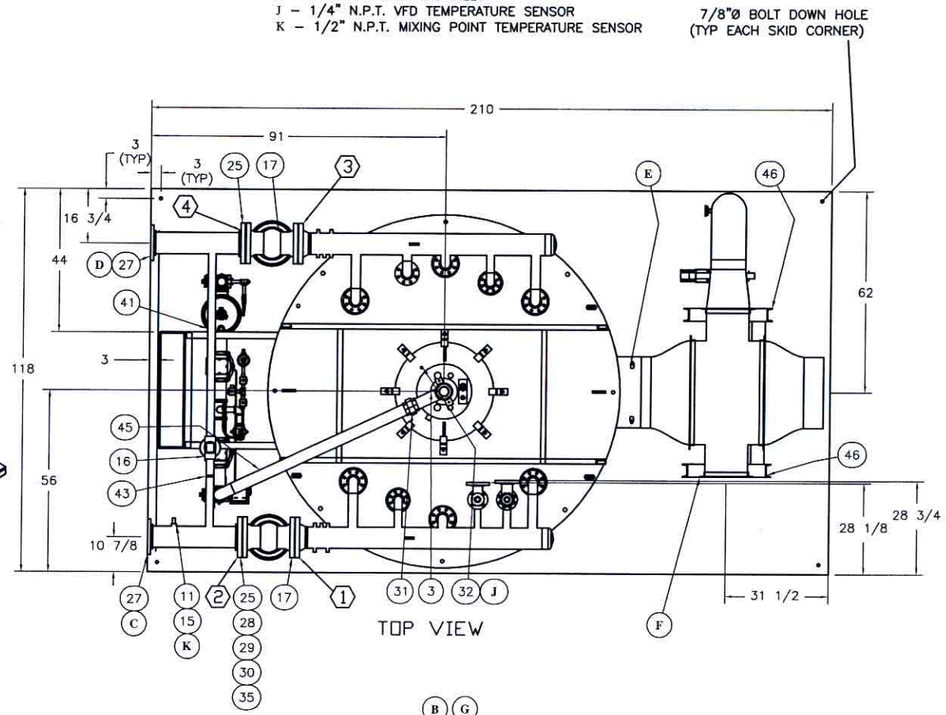
Therma-Flite
The Screw Heat Exchange Company
P.O.Box 847
848 Jackson Street,
Benicia, CA 94510
Telephone: (707) 747-0940
Fax: (707) 747-0951

SCALE: NTS | DWG. No.: TFL5412-PID | REV.: 1

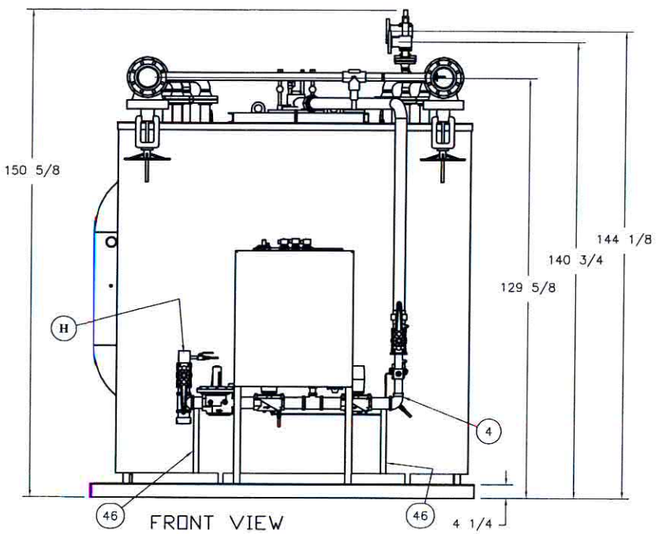
THE FOLLOWING ARE MAJOR CUSTOMER CONNECTIONS:
- A – 22"Ø FLUE CONNECTION
  26"Ø RECOMMENDED VERTICAL STACK DIAMETER
- B – 2 1/2" 150# FLANGED SAFETY RELIEF VALVE OUTLET
- C – 6" 150# THERMAL FLUID OUTLET
- D – 6" 150# THERMAL FLUID INLET
- E – 1/2" STACK LIMIT SWITCH
- F – 13 1/8" x 33 1/4" FLANGED AIR INLET CONNECTION
- G – 3" 150# FLANGED SAFETY RELIEF VALVE OUTLET
- H – 3" N.P.T. NAT. GAS INLET
- J – 1/4" N.P.T. VFD TEMPERATURE SENSOR
- K – 1/2" N.P.T. MIXING POINT TEMPERATURE SENSOR



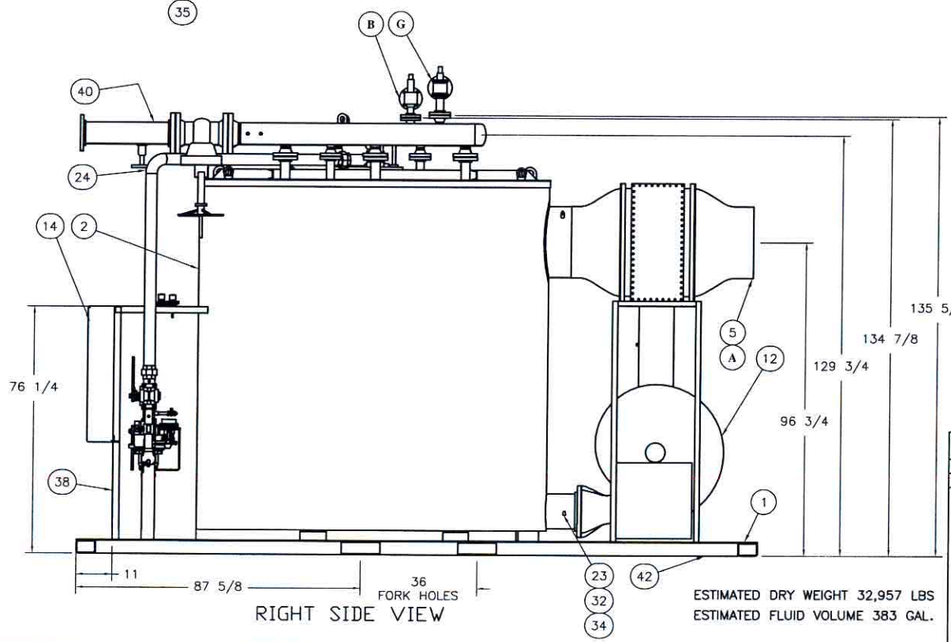
ISO VIEW



TOP VIEW



FRONT VIEW



RIGHT SIDE VIEW

ESTIMATED DRY WEIGHT 32,957 LBS
ESTIMATED FLUID VOLUME 383 GAL.

Parts List

ITEM	PART NUMBER	DESCRIPTION	QTY	U.O.M.
1		1/4" HR PLATE	173	S.F.
2	9-FT-1200-C	FT-1200-C HEATER	1	EA.
3	7-30-004027	DUEL FUEL BURNER FOR FT1000,1200, AND 1400-C HEATER	1	EA.
4	7-54-120006	7-54-NFPA GAS TRAIN	1	EA.
5	PO#	EXOTHERMIC TUBULAR HEAT EXCHANGER (TBS-01U)	1	EA.
6	PO#	1/2" COLLAR (MCMASTER 6435K14)	2	EA.
7	PO#	1/2" BEARING (MCMASTER 6384K361)	2	EA.
8	PO#	10" 150# GASKET	4	EA.
9	PO#	10" BUTTERFLY VALVE	1	EA.
10	PO#	7/8" x 3" BOLT	24	EA.
11	PO#	3/4" S.W. COUPLING	1	EA.
12	PO#	NY BLOWER (23TO2610)	1	EA.
13	PO#	14MM TO 1/2" SHAFT COUPLING	1	EA.
14	(SEE ELECTRICAL)	PANEL BOX 42" H x 36" W x 8" D	1	EA.
15	2-30-000556	THERMOWELL 3/4" SW. x 1/2" N.P.T. FOR 4" PIPING AND UP	1	EA.
16	2-30-000903	2" S.W. GLOBE VALVE	1	EA.
17	2-30-000844	6" 300# GATE VALVE	2	EA.
18	2-40-000433	SIEMENS AIR SERVO MOTOR	1	EA.
19	5-10-003067	SERVO MOTOR BRACKET	1	EA.
20	2-22-000095	6-32- X 1/2" SS MACHINE SCREW	3	EA.
21	2-30-001003	200-1000F THERMOMETER 1/2" NPT	1	EA.
22	2-35-000725	10" WELD ELBOW	2	EA.
23	2-35-000269	1/4" N.P.T. ELBOW	1	EA.
24	2-35-000422	3" SCH. 40 WELD ELBOW	1	EA.
25	2-35-000555	6" 300# R.F. S.O. FLANGE SA-105	2	EA.
26	2-35-000676	10" 150# R.F. S.O. FLANGE	2	EA.
27	2-35-000553	6" 150# R.F. S.O. FLANGE	2	EA.
28	2-12-000421	6" 300# GASKET	4	EA.
29	2-35-000343	3/4" x 4 1/2" BOLT	48	EA.
30	2-22-000068	3/4" LOCK WASHER	48	EA.
31	2-35-000066	3" N.P.T. UNION	1	EA.
32	2-35-000210	1/4" N.P.T. SCH-40 COUPLING	4	EA.
33	2-35-000460	1/2" FS COUPLING N.P.T.	1	EA.
34	2-35-000371	1/4" x 2" N.P.T. NIPPLE SCH 80	1	EA.
35	2-35-000346	3/4" HEX NUT	48	EA.
36	2-22-000129	7/8" LOCK WASHER	24	EA.
37	2-22-000128	7/8" HEX NUT	24	EA.
38	1-10-000109	2" x 2" x 1/4" ANGLE STEEL	23	FT.
39	1-10-000008	10" PIPE	7	FT.
40	2-10-000147	6" PIPE	4	FT.
41	2-10-000112	2" PIPE	7	FT.
42	2-10-000216	4" x 6" TUBE STEEL	53	FT.
43	CUSTOM MANUFACTURED	4 HOLES @ 3/8" ORIFICE	1	EA.
44	CUSTOM MANUFACTURED	10" BUTTERFLY FLANGES	2	EA.
45	2-10-000114	3" PIPE	12	FT.
46	2-10-000100	4" x5.4# CHANNEL	40	FT.
47	2-12-000120	1/4" HOLLOW GASKET	2	EA.

NOTES:
1. PORTIONS OF THE PIPING AND COMPONENTS WILL BE DISASSEMBLED FOR SHIPPING.
2. THE SUPPORT STRUCTURE MAY BE CROSS BRACED OR OTHERWISE ENHANCED BEYOND WHAT IS SHOWN, AS REQUIRED.
3. FORK HOLES ARE LOCATED ON RIGHT SIDE OF SKIDS. HEATER SKID CONSTRUCTION FOR FT-0600-C THRU FT-1200-C, PLACE ONE RUNNER ON HEATER CENTERLINE & ONE ON OUTSIDE EDGE OF EACH FORK HOLE. PLACE ALL OTHER RUNNERS MAX. 24" ON CENTER
4. ADDITIONAL FIELD SUPPORTS MAY BE REQUIRED.
5. PLEASE REFER TO THE O&M MANUAL FOR ADDITIONAL INFORMATION REGARDING CLEARANCES AND INSTALLATION INSTRUCTIONS.

(X) — DENOTES FLANGE CONNECTION NUMBER-
USE NUMBERS STAMPED ON MATCHING FLANGES TO AID REASSEMBLY.

REV.	DESCRIPTION	CHECKED	MECH. ENG.	ELEC. ENG.	APPROVAL
-	INITIAL RELEASE	4/20/10	4/20/10	4/20/10	4/20/10

REVISIONS

The item shown in this drawing may be covered by one or more patents of The Fulton Companies.

This design and drawing are proprietary and are the exclusive property of The Fulton Companies. The corporation does not permit their use except with prior written consent.

DWG BY: T. CORSON — DATE: 15 APR 2010
SCALE: 3 / 64 — SHEET NO. 1 / 1
UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCE ON
FRACTIONS ± 1/4
TWO PLACE DECIMALS ± .01
THREE PLACE DECIMALS ± .005
ANGLES ± 2 DEG.
SURFACE FINISH 250 MICROINCHES

Fulton Thermal Corp.
972 Centerville Road
Pulaski, New York, USA 13142

Fulton

FT-1200-C THERMAL FLUID HEATER
SKID MOUNTED WITH
EXOTHERMICS TUBULAR HEAT EXCHANGER

SHEET SIZE D — DWG NO. T91DR-0565 — REV. -

Supplement #3

Therma-Flite
The Screw Heat Exchanger Company

P.O. Box 847
849 Jackson St.
Benicia, CA 94510
P (707) 747-5949
F (707) 747-5951
www.therma-flite.com

DOCUMENT TRANSMITTAL

Number: TFL5412-9

Date: July 8, 2010

Company: Bowling Green / BGMU

Attention: **Kristi Schnell, P.E.**

Project: TFL5412 IC10,000 “Bio-Scru”

Description	File Name	Sheet	Date	Rev.	Issued For
Cooling Screw Drawing	TFL5412-Cooling Screw-R0.pdf	1	7-8-10	0	FI

Legend:

FA **For Approval**
FI **For Information**
FC **Certified for Construction**
AB **As Built**

Submitted By: *Robert D. Nickerson*

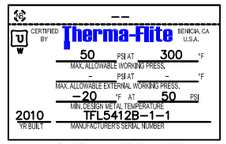
Robert D. Nickerson
Therma-Flite, Inc.

DESIGN AND CONSTRUCTION NOTES:

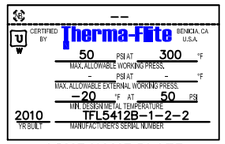
1. DESIGN AND CONSTRUCTION PER ASME CODE, SECTION VIII, DIVISION I, 2007, JULY 09 ADDENDA. 'NB' & 'U' STAMP REQUIRED.
2. WELDING PROCEDURE PER ASME CODE SECTION IX, 2007, JULY 09 ADDENDA.
3. MILL CERTIFICATES REQUIRED FOR ALL MATERIALS.
4. NDE PER UG-93.
5. IMPACT TEST EXEMPT PER UG-20.
6. DESIGN PRESSURE:
   SCREW ROTOR: 50 PSI.
   JACKETED HOUSING: 50 PSI.
7. HYDRO-TEST PRESSURE:
   SCREW ROTOR: 65 PSI
   JACKETED HOUSING: 65 PSI
8. MDMT: -20°F @ 50 PSI
9. NO PWHT PER UCS-56.

DESIGN DATA:

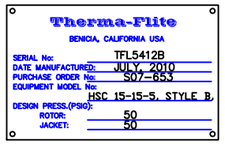
PROCESSING RATE:	2250 LBS/HR
PRODUCT INLET TEMP.:	240°F (MAX.)
PRODUCT OUTLET TEMP.:	120°F
COOLING FLUID TEMP.:	78°F (WET BULB)
COOLING FLUID (GMP):	
HOUSING & ROTOR:	30 GPM @ 45 PSI.



ASME NAME PLATE
(HOUSING)



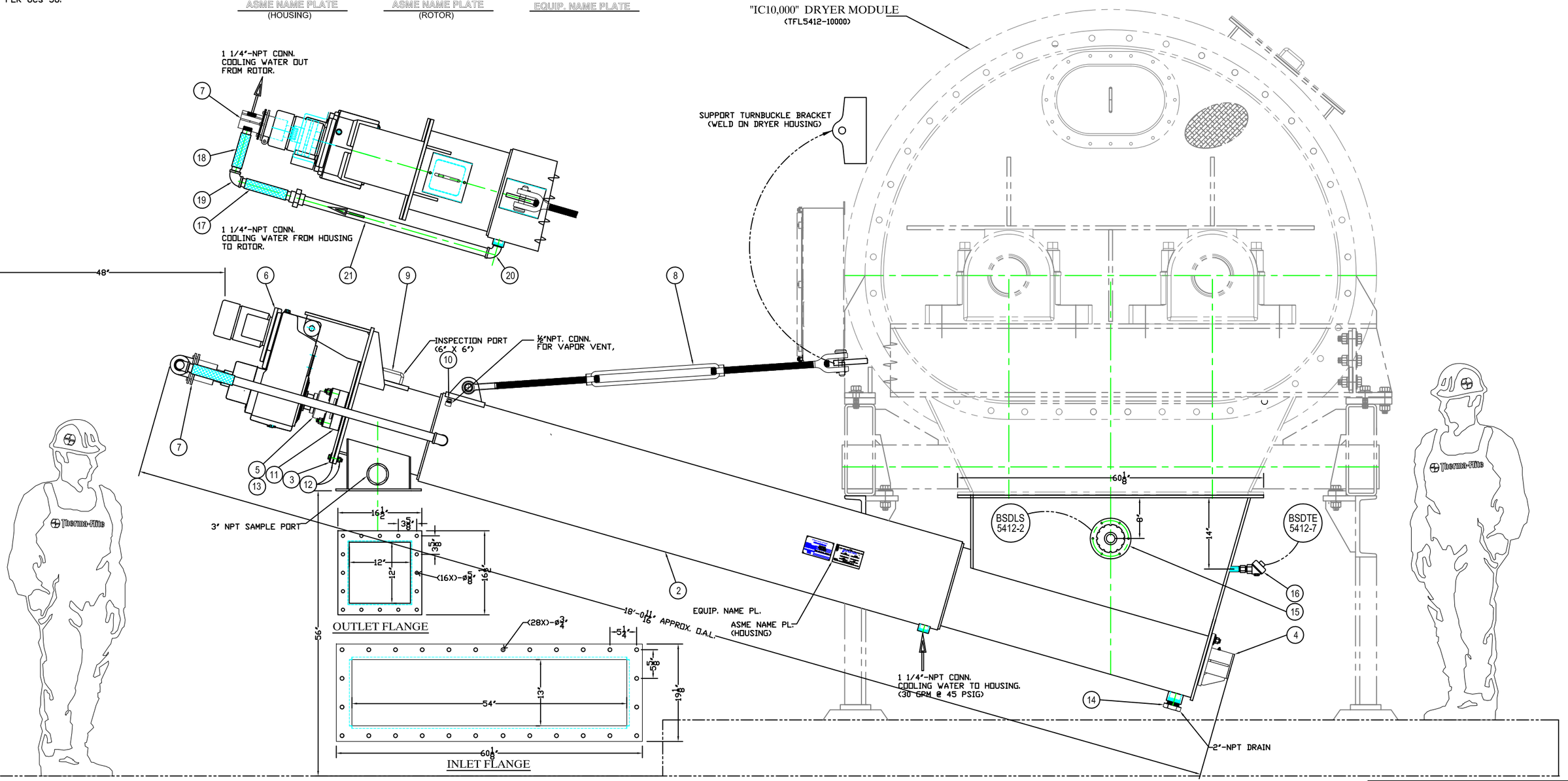
ASME NAME PLATE
(ROTOR)



EQUIP. NAME PLATE

	ITEM	QTY	DESCRIPTION	MATERIAL
	12	LOT	HARDWARE/GASKET LIST, (1/8"THK. "KLINGERSIL"-C4433)	--
	13	2	EXTERNAL RETAINING RING, -#5100-300,	C.S.
	14	1	2" NPT SQ. HEAD PLUG.	SA-105
	15	1	ROTARY PADDLE BIN SENSOR, "MONITOR TECHNOLOGIES"	--
	16	1	THERMOCOUPLE ASSEMBLY	--
	17	1	FLEX HOSE, 1 1/4" X 12"LG. CARBON STEEL W/GALV. STEEL	C.S.
			BRAID, NPT MALE ONE END, FEMALE UNIONON OTHER END.	
	18	1	FLEX HOSE, 1 1/4" X 10"LG. CARBON STEEL W/GALV. STEEL	C.S.
			BRAID, RIGID MALE ON BOTH END.	
	19	1	1 1/4"-90°-#150 PIPE ELBOW, FEMALE X MALE,	CS. GALV
	20	1	1 1/4"-90°-#150 PIPE ELBOW, FEMALE X FEMALE,	CS. GALV
	21	1	1 1/4"PIPE, SCH40(0.140"WALL) X 4'-0"LG. (CUT TO LENGTH)	SA-106-B

REF. DWG.	ITEM	QTY	DESCRIPTION	MATERIAL
	1	1	L.H. HOLLOW FLIGHT ROTOR, VARIABLE PITCH SOLID FLIGHT INLET SECTION,	SA-516-Gr70/SA-36-1
	2	1	JACKETED HOUSING W/ INTEGRAL DRIVE BASE.	SA-516-Gr-70/CS
	3	1	REMOVABLE END PLATE. (DRIVE END)	MILD STEEL
	4	1	BRONZE BUSHED BEARING ASSEMBLY.	--
	5	1	FLANGE BEARING, "DODGE"-TYPE E, SHAFT SIZE 3", PART-#023111, PART NAME-F4B-E-300R	--
	6	1	GEAR REDUCER, "NORD"-#SK 6382ASH-90L/4, 393.19 : 1 RATIO, 2 HP.	--
			4.5 RPM OUT, ø3.000" SHAFT, 230/460V-3PH-60HZ, M1 MOUNTING,	
			TB2 & CE1 POSITIONS.	
	7	1	ROTARY UNION, KADANT 4200RXB2, DUAL FLOW, 2" R.H. MALE NPT. CONN,	--
			M=1 1/4", P=1 1/4", S=1 1/4", WATER SERVICE P/N 12K41610	
	8	1	STRUCTRUAL SUPPORT.	MILD STEEL
	9	1	INSPECTION PORT COVER.	MILD STEEL
	10	1	1/2" NPT HEX HEAD PLUG.	SA-105
	11	1	SHAFT SEAL,"MARTIN" SUPER PACK SEAL, PART No: MSP6,	--
			SHAFT 3", E DIM.=6",	



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REVISIONS No.	MADE BY	CHECKED BY	DATE	DESCRIPTION
1	--		-- --	--

JOB No: TFL5412B
DRAWN BY: C.J.
CHECKED BY:
APPROVED BY:
DATE: 10/10/2010

GENERAL ARRANGEMENT DRAWING OF
COOLING SCREW
MODEL No: HSC 15-15-5
FOR
BOWLING GREEN MUNICIPAL UTILITIES

CUSTOMER: BGMU
P.O. No: S07-653

Therma-Flite
The Screw Heat Exchange Company
P.O.Box 847
849 Jackson Street,
Benicia, CA 94510
Telephone: (707) 747-5949
Fax: (707) 747-5951

SCALE: 1=10
DWG. No: TFL5412-Cooling Screw
REV: 0

Supplement #4

Therma-Flite
The Screw Heat Exchanger Company

P.O. Box 847
849 Jackson St.
Benicia, CA 94510
P (707) 747-5949
F (707) 747-5951
www.therma-flite.com

DOCUMENT TRANSMITTAL

Number: TFL5412-10

Date: July 12, 2010

Company: Bowling Green / BGMU

Attention: **Kristi Schnell, P.E.**

Project: TFL5412 IC10,000 “Bio-Scru”

Description	File Name	Sheet	Date	Rev.	Issued For
BIOREM Submittal Data Package to Therma-Flite, Inc.	Submittal-Therma-Flite 5.13.10.pdf	---	7-12-10	0	FI

Legend:

FA **For Approval**
FI **For Information**
FC **Certified for Construction**
AB **As Built**

Submitted By: *Robert D. Nickerson*

Robert D. Nickerson
Therma-Flite, Inc.

SUBMITTAL DATA PACKAGE

Therma-Flite
BIOREM Odor Control System
Model SK-450

100 Rawson Road, Suite 230
Victor, New York 14564
Toll Free: 877.299.2108
Ph: (585) 924-2220 Fax: (585) 924-8280
www.biorem.biz

Therma-Flite

Re: Therma-Flite – BIOREM SK-450 Odor Control System

Dear Customer:

This submittal contains information and detail regarding the proposed Biorem Odor Control System.

We certify that BIOREM Inc. has been involved in the manufacture of biofiltration systems for more than ten years. There are over 450 installations throughout the United States, Canada, Europe, Asia and South America.

For your convenience we have also included an abbreviated reference list of our customers. Please be aware that several of these utilities have purchased multiple biofilters over the last few years. In fact, the majority of our current sales are from repeat customers or referrals from existing customers. If you call any of our customers, please make sure to ask about our service after the sale and our commitment to continuous improvement.

We are dedicated to 100% customer satisfaction.

Please do not hesitate to call me if you have any questions or would like further information.

Sincerely,

Pete Trabert
BIOREM Environmental, Inc

Contact Information:

Biofilter Supplier

BIOREM Environmental, Inc. (www.biorem.biz)
100 Rawson Road Ste 230
Victor, NY 14564
Phone: (585) 924-2220
Fax: (585) 924-8280

Project Manager: Dan Mckague, Ext. 203 dmckague@biorem.biz
Operations Manager: Pete Trabert, Ext. 202 ptrabert@biorem.biz

Manufacturer's Agent

Therma-Flite, Inc
849 Jackson St
Benicia, CA 94510

Phone: 707-747-5949
Fax: 707-747-5051
Contact: Kevin Gibson

Contractor

Scope of Supply: BIOREM Odor Control System for SK-450

This document covers the furnishing and delivery of all materials, equipment, controls and related appurtenances necessary to install and place into successful operation the odor control biofiltration system (SK-450).

System Description:

A. The intent and purpose of the odor control system is to treat and effectively eliminate odors. The exhaust fan / blower located at the inlet end of the biofilter shall push the foul air through the system under a positive pressure for purpose of biological odor reduction.

B. The system shall be capable of continuously providing a treated exhaust air stream having a hydrogen sulfide (H_2S) concentration not greater than 1ppm at the rated capacity and/or a removal efficiency of greater than ninety-nine percent (99%) based on the design capacity.

Capacities and Performance:

The biofilter system shall be designed to remove odiferous constituents from a process air stream under the following operating conditions:

Table 1: Air Stream Characteristics

Process Parameter	Value	
Duty	Continuous	
Climate	Outdoors – Warm Climate	
Ambient Air Temperature	35 to 100ºF	
Total Air Volume	450 acfm	
Average Inlet Relative Humidity (RH)	Ambient	
Average Inlet Particulate Concentration	None	
Type of Contamination	Hydrogen Sulfide (H_2S)	Total Reduced Sulphurs (TRS)
Average Inlet Concentration	100 ppm	
Maximum Inlet Concentration	200 ppm	<3 ppm
% Removal Required	>99%	>90%

The Biofilter system shall conform to the following specified parameters:

Table 2: System Design Parameters

Design Parameter	Value
Model of Modular Biofilter Unit	SK-450
Number of Biofilter Modules	1
Number of media chambers	2
Media Qty chamber 1	~75 ft^3
Empty Bed Residence Time	10 seconds
Media Qty chamber 2	~60 ft^3
Empty Bed Residence Time	8.2 seconds
Total Footprint Dimensions (L:W)	10' L x 6' 4" W
Biofilter Dimensions	6' diameter : 95" high
Water Consumption (Humidification)	0.16 GPM (Continuous)
Water Supply Connection	½" Sch 80 PVC
Drain Piping Connection	1 1/2" Sch 80 PVC
Air Inlet / Outlet Connection Diameter	Inlet – 8" diameter – Flange Outlet – 12" diameter – Stack
Electrical Requirements	480V / 3 Phase / 60 Hz
Dry Weight of Biofilter Unit	~4,500 lbs
Operating Weight of Biofilter Unit	~6,500 lbs
Exhaust Fan	2 HP, 480V / 60Hz / 3 Phase

Supplied Components:

The biofilter odor control system shall include and is limited to the following components:

1. 1 – SK-450 HDPE Biotrickler/Biofilter, 2 stage filter system, skid mounted.
2. 1 – 316 Stainless Steel blower, 2 HP, 480V, 3 Phase
3. 1 – SS water control cabinet
4. 1 – SS Active Front Electrical Control Panel, 480V, 20 A, with VFD
5. Submittal
6. O & M Manual

Biofilter Manufacturer's Responsibility:

BIOREM Inc. (BIOREM) shall supply the essential biofilter system components, submittals and services. All components are in accordance with the specifications and include the following:

SK-450 BTF/BF Odor Control Module

The modular biofilter shall be formed assembling two HDPE tanks filled with poprietary media. Each tank shall consist of a media chamber with one designed as biotrickling filter and the other designed as a biofilter. Each process will be separate from the other to provide a two stage odor control solution. The unit shall be approximately six feet in diameter and 95 inches high, shall be capable of holding 135 cubic feet of medium, and weigh ~700 pounds empty. They shall be designed for flow rates of between 50 and 450 SCFM, and molded from High Density Polyethylene (HDPE). System will ship complete and require field installation on a poured concrete slab.

Centrifugal Fan

A. A Centrifugal pressure blower will provide the motive force to pull air from the air collection ducting and through the entire biofilter system. The blower has a rated capacity of 500 SCFM, draws a vacuum of 9.5 inches of water, and is powered by a 2 HP TEFC motor. The blower is constructed of 316 stainless steel. A 316 stainless steel impeller is provided for added corrosion resistance as well as complete epoxy coating.

B. Design - The blower shall be designed to meet the following criteria:

1. Number of fans - 1
2. Capacity at design conditions (SCFM) - 500
3. Static suction pressure (in. of water) - 9.5 IWG
4. Maximum inlet temperature (°F) - 180
5. Blower Speed, max. (RPM) - 3500
6. Motor size, min. (HP) - 2.0
7. Inlet size (in.) - 8”
8. Outlet size (in.) - 6”

Electrical Control Panel

A. All equipment used to control the biofiltration system shall be supplied by the biofiltration system Manufacturer to the Contractor. This is to keep continuity and single source responsibility for the entire system. The panel conforms to all applicable UL standards and carries the UL label.

B. Local Control Panel - A NEMA 4X, SS all-weather, electrical control panel shall be provided. The panel shall provide branch circuit protection and controls for the blower and recirculation pump. Alarms shall be provided for low flow fault conditions. A main disconnect and security lock out shall be included. The control voltage shall be 120 V, 1 phase electrically isolated through a grounded control transformer and 24 VDC. A dedicated ***480V, 20 A, 3 Ph*** feed is required. The local control panel shall meet the following minimum requirements:

1. The blower shall be provided with a hand/off/auto switch and green run light. The switch shall contain a spring loaded mechanism to prevent the switch from being left in the hand position. The panel shall be equipped with a variable frequency drive to control the blower.

2. The recirculation pump shall be provided with a pump hand/off/auto switch and green run light. A low water flow switch shall prevent the pump from operating under low water conditions. Under such a fault condition an amber warning light shall indicate the condition. An adjustable current sensing overload shall be provided to prevent damage to the pump motor in case of overloading conditions.

3. A terminal strip shall be provided near the bottom of the panel for all input and output connections. The terminal strip shall be clearly marked in accordance with the schematic.

Piping

All piping, pipe fittings, piping supports and other related supplies, except the piping within the unit shall be provided by the contractor/installer and installed in accordance with the Engineer's and Manufacturer's recommendations. Recommended water supply piping for the unit shall be a minimum 1/2", schedule 80 PVC. Drain piping shall be a minimum of 2" schedule 80 PVC.

Wiring

All wiring, conduit, junction boxes and other related supplies from the biofilter control panel to all biofilter accessories shall be provided by the Manufacturer and installed in accordance with the Manufacturer's recommendations. All wiring shall be in accordance with applicable electrical codes and other related local fire code requirements.

Installation

Installation of the Biofilter by the Contractor shall be in strict accordance with the respective Manufacturer's and Engineer's instructions and recommendations in the locations shown on the drawings. All costs for site evaluation and/or preparation, concrete slab, external utilities (water supply line and electric supply to biofilter control panel), installation of main drain line to wet well or any installation other than the biofilter and accessories supplied by the Biofilter manufacturer shall be borne by the Contractor.

Inspection, Start-up, and Operator Training

An authorized and trained representative from the Manufacturer shall be present to perform the required inspection, start-up, and operator training services for the system. The Owner or Contractor shall schedule this service with the Manufacturer or his designated representative and his intended system operators. The Owner or Contractor shall provide the Manufacturer a minimum of two weeks notice of intended start up, training and/or testing date.

Owner's / Contractor's Responsibility:

The following items are to be supplied and / or installed by the CONTRACTOR or others:

1) Installation and assembly of all equipment and instrumentation components provided by BIOREM and all other equipment required for a complete system including labor, equipment and materials. Equipment installation to include biofilter system and all associated instrumentation and components, where applicable.
2) Site preparation and clearing of materials.
3) Appropriately sized reinforced concrete slab for biofilter vessel and fan placement.
4) Supply and install all external water piping and drain piping to and from the biofilter vessel including heat tracing, insulation, piping supports and drainage trap where necessary.
5) Supply and install air ductwork to and from the biofilter system and exhaust fan including manual or actuated dampers, filters, insulation, and necessary supports.
6) All external water supply (minimum of 40psi) and drain piping to and from the biofilter.
7) Utility requirements including main electrical service and system field wiring outside the main biofilter control panel.

DIVIDER:

LAYOUT DRAWINGS

PROCESS AND INSTRUMENTATION DIAGRAM SET FOR

SK450

BIOREM

PROJECT NUMBER: XXXXF

VALVE/DAMPER & GATE SYMBOLS

NORMALLY CLOSED	NORMALLY OPEN	DESCRIPTION
		DIAPHRAGM
		BUTTERFLY
		GATE OR OTHER IN-LINE TYPE NOT OTHERWISE IDENTIFIED
		BALL
		PLUG OR ANGLE SEAT
		NEEDLE
		PINCH
K	K	KNIFE GATE
		GLOBE
		CHECK
		BACKFLOW PREVENTER
		INJECTION QUILL
		THREE WAY
		RUPTURE DISC (PRESSURE)
		RUPTURE DISC (VACCUUM)
		VACCUUM BREAKER
		PRESSURE REGULATOR
		BACK PRESSURE REGULATOR
		PRESSURE RELIEF MULTI FUNCTION VALVE
		FLOAT CONTROLLED
		Y STRAINER
		FOUR WAY

EQUIPMENT SYMBOLS

- COMPRESSOR PISTON
- REGENERATIVE BLOWER/FAN (R)
- AXIAL FLOW PUMP
- DESICCANT DRYER
- AIR DRYER
- METERING PUMP
- K-FACTOR =
- PADDLEWHEEL FLOWMETER
- FLOWMETER VORTEX OR MAGNETIC (TYPE INDICATED)
- INLINE STRAINER
- ROTAMETER (VARIABLE AREA FLOWMETERS)
- MEDIA OR PACKED BED
- PITOT TUBE
- LOBE BLOWER/FAN
- CENTRIFUGAL BLOWER/FAN
- SUBMERSIBLE PUMP
- CENTRIFUGAL PUMP
- POSITIVE DISPLACEMENT PUMP
- DIAPHRAGM PUMP
- FLUME
- ORIFICE PLATE IN QUICK CHANGE FITTING
- ORIFICE PLATE
- CALIBRATION COLUMN
- STATIC MIXER
- PULSATION DAMPENER
- SILENCER OR FILTER
- MUFFLER
- DIAPHRAGM SEAL
- CARTRIDGE FILTER
- VENT AND FILTER (F)
- MIXER
- FIXED SCREEN
- NOZZLE
- BACKDRAFT DAMPER
- HEAT EXCHANGER
- HEATER
- HEATING/COOLING COIL

LINE SYMBOLS & MISC

P&ID LINE TYPES

- PROCESS LINE
- EQUIPMENT/LINE SUPPLIED BY OTHERS
- BOUNDARY
- REVISED ITEM
- OPTIONAL/ADDER ITEM
- LOCAL PANEL

INSTRUMENTATION LINES

- I/P CONVERTER (ELECTRIC ANALOG TO PNEUMATIC SIGNAL CONVERTER)
- MECHANICAL LINK
- ULTRASONIC/ELECTROMAGNETIC
- INSTRUMENT CONNECTION
- ELECTRIC SIGNAL (ANALOG OR DIGITAL)
- SOFTWARE LINK
- CALCULATED VALUE
- PNEUMATIC LINE

- TERMINATION TAG
- PIPING SPOOL TAG
- REVISION TRIANGLE
- CONTINUATION SYMBOL
- THERMOWELL
- FLEXIBLE COUPLING
- FLEXIBLE HOSE
- VICTAULIC CONNECTION
- CAMLOCK CONNECTION
- FLANGED CONNECTION
- BLIND FLANGE
- REDUCER
- THREADED COUPLING
- CYLINDRICAL STRAINER
- FLOOR DRAIN

P&ID TIE – INS

EX.

SIGNAL
FROM
SIGNAL
F-D-003
FROM
SIGNAL
F-D-003
FROM

COMMON ABBREVIATIONS

OP	OPERATING POINT
SP	SET POINT
MCC	MOTOR CONTROL CENTER
HOA	HAND–OFF AUTO
LOR	LOCAL–OFF REMOTE
DI	DIGITAL INPUT
DO	DIGITAL OUTPUT
AI	ANALOG INPUT
AO	ANALOG OUTPUT

GENERAL INSTRUMENT FUNCTION SYMBOLS

	LOCATED ON SKID CONTROL PANEL	FIELD MOUNTED	AUXILIARY LOCATION, NORMALLY ACCESSIBLE TO OPERATOR
DISCRETE INSTRUMENTS			
HUMAN MACHINE INTERFACE HMI			
COMPUTER/DCS FUNCTION			
PROGRAMMABLE LOGIC CONTROL			

- HH H L LL — PLC ALARM FUNCTION WITH MULTIPLE TRIGGER POINTS SEE INSTRUMENT LETTERS
- INSTRUMENTS SHARING COMMON HOUSING
- PILOT LIGHT
- UNDEFINED INTERLOCK LOGIC
- PLC–X — SYSTEMS WITH MULTIPLE PLC'S
- Σ SUMMING
- Σ/n AVERAGING
- < LOW SELECTING
- > HIGH SELECTING
- f(x) UNSPECIFIED FUNCTION

VALVE & GATE ACTUATOR SYMBOLS

NOTE: ON LOSS OF PRIMARY POWER (PNEUMATIC, ELECTRICAL OR HYDRAULIC)
XX: FC = FAIL CLOSED, FO = FAIL OPEN, FL = FAIL TO LAST POSITION
IF NOT SPECIFIED ASSUME FC.

- PNEUMATIC DIAPHRAGM
- DOUBLE ACTING PNEUMATIC CYLINDER (INST.AIR LINES NOT ALWAYS SHOWN)
- SPRING CLOSE PNEUMATIC CYLINDER (INST.AIR LINES NOT ALWAYS SHOWN)
- SPRING OPEN PNEUMATIC CYLINDER (INST.AIR LINES NOT ALWAYS SHOWN)
- SOLENOID
- TS TRAVEL STOP
- VALVE POSITIONER
- ELECTRIC MOTOR (ANALOG – CONTROL)
- ELECTRIC MOTOR (DIGITAL– OPEN/CLOSED)
- ELECTRIC MOTOR (DIGITAL– OPEN DIGITAL – CLOSE)
- HAND WHEEL
- HAND LEVER

LINE DESIGNATION

(SIZE,SCHEDULE,MATERIAL)

SIZE (x"), SCHEDULE, MATERIAL

EX. 4", SCH.80, PVC

MOST COMMON MATERIAL'S

SCH.80, PVC	SCH.40, C.S.
SCH.80, CPVC	P.E. TUBING
SCH.10, 316L SS	SS TUBING
SCH.40, 316L SS	NYLON TUBING
SCH.10, 304L SS	FRP DUCT
SCH.40, 304L SS	316LSS DUCT

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REV	DATE	DESCRIPTION	BY

REVISIONS

CUSTOMER:

TITLE: ISA SYMBOLOGY

JOB #:

SCALE:

SIZE: B

DRAWING NUMBER: SH:1of 1

REV:

MECHANICAL OR INSTRUMENT DEVICE TAG IDENTIFICATION PREFIX

AV	AIR VENT	NZ	NOZZLE
AC	AIR COMPRESSOR	P	PUMP
AE/AIT	ANALYSIS ELEMENT WITH ANALYSIS INDICATING TRANSMITTER	PE/PIT	PRESSURE ELEMENT WITH PRESSURE INDICATING TRANSMITTER
AE/AT	ANALYSIS ELEMENT WITH ANALYSIS TRANSMITTER	PE/PT	PRESSURE ELEMENT WITH PRESSURE TRANSMITTER
B	BLOWER	PI	PRESSURE INDICATOR
BF	BIOFILTER	PRV	PRESSURE REGULATING VALVE
BPV	BACK PRESSURE VALVE	PS*	PRESSURE SWITCH
BTF	BIOTRICKLING FILTER	PSV	PRESSURE RELIEF VALVE
CV	CHECK VALVE/INJECTION QUILL	SCR	SCREEN
DR	AIR DRIER	SG	SIGHT GLASS
EF	EXHAUST FAN	STR	STRAINER
FCV	FLOW CONTROL VALVE	SV	SAMPLE VALVE
FE/FIT	FLOW ELEMENT WITH FLOW INDICATING TRANSMITTER	TE/TIT	TEMPERATURE ELEMENT WITH TEMPERATURE INDICATING TRANSMITTER
FE/FQI	FLOW ELEMENT WITH FLOW INDICATING TOTALIZER	TE/TT	TEMPERATURE ELEMENT WITH TEMPERATURE TRANSMITTER
FE/FT	FLOW ELEMENT WITH FLOW TRANSMITTER	TI	TEMPERATURE INDICATOR
FI	FLOW INDICATOR	TK	TANK
FV	AUTOMATIC VALVE	TS*	TEMPERATURE SWITCH
H	HEATER	YY	SOLENOID FOR PNEUMATIC CONTROL OF AUTOMATIC VALVE
HC	HEATING COIL		
HCV	HAND CONTROL VALVE		
HV	HAND VALVE		
LCV	LEVEL CONTROL VALVE		
LE/LIT	LEVEL ELEMENT WITH LEVEL INDICATING TRANSMITTER		
LE/LT	LEVEL ELEMENT WITH LEVEL TRANSMITTER		
LG	LEVEL SIGHT GLASS		
LS*	LEVEL SWITCH		
ME	MIST ELIMINATOR		
MD	MEDIA		
MFV	MULTI FUNCTION VALVE (COMBINATION RELIEF & BACKPRESSURE VALVE FOR METERING PUMPS)		
MX	MIXER		

* ADD THE SUFFIX HH (HIGH HIGH), H (HIGH), L (LOW), LL (LOW LOW) AS REQUIRED FOR THESE ITEMS.

* ADD THE SUFFIX HH (HIGH HIGH), H (HIGH), L (LOW), LL (LOW LOW) AS REQUIRED FOR THESE ITEMS.

ISA TEXT ABBREVIATIONS

	MEASURED OR INDICATING VARIABLE	MODIFIER	READOUT OR PASSIVE FUNCTION	OUTPUT FUNCTION	MODIFIER
A	ANALYSIS		ALARM		
B	BURNER, COMBUSTION		USERS CHOICE	USERS CHOICE	USERS CHOICE
C	USERS CHOICE			CONTROL	
D	USERS CHOICE	DIFFERENTIAL			
E	VOLTAGE		SENSOR (PRIMARY ELEMENT)		
F	FLOW RATE	RATIO (FRACTION)			
G	USERS CHOICE		GLASS, VIEWING DEVICE		
H	HAND				HIGH
I	CURRENT (ELECTRICAL)		INDICATE		
J	POWER	SCAN			
K	TIME, TIME SCHEDULE	TIME RATE OF CHANGE		CONTROL STATION	
L	LEVEL		LIGHT		LOW
M	USERS CHOICE	MOMENTARY			MIDDLE, INTERMEDIATE
N	LOG REMOVAL		USERS CHOICE	USERS CHOICE	USERS CHOICE
O	USERS CHOICE		ORIFICE, RESTRICTION		
P	PRESSURE, VACUUM		POINT (TEST) CONNECTION		
Q	QUANTITY	INTEGRATE, TOTALISE			
R	RADIATION		RECORD		
S	SPEED, FREQUENCY	SAFETY		SWITCH	
T	TEMPERATURE			TRANSMIT	
U	MULTIVARIABLE		MULTIFUNCTION	MULTIFUNCTION	MULTIFUNCTION
V	VIBRATION, MECHANICAL ANALYSIS			VALVE, DAMPER, LOUVER	
W	WEIGHT, FORCE		WELL		
X	UNCLASSIFIED	X AXIS	AVERAGE	UNCLASSIFIED	UNCLASSIFIED
Y	EVENT, STATE OR PRESENT	Y AXIS		RELAY, COMPUTE, CONVERT	
Z	POSITION, DIMENSION	Z AXIS		DRIVER, ACTUATOR, UNCLASSIFIED FINAL CONTROL ELEMENT	

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SCALE:

CUSTOMER:

TITLE: ISA SYMBOLOGY IDENTIFIERS

JOB #:

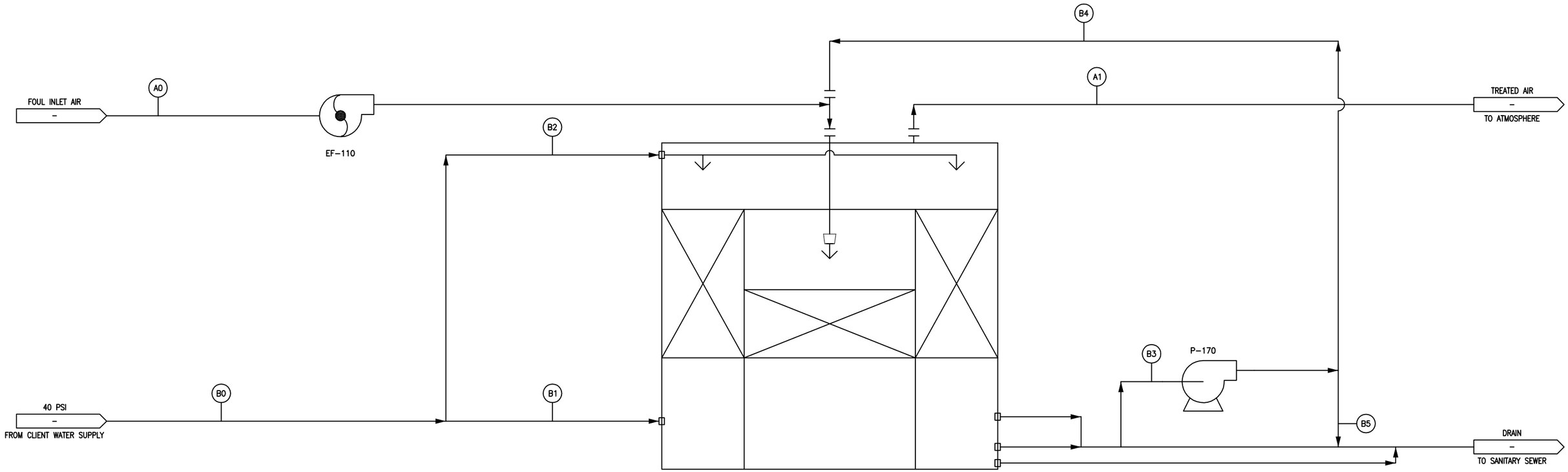
SIZE: B

DRAWING NUMBER: SH:1of 1

REV:

SK450 Process-Flow Table

STREAM	FLOW	RH	H2S	TRS	TEMP	Ph
A0	450 CFM	≥50%	100 PPM (AVG) 200 PPM (PEAK)	2.5-3 PPM	50-100°F	-
A1	450 CFM	100%	≤100 PPB	-	50-100°F	-
B0	458.5 GPD	-	-	-	50-100°F	5-8
B1	447 GPD	-	-	-	50-100°F	5-8
B2	11.5 GPD	-	-	-	50-100°F	5-8
B3	11.5 GPM	-	-	-	50-100°F	1-3
B4	11.1 GPM	-	-	-	50-100°F	1-3
B5	0.3 GPM	-	-	-	50-100°F	1-3



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01	21/01/10	ADDITION OF PG 5, NUTRIENT ADDITION	BAD
00	03/11/009	FOR REVIEW AND APPROVAL	BAD

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ANGLES ±1.0°

SCALE: N/A

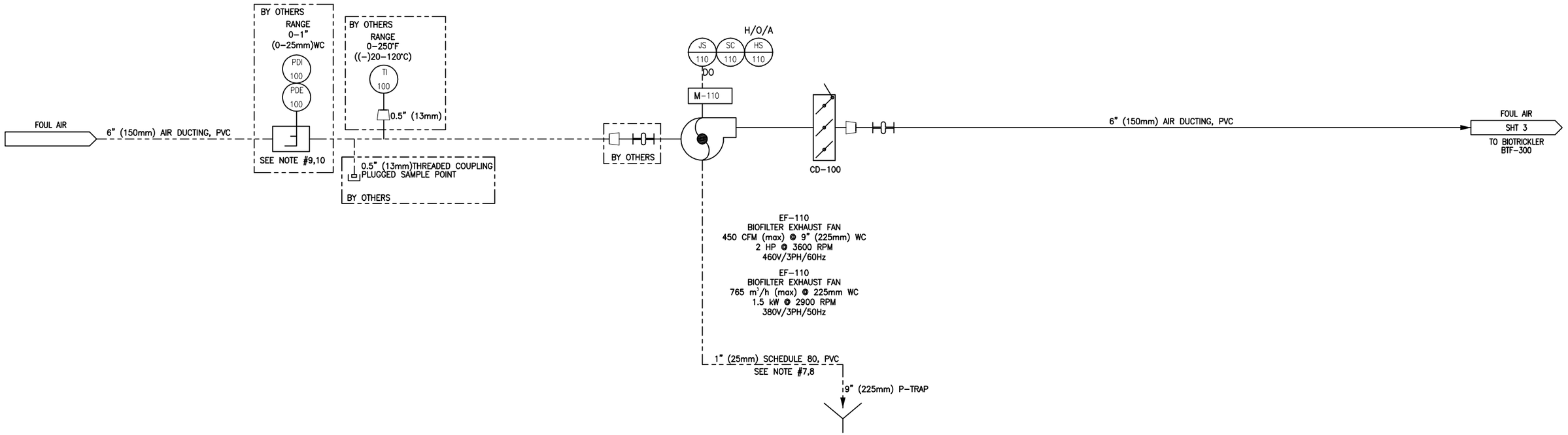
CUSTOMER:

TITLE: SK450 PROCESS FLOW DIAGRAM

JOB #: XXXXF

SIZE: B | DRAWING NUMBER: SK450-D-000 SH:1of 5 | REV: 01

NOTES:
1. ALL DOTTED PIPES, DUCTS, FLEXIBLE CONNECTORS AND EQUIPMENT BY OTHERS.
2. ALL EXPOSED WATER LINES TO BE HEAT TRACED AND INSULATED OR PAINTED FOR UV PROTECTION AS SPECIFIED.
3. ELECTRICAL WIRING BETWEEN INSTRUMENTATION AND BIOFILTER CONTROL PANEL TO BE SUPPLIED AND INSTALLED BY OTHERS.
4. ALL ELECTRICAL COMPONENTS LOCATED WITHIN 3 FEET OF THE ODOR CONTROL SYSTEM SHALL BE RATED FOR N.E.C. CLASS 1, DIVISION 2, GROUP D AREAS.
5. ALL PIPING AND AIR DUCTING SUPPORTS ARE SUPPLIED AND INSTALLED BY OTHERS.
6. INSTALLATION TO BE COMPLETED BY OTHERS.
7. LENGTH OF PIPE RUN FOR DRAIN FROM SOURCE NOT TO EXCEED 12 FEET PRIOR TO DISCHARGE INTO LARGER DRAIN LINE OR FLOOR DRAIN.
8. DRAIN LINES WITH (1–1/2 X FAN DISCHARGE PRESSURE)" P–TRAP PROVIDED BY OTHERS.
9. PITOT TUBE TO HAVE 8 ½ X DUCT DIA. UPSTREAM OF STRAIGHT DUCT, & 1 ½ X DUCT DIA. DOWSTREAM OF STRAIGHT DUCT.
10. PDI SHALL BE SUPPLIED WITH PRE–ASSEMBLED DRIP LEGS, TO BE INSTALLED BY OTHERS.
11. ALL PIPE TO BE SCH 80 PVC.



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2 PLACE DEC. ±.030
3 PLACE DEC. ±.010
ANGLES ±1.0°

SCALE: N/A

CUSTOMER:

TITLE: SK450
EXHAUST FAN & ASSOC. EQUIPMENT

JOB #: XXXXF

SIZE: B | DRAWING NUMBER: SK450–D–000 SH:2of 5 | REV: 01

NOTES:
1. ALL DOTTED PIPES, DUCTS, FLEXIBLE CONNECTORS AND EQUIPMENT BY OTHERS.
2. ALL EXPOSED WATER LINES TO BE HEAT TRACED AND INSULATED OR PAINTED FOR UV PROTECTION AS SPECIFIED.
3. ELECTRICAL WIRING BETWEEN INSTRUMENTATION AND BIOFILTER CONTROL PANEL TO BE SUPPLIED AND INSTALLED BY OTHERS.
4. ALL ELECTRICAL COMPONENTS LOCATED WITHIN 3 FEET OF THE ODOR CONTROL SYSTEM SHALL BE RATED FOR N.E.C. CLASS 1, DIVISION 2, GROUP D AREAS.
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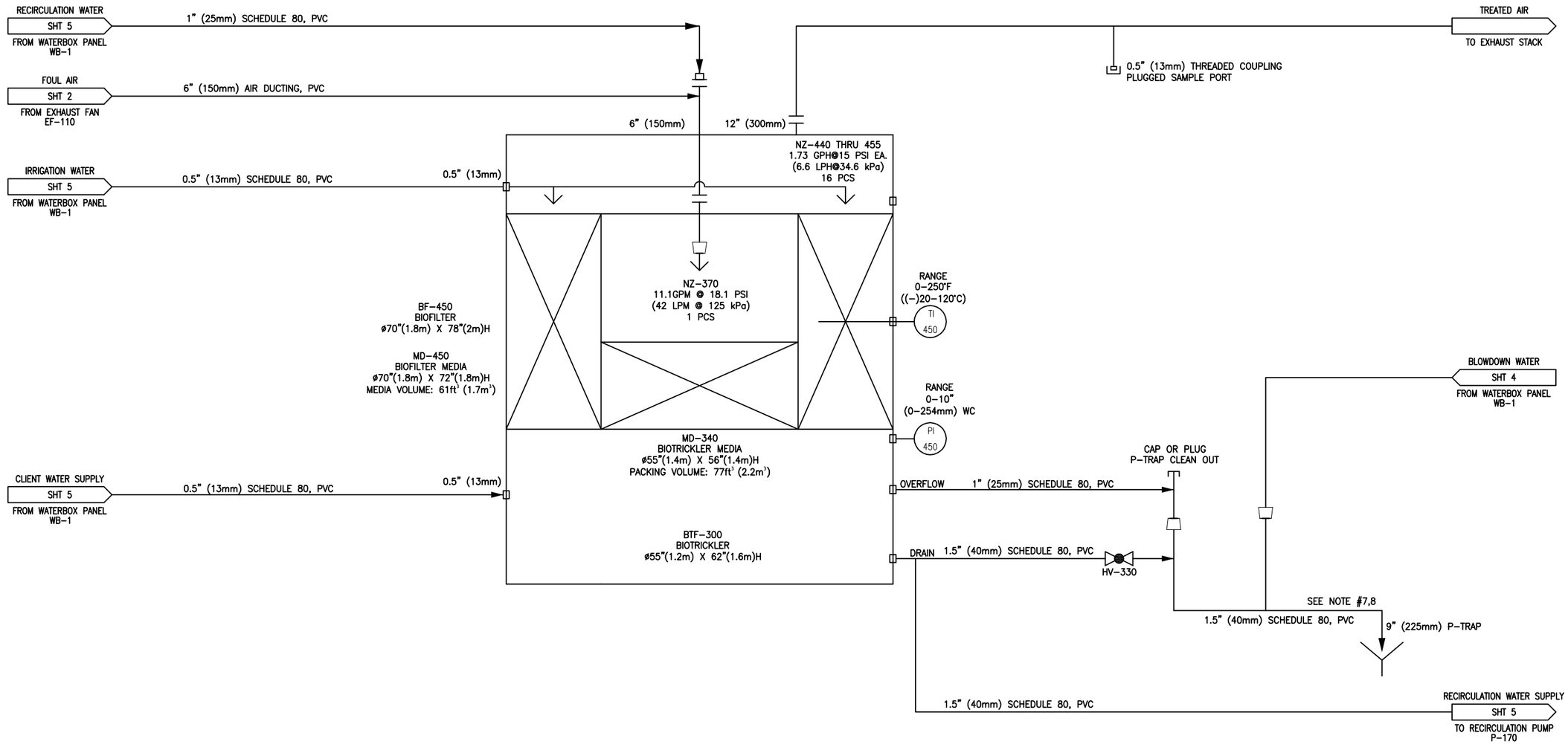
6. INSTALLATION TO BE COMPLETED BY OTHERS.
7. LENGTH OF PIPE RUN FOR DRAIN FROM SOURCE NOT TO EXCEED 12 FEET PRIOR TO DISCHARGE INTO LARGER DRAIN LINE OR FLOOR DRAIN.
8. DRAIN LINES WITH (1-1/2 X FAN DISCHARGE PRESSURE)" P-TRAP PROVIDED BY OTHERS.
9. PITOT TUBE TO HAVE 8 ½ X DUCT DIA. UPSTREAM OF STRAIGHT DUCT, & 1 ½ X DUCT DIA. DOWSTREAM OF STRAIGHT DUCT.
10. PDI SHALL BE SUPPLIED WITH PRE-ASSEMBLED DRIP LEGS, TO BE INSTALLED BY OTHERS.
11. ALL PIPE TO BE SCH 80 PVC.



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3 PLACE DEC. ±.010
ANGLES ±1.0°

SCALE: N/A

CUSTOMER:

TITLE: SK450
MEDIA FILTER & ASSOC. EQUIPMENT

JOB #: XXXXF

SIZE: B | DRAWING NUMBER: SK450-D-000 SH:3of 5 | REV: 01

NOTES:
1. ALL DOTTED PIPES, DUCTS, FLEXIBLE CONNECTORS AND EQUIPMENT BY OTHERS.
2. ALL EXPOSED WATER LINES TO BE HEAT TRACED AND INSULATED OR PAINTED FOR UV PROTECTION AS SPECIFIED.
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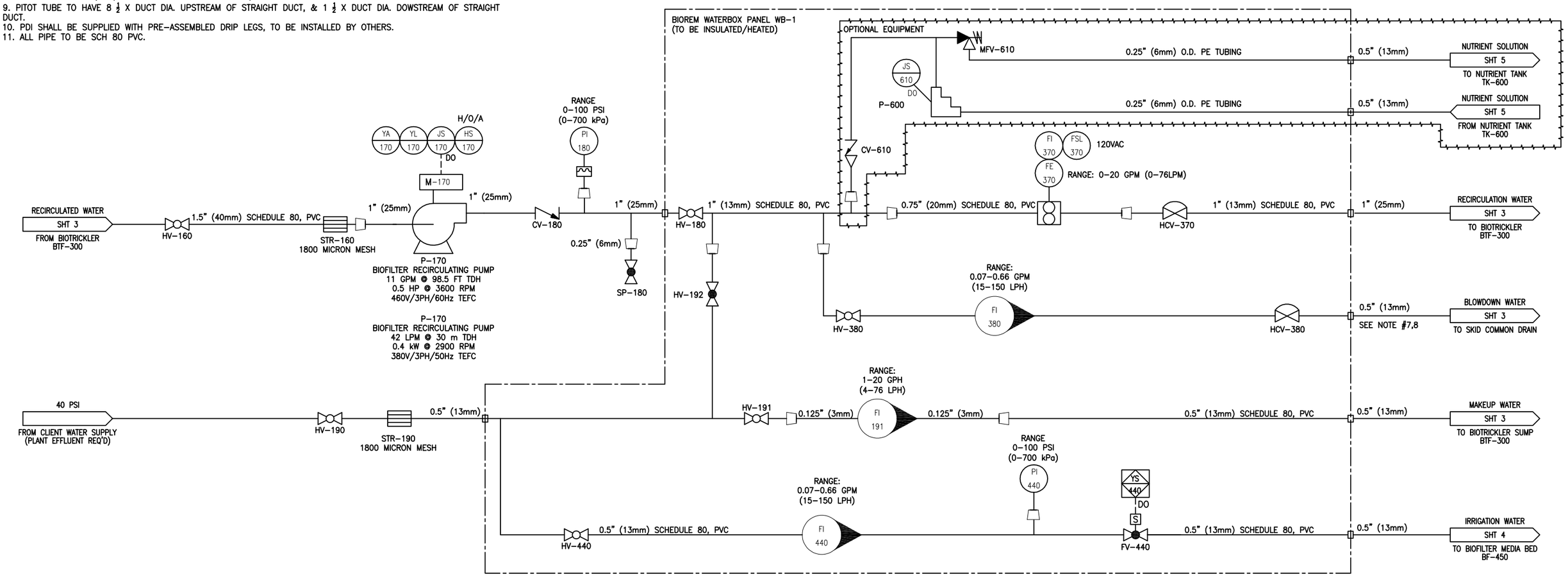

REV	DATE	DESCRIPTION	BY
01	21/01/10	ADDITION OF PG 5, NUTRIENT ADDITION	BAD
00	03/11/09	FOR REVIEW AND APPROVAL	BAD

REVISIONS

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APPROVAL	NAME	DATE (DD/MM/YY)
DRAWN BY:	B.DERYCK	03/11/09
DESIGNED BY:	B.DERYCK	03/11/09
CHECKED BY:		
APPROVED BY:		

UNLESS OTHERWISE SPECIFIED:
1. DIMENSIONS ARE IN INCHES
2. TOLERANCES:
FRACTIONS ± 1/32
2 PLACE DEC. ±.030
3 PLACE DEC. ±.010
ANGLES ±1.0°

SCALE: N/A

CUSTOMER:

TITLE: SK450 WATER BOX & ASSOC. EQUIPMENT

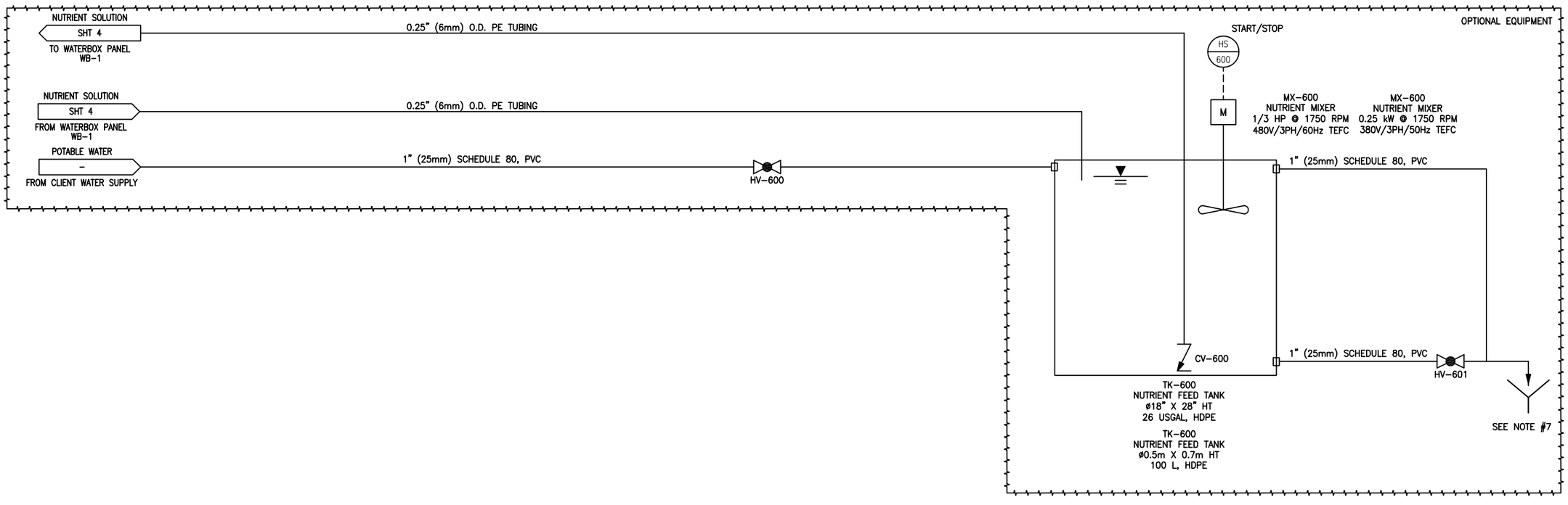
JOB #: XXXXF

SIZE: B

DRAWING NUMBER: SK450–D–000 SH:4of 5

REV: 01

NOTES:
1. ALL DOTTED PIPES, DUCTS, FLEXIBLE CONNECTORS AND EQUIPMENT BY OTHERS.
2. ALL EXPOSED WATER LINES TO BE HEAT TRACED AND INSULATED OR PAINTED FOR UV PROTECTION AS SPECIFIED.
3. ELECTRICAL WIRING BETWEEN INSTRUMENTATION AND BIOFILTER CONTROL PANEL TO BE SUPPLIED AND INSTALLED BY OTHERS.
4. ALL ELECTRICAL COMPONENTS LOCATED WITHIN 3 FEET OF THE ODOR CONTROL SYSTEM SHALL BE RATED FOR N.E.C. CLASS 1, DIVISION 2, GROUP D AREAS.
5. ALL PIPING AND AIR DUCTING SUPPORTS ARE SUPPLIED AND INSTALLED BY OTHERS.
6. INSTALLATION TO BE COMPLETED BY OTHERS.
7. LENGTH OF PIPE RUN FOR DRAIN FROM SOURCE NOT TO EXCEED 12 FEET PRIOR TO DISCHARGE INTO LARGER DRAIN LINE OR FLOOR DRAIN.
8. DRAIN LINES WITH (1–1/2 X FAN DISCHARGE PRESSURE)" P–TRAP PROVIDED BY OTHERS.
9. PITOT TUBE TO HAVE 8 ½ X DUCT DIA. UPSTREAM OF STRAIGHT DUCT, & 1 ½ X DUCT DIA. DOWSTREAM OF STRAIGHT DUCT.
10. PDI SHALL BE SUPPLIED WITH PRE–ASSEMBLED DRIP LEGS, TO BE INSTALLED BY OTHERS.
11. ALL PIPE TO BE SCH 80 PVC.



REV	DATE	DESCRIPTION	BY
01	21/01/10	ADDITION OF PG 5, NUTRIENT ADDITION	BAD
00	03/11/09	FOR REVIEW AND APPROVAL	BAD

REVISIONS

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APPROVAL	NAME	DATE (DD/MM/YY)
DRAWN BY:	B.DERYCK	03/11/09
DESIGNED BY:	B.DERYCK	03/11/09
CHECKED BY:		
APPROVED BY:		

UNLESS OTHERWISE SPECIFIED:
1. DIMENSIONS ARE IN INCHES
2. TOLERANCES:
FRACTIONS ± 1/32
2 PLACE DEC. ±.030
3 PLACE DEC. ±.010
ANGLES ±1.0°

SCALE: N/A

CUSTOMER:

TITLE: SK450
NUTRIENT ADDITION & ASSOC. EQUIPMENT

JOB #: XXXXF

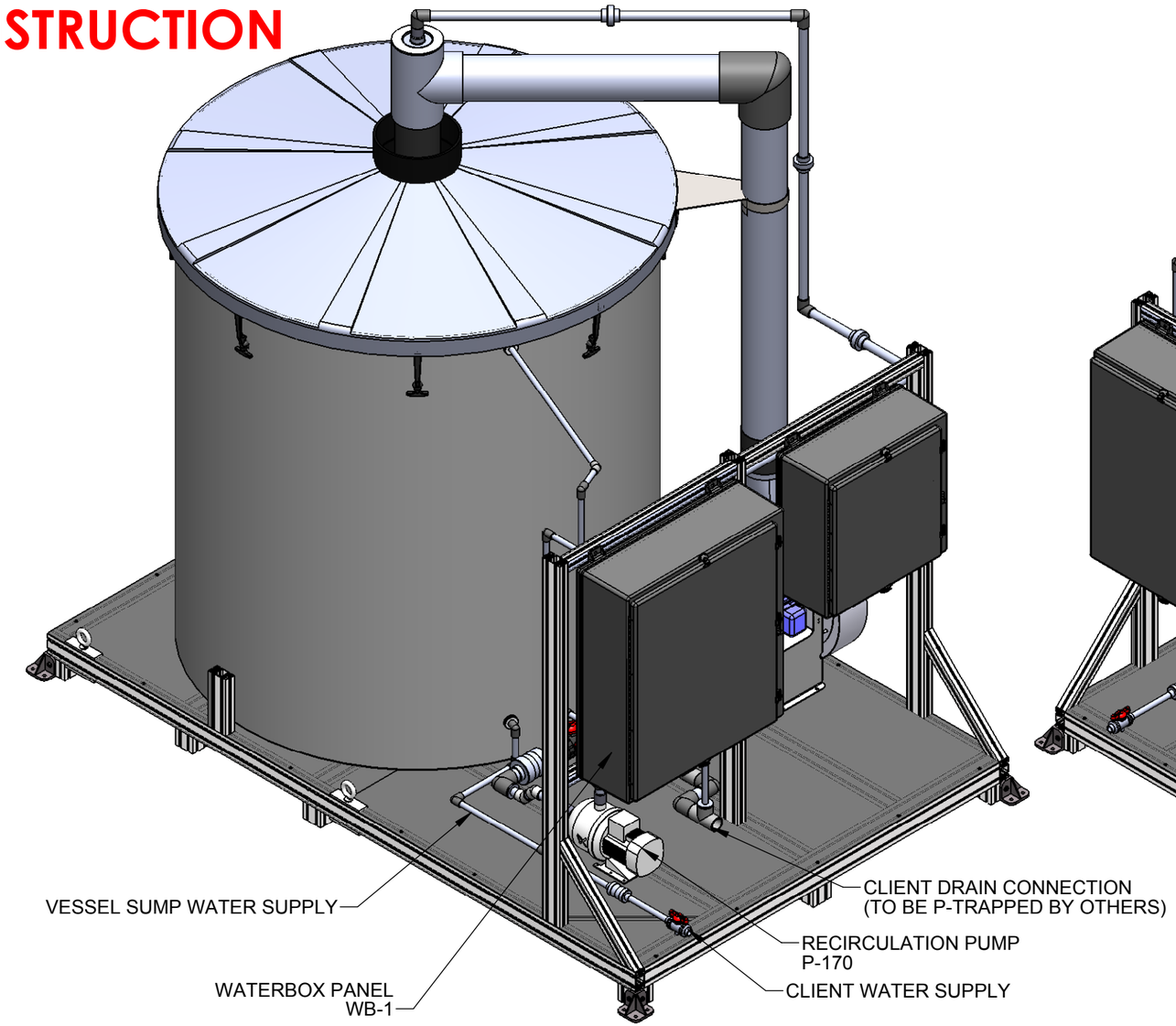
SIZE: B

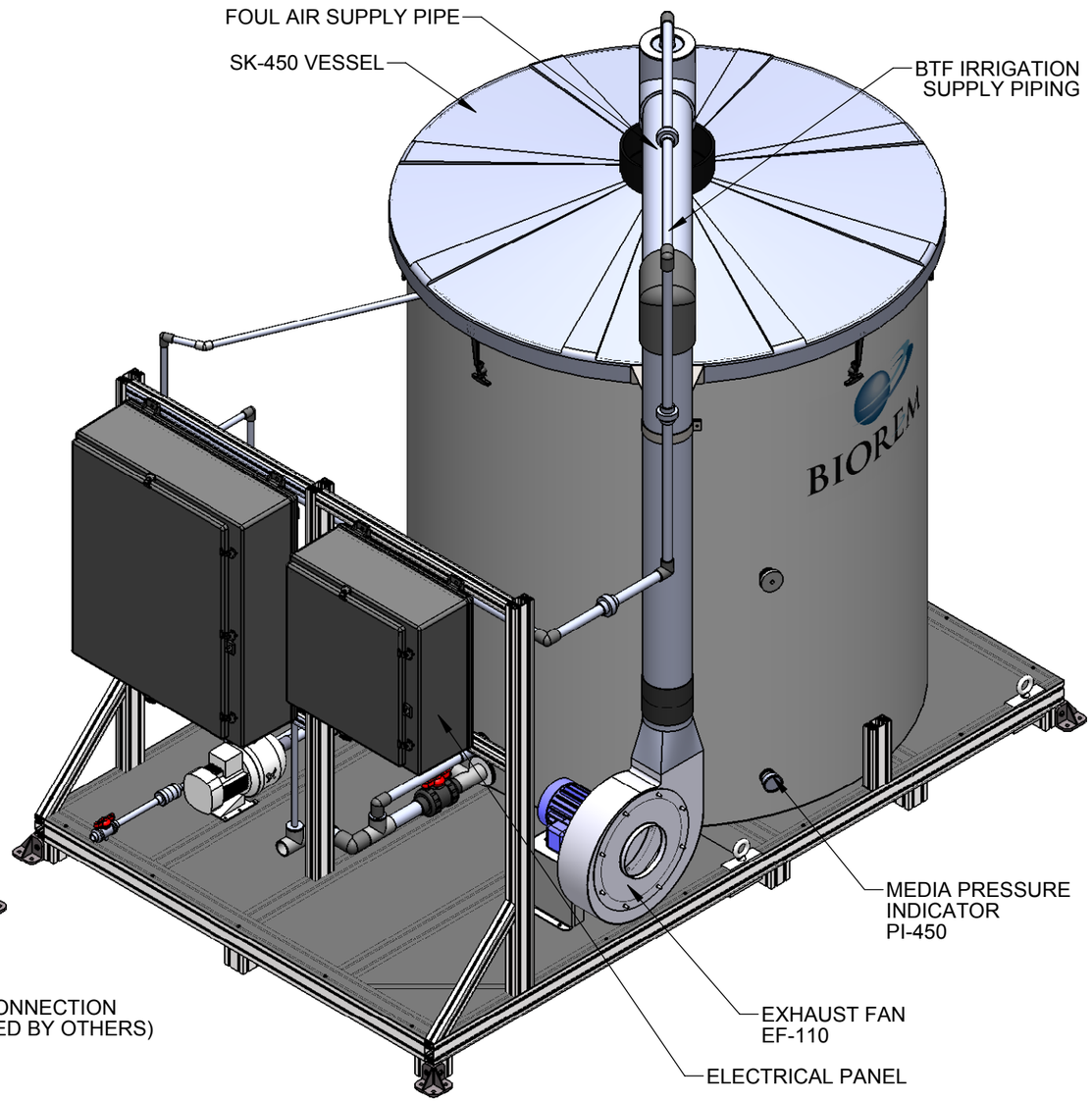
DRAWING NUMBER: SK450–D–000 SH:5of 5

REV: 01

PRELIMINARY
NOT FOR CONSTRUCTION

REVISIONS			
REV.	DATE	DESCRIPTION	BY
00	12/11/2009	FOR REVIEW AND APPROVAL	BAD





This design drawing has been prepared as part of a design/build proposal submission for the sole purpose of communicating design intent and is not to be used for any other purpose including but not limited to construction, permitting or pricing. Unique features of the design remain the intellectual property of Biorem Technologies Inc.

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APPROVAL	NAME	DD/MM/YY
DRAWN BY:	B.D.	12/11/09
DESIGNED BY:	B.D.	12/11/09
CHECKED BY:		12/11/09
APPROVED BY:		12/11/09

UNLESS OTHERWISE SPECIFIED

1. DIMENSIONS IN INCHES
2. TOLERANCES:
   FRACTIONS ± 1/32
   2 PLACE DEC. ±.030
   3 PLACE DEC. ±.010
   ANGLES ±1.0°

CLIENT: SK-450

TITLE: SK-450 GENERAL ARRANGEMENT

PROJECT: XXXXF

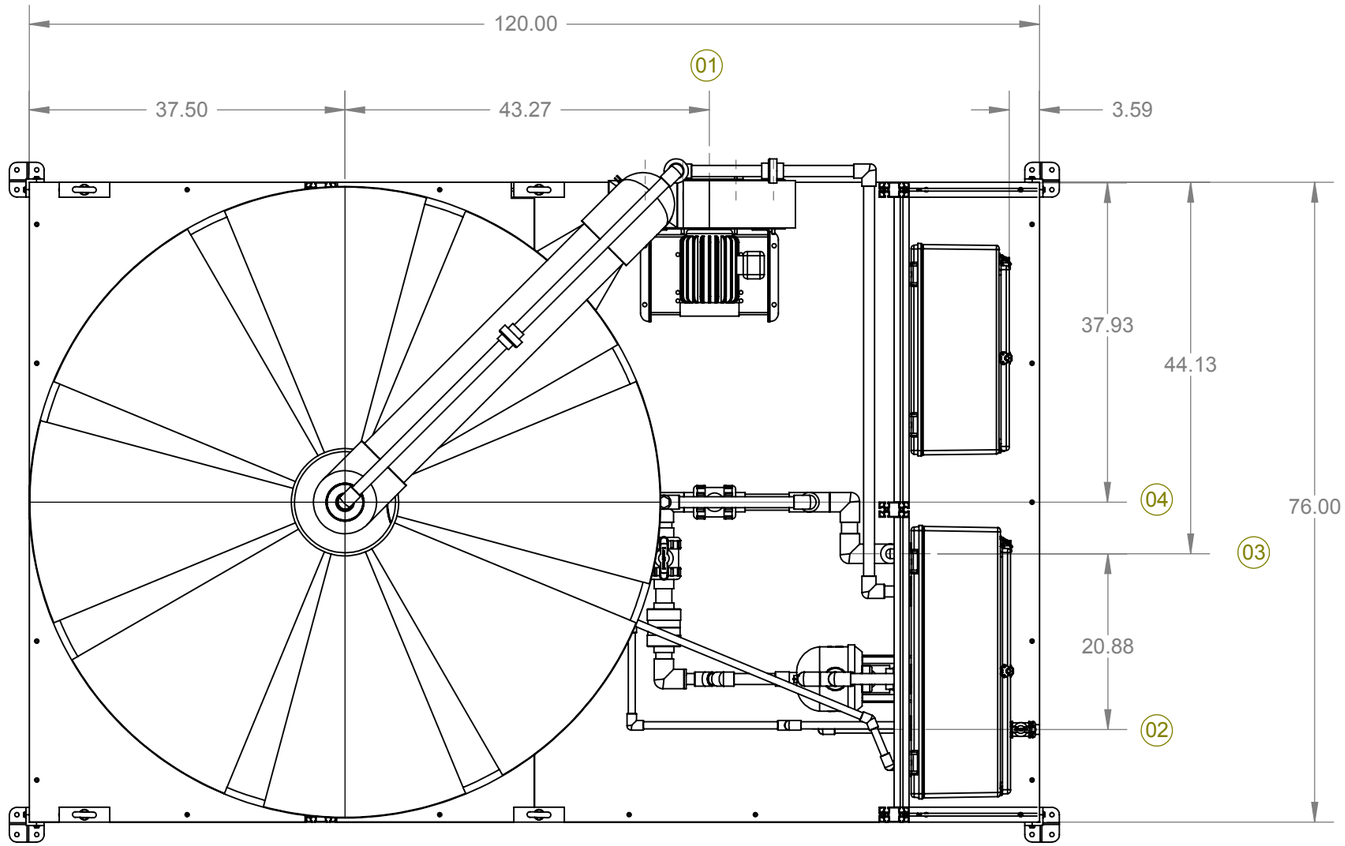
SCALE: 1:20

SIZE: B

DRAWING NUMBER: SK450-GA-000

SHT 1 OF 7

REV: 00



T.P.	SIZE	TYPE	DESCRIPTION
01	8"	FLG	FAN INLET
02	0.5"	SOC	CLIENT WATER SUPPLY
03	1.5"	SOC	TO CLIENT DRAIN
04	12"	N/A	VESSEL EXHAUST

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APPROVED BY:		12/11/09

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   2 PLACE DEC. ±.030
   3 PLACE DEC. ±.010
   ANGLES ±1.0°

CLIENT: SK-450

TITLE: SK-450 GENERAL ARRANGEMENT

PROJECT: XXXXF

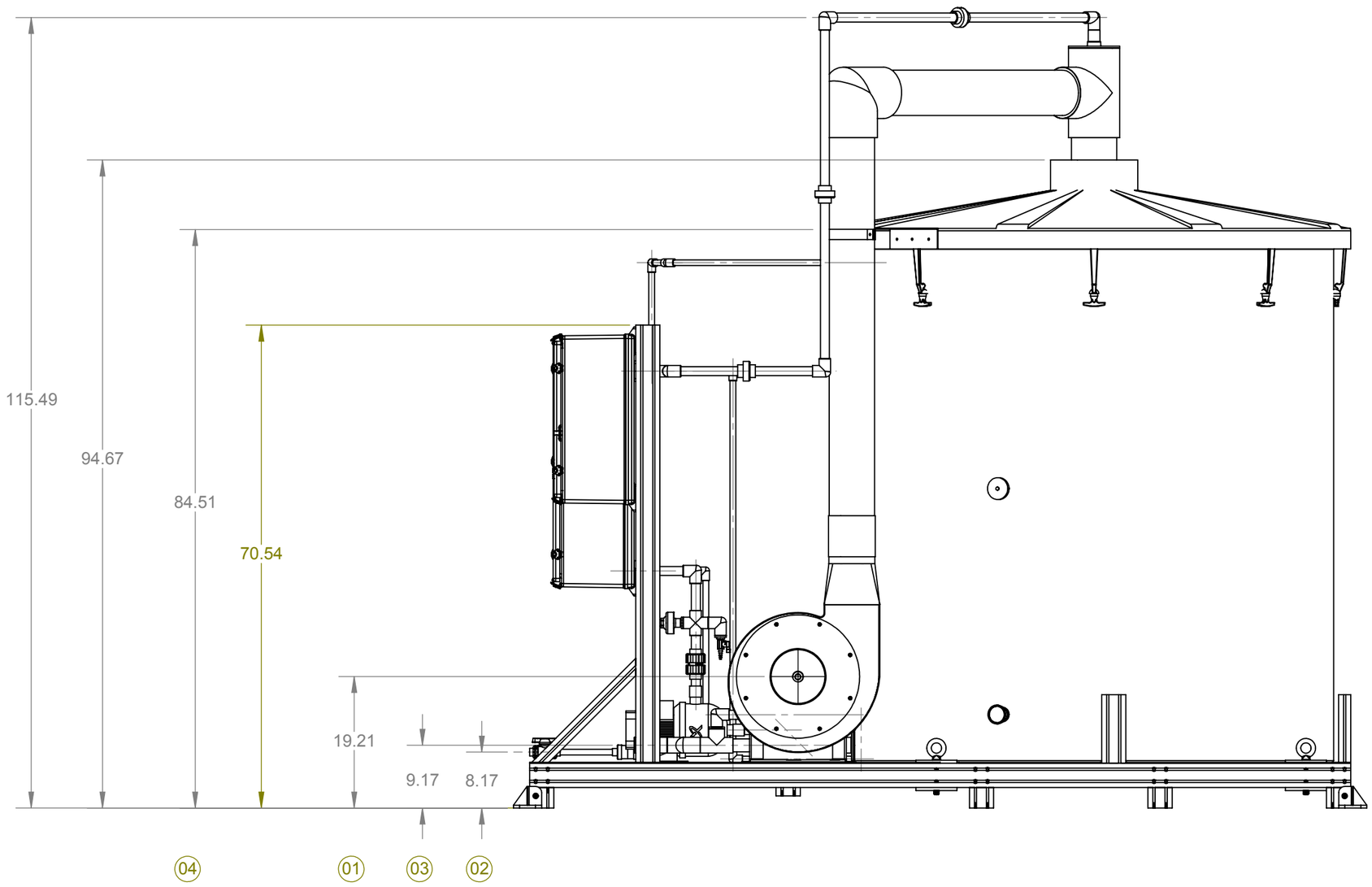
SCALE: 1:18

SIZE: B

DRAWING NUMBER: SK450-GA-000

SHT 2 OF 7

REV: 00



T.P.	SIZE	TYPE	DESCRIPTION
01	8"	FLG	FAN INLET
02	0.5"	SOC	CLIENT WATER SUPPLY
03	1.5"	SOC	TO CLIENT DRAIN
04	12"	N/A	VESSEL EXHAUST

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CHECKED BY:		12/11/09
APPROVED BY:		12/11/09

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   2 PLACE DEC. ±.030
   3 PLACE DEC. ±.010
   ANGLES ±1.0°

CLIENT: SK-450

TITLE: SK-450 GENERAL ARRANGEMENT

PROJECT: XXXXF

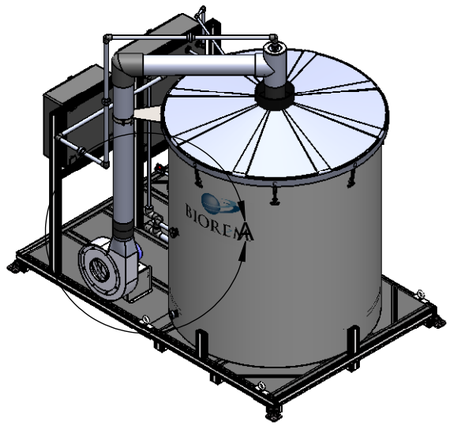
SCALE: 1:18

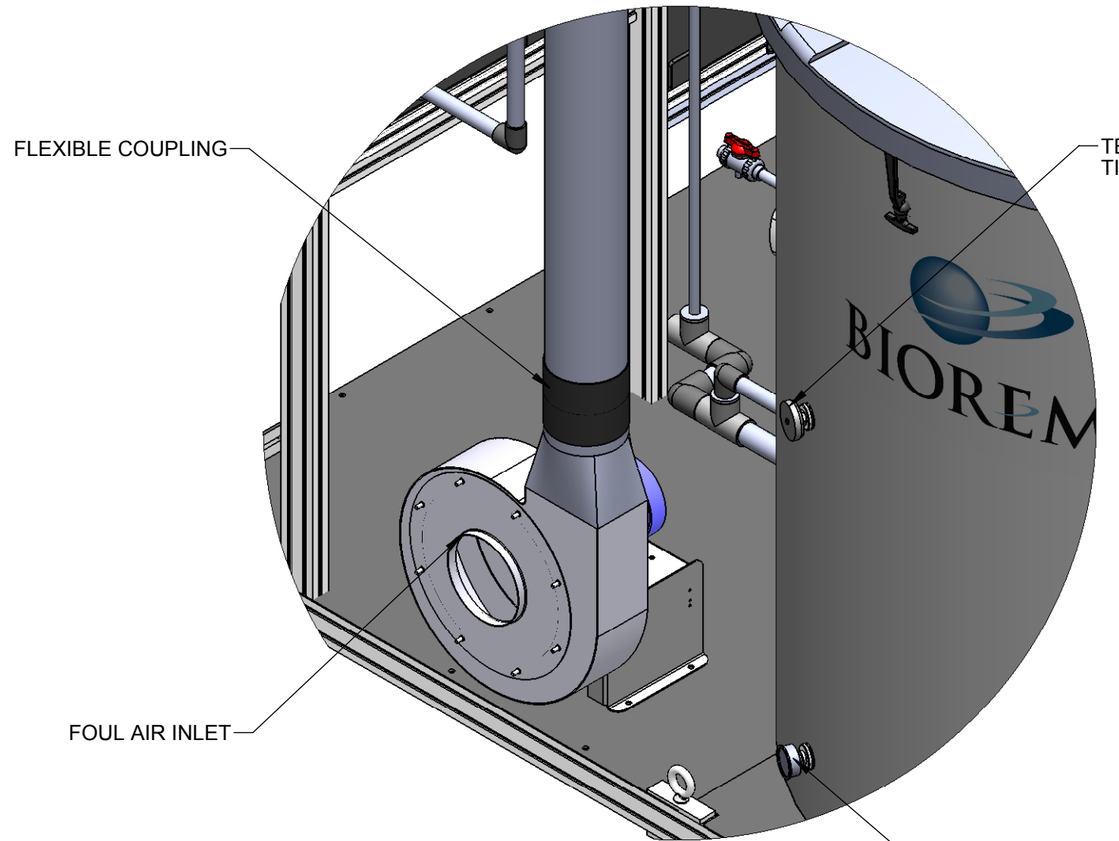
SIZE: B

DRAWING NUMBER: SK450-GA-000

SHT 3 OF 7

REV: 00





DETAIL A
SCALE 1 : 12

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DESIGNED BY:	B.D.	12/11/09
CHECKED BY:		12/11/09
APPROVED BY:		12/11/09

UNLESS OTHERWISE SPECIFIED

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2. TOLERANCES:
   FRACTIONS ± 1/32
   2 PLACE DEC. ±.030
   3 PLACE DEC. ±.010
   ANGLES ±1.0°

CLIENT: SK-450

TITLE: SK-450 GENERAL ARRANGEMENT

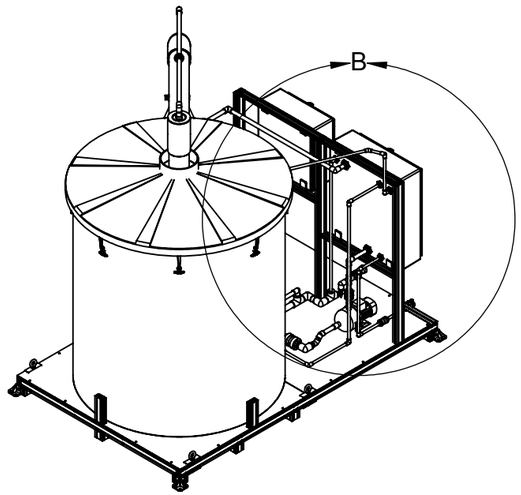
PROJECT: XXXXF

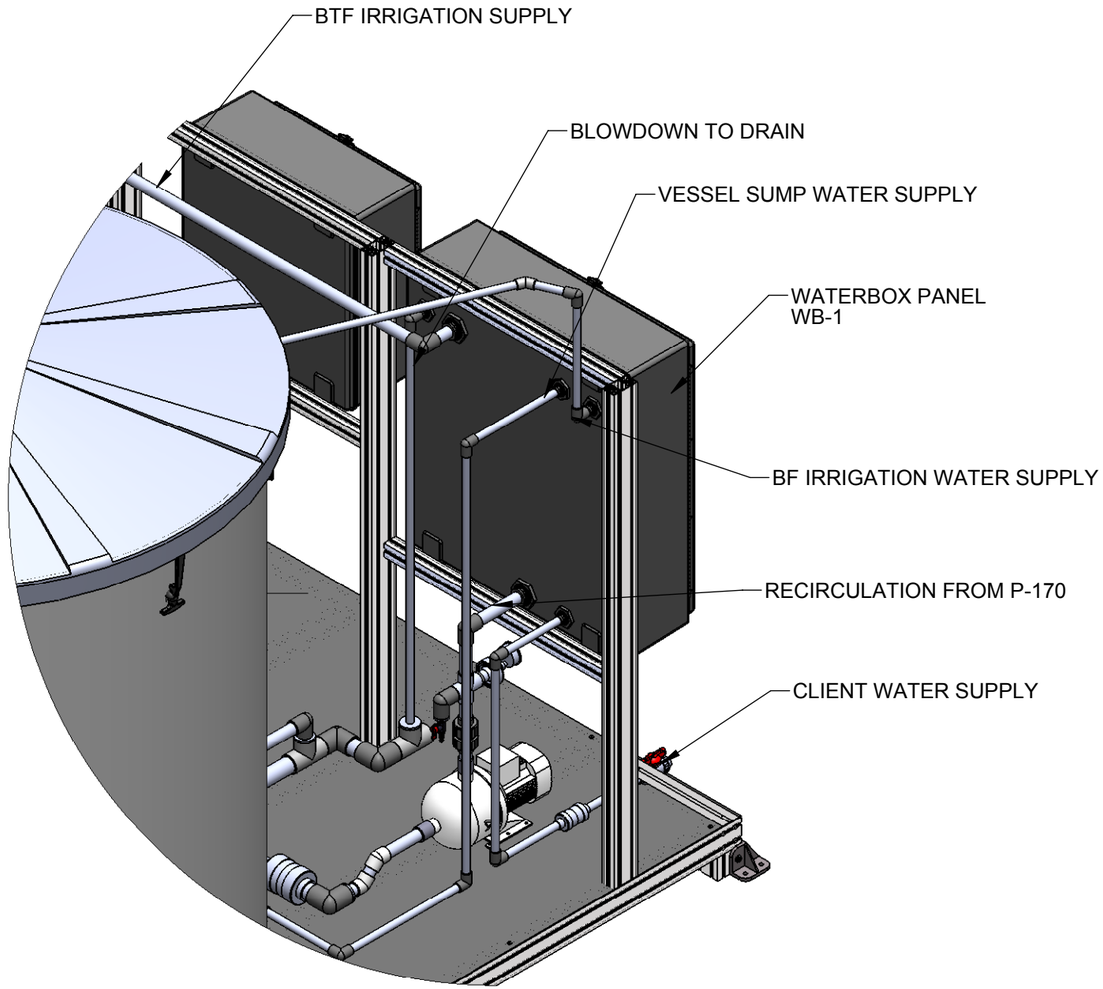
SCALE: 1:50

SIZE: B

DRAWING NUMBER: SK450-GA-000

REV: 00





DETAIL B
SCALE 1 : 16

BIOREM

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APPROVAL	NAME	DD/MM/YY
DRAWN BY:	B.D.	12/11/09
DESIGNED BY:	B.D.	12/11/09
CHECKED BY:		12/11/09
APPROVED BY:		12/11/09

UNLESS OTHERWISE SPECIFIED

1. DIMENSIONS IN INCHES
2. TOLERANCES:
   FRACTIONS ± 1/32
   2 PLACE DEC. ±.030
   3 PLACE DEC. ±.010
   ANGLES ±1.0°

CLIENT: SK-450

TITLE: SK-450 GENERAL ARRANGEMENT

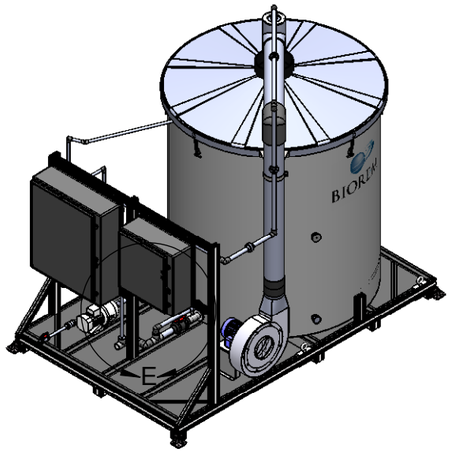
PROJECT: XXXXF

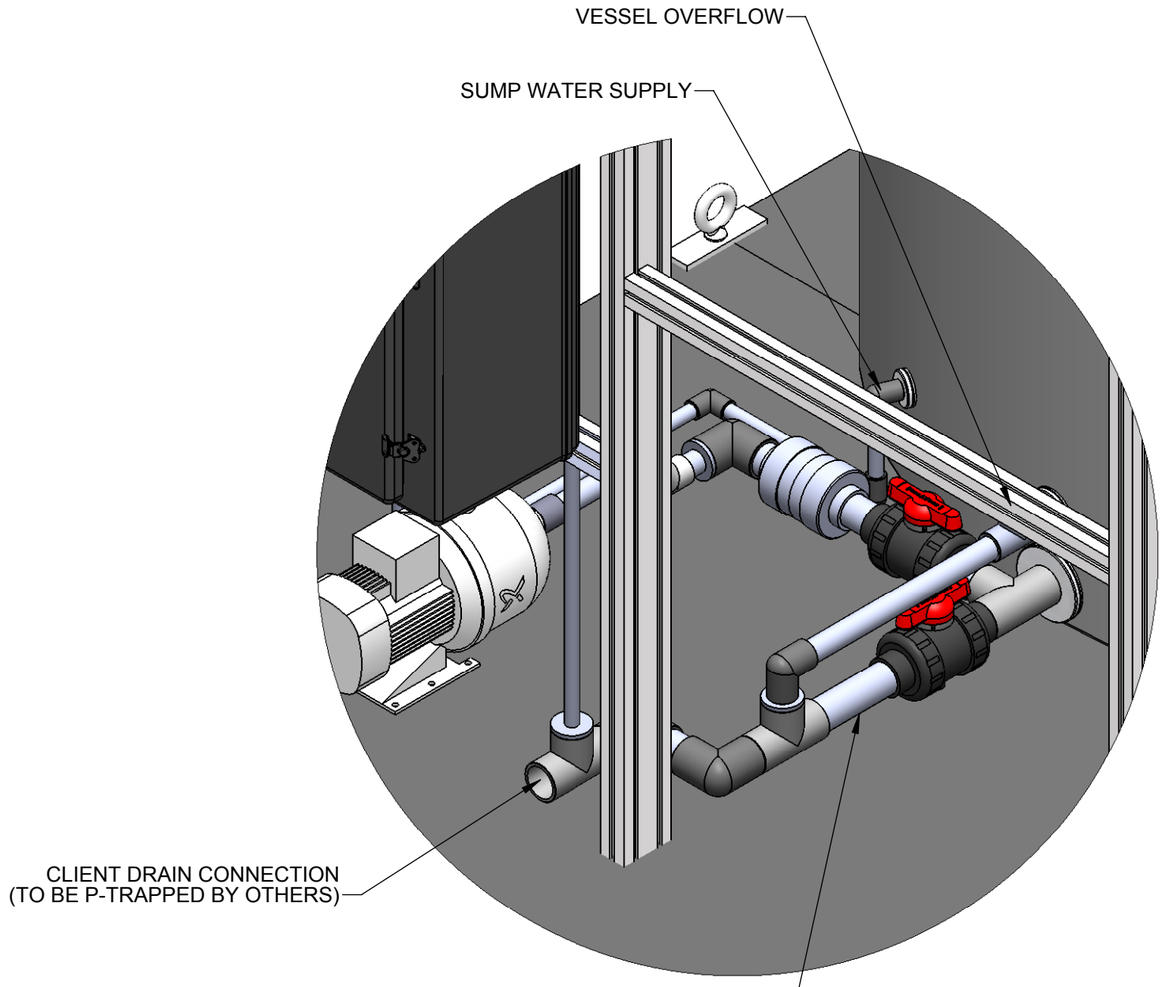
SCALE: 1:50

SIZE: B

DRAWING NUMBER: SK450-GA-000

REV: 00





DETAIL E
SCALE 1 : 8

BIOREM

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APPROVAL	NAME	DD/MM/YY
DRAWN BY:	B.D.	12/11/09
DESIGNED BY:	B.D.	12/11/09
CHECKED BY:		12/11/09
APPROVED BY:		12/11/09

UNLESS OTHERWISE SPECIFIED

1. DIMENSIONS IN INCHES
2. TOLERANCES:
   FRACTIONS ± 1/32
   2 PLACE DEC. ±.030
   3 PLACE DEC. ±.010
   ANGLES ±1.0°

CLIENT: SK-450

TITLE: SK-450 GENERAL ARRANGEMENT

PROJECT: XXXXF

SCALE:	SIZE:	DRAWING NUMBER:	REV:
1:50	B	SK450-GA-000 SHT 7 OF 7	00

DIVIDER:

ELECTRICAL

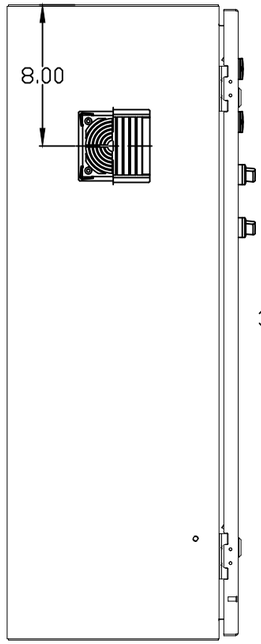
WARNING
DISCONNECT POWER
BEFORE ENTERING

CAUTION
VOLTAGE SUPPLIED FROM OTHER SOURCES
DISCONNECT POWER BEFORE ENTERING

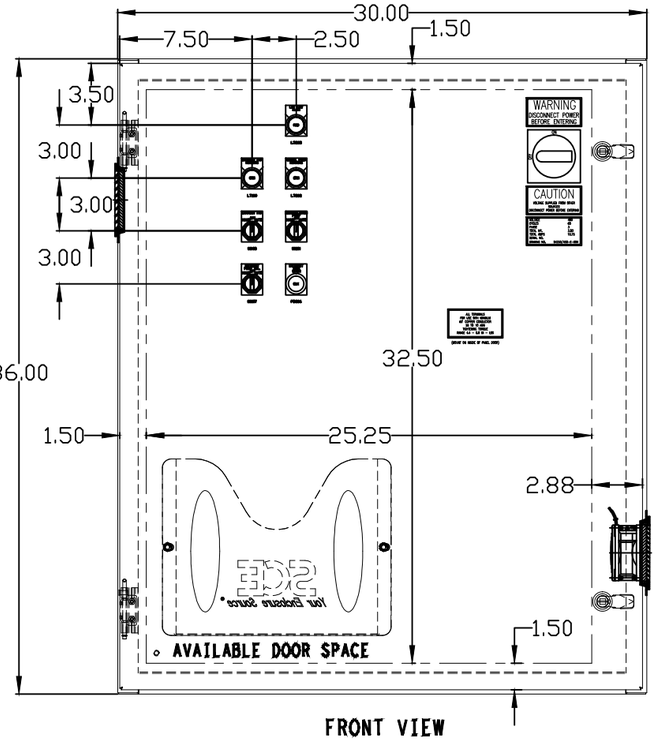
VOLTAGE	460
CYCLES	60
PHASE	3
TOTAL HP.	2.83
TOTAL AMPS	10.75
SERIAL NO.	
DRAWING NO.	SK250/450-E-00X

ALL TERMINALS
FOR USE WITH MINIMUM
60° COPPER CONDUCTOR
26 TO 10 AWG
TIGHTENING TORQUE
RANGE 4.4 – 8.8 IN – LBS

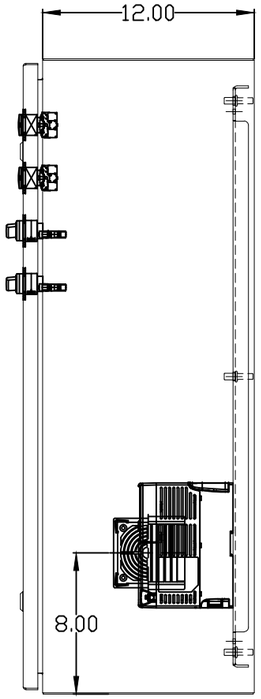
(MOUNT ON INSIDE OF PANEL DOOR)



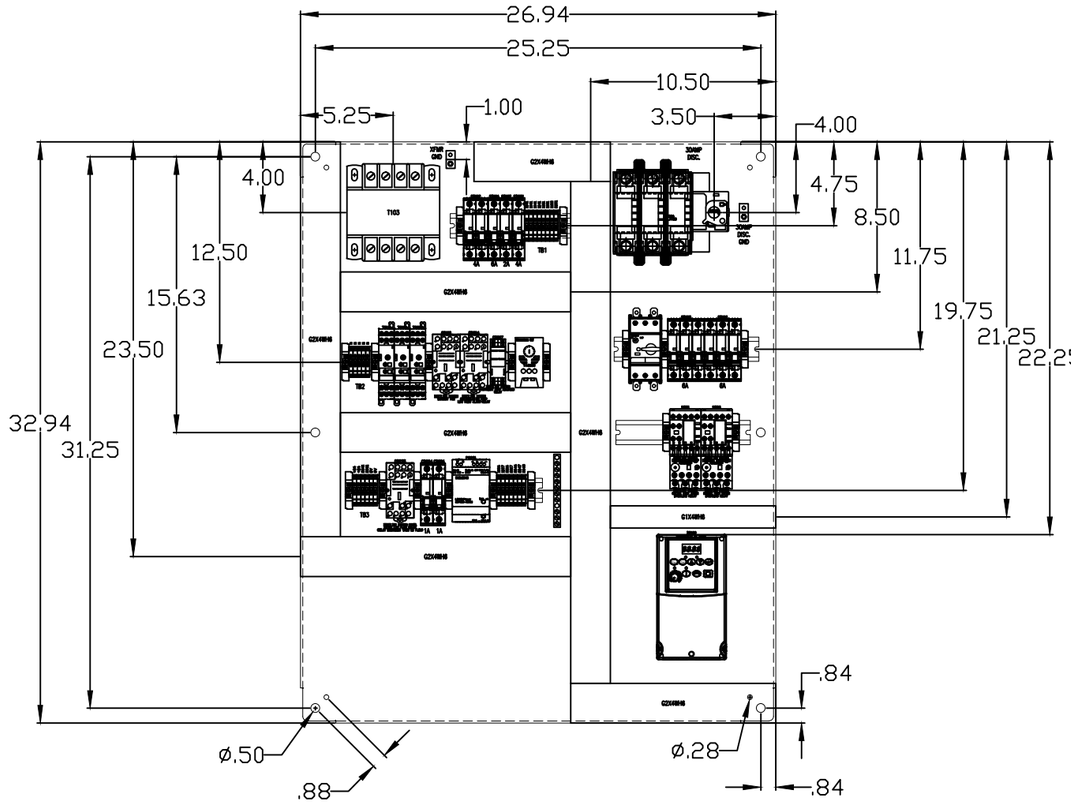
LEFT SIDE VIEW

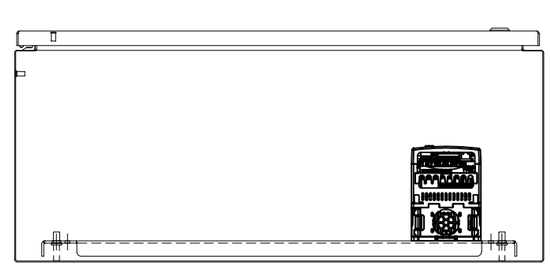


FRONT VIEW

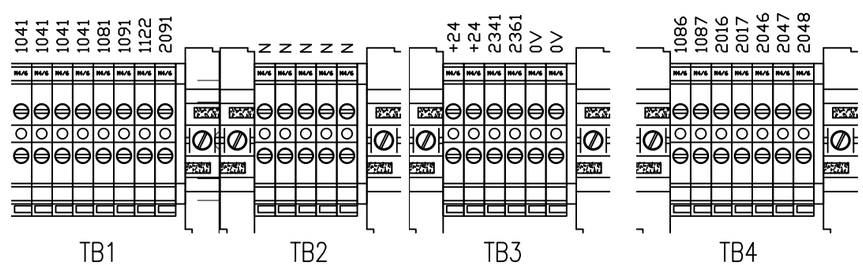


RIGHT SIDE VIEW





BOTTOM VIEW



REV	DATE	DESCRIPTION
A	09JUL09	ISSUED FOR APPROVAL

REVISIONS

IDT REF:
CAD REF:

BIOREM TECHNOLOGIES INC.

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APPROVAL	NAME	DATE (DD/MM/YY)
DRAWN BY:	M.H.	09JUL09
DESIGNED BY:	M.H.	09JUL09
CHECKED BY:		
APPROVED BY:		

UNLESS OTHERWISE SPECIFIED:
1. DIMENSIONS ARE IN INCHES
2. TOLERANCES
FRACTIONS ± 1/32
1 PLACE DEC. ± .030
2 PLACE DEC. ± .010
ANGLES ± 1°

SCALE: N.T.S.

CUSTOMER: SK-450 THERMA-FLITE

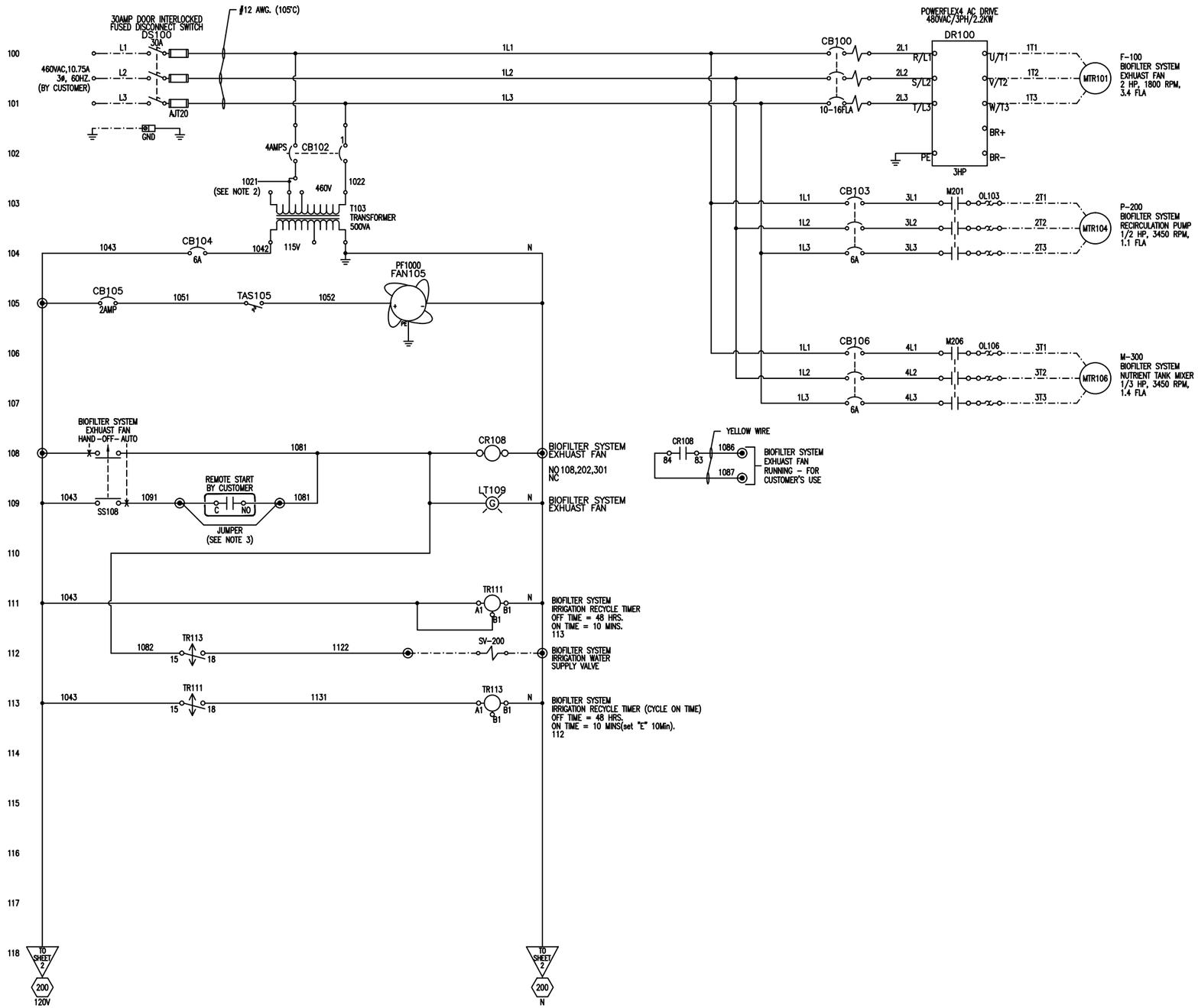
TITLE: U500 ODOUR CONTROL SYSTEM CONTROL PANEL LAYOUT DIAGRAM

JOB #: ###X

SIZE: D

DRAWING NUMBER: ###X-E-004 SH: 4 of 4

REV: A



NOTES:

1. ENCLOSURE WIRE CODE UNLESS STATED OTHERWISE:
   - 380VAC: 12AWG TEW/MTW BLACK
   - 120VAC: 16AWG TEW/MTW RED
   - 120VAC NEUTRAL: 16AWG TEW/MTW WHITE
   - DC VOLTAGE: 16AWG TEW/MTW BLUE
   - OTHER SOURCE: 16AWG TEW/MTW YELLOW
2. TRANSFORMER JUMPER INSTALLED DURING CONTROL PANEL ASSEMBLY.
3. REMOVE JUMPER IF REMOTE START CONTACT(S) ARE WIRED INTO THE CIRCUIT.

IDT REF:
CAD REF:

REV	DATE	DESCRIPTION
A	10FEB10	ISSUED FOR APPROVAL

REVISIONS

BIOREM TECHNOLOGIES INC.

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APPROVAL	NAME	DATE (DD/MM/YY)
DRAWN BY:	J.P.	10FEB10
DESIGNED BY:	TBD	TBD
CHECKED BY:		
APPROVED BY:		

UNLESS OTHERWISE SPECIFIED:
1. DIMENSIONS ARE IN INCHES
2. TOLERANCES
FRACTIONS ± 1/32
2 PLACE DEC. ±.030
3 PLACE DEC. ±.010
ANGLES ±1/2°

SCALE: N.T.S.

CUSTOMER: SK-450 THERMA-FLITE

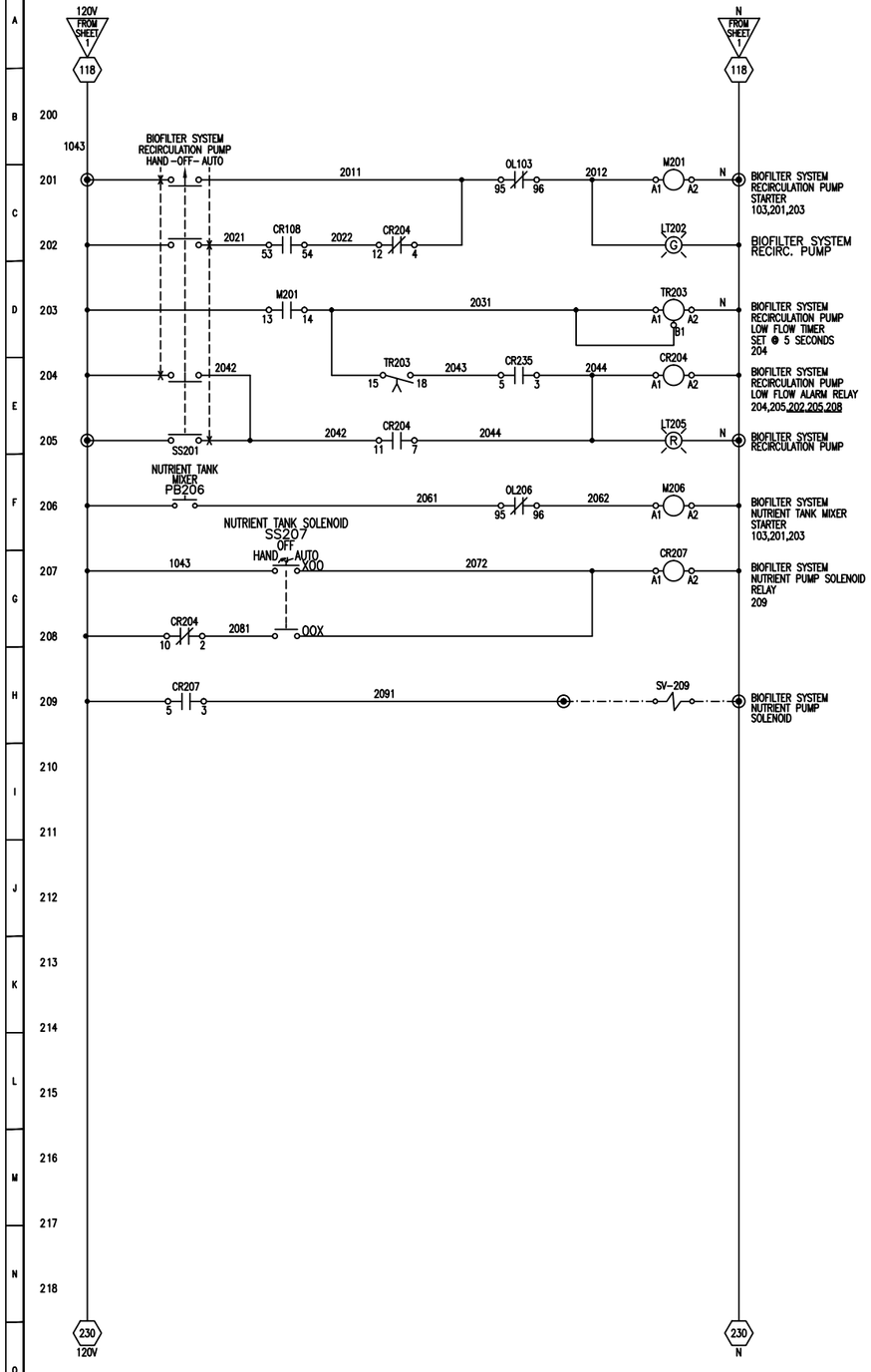
TITLE: U500 ODOUR CONTROL SYSTEM ELECTRICAL WIRING DIAGRAM

JOB #: ####X

SIZE: D

DRAWING NUMBER: SK250_450-E-001 Sh: 1 of 4

REV: A



NOTES:

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   - 380VAC: 12AWG TEW/MTW BLACK
   - 120VAC: 16AWG TEW/MTW RED
   - 120VAC NEUTRAL: 16AWG TEW/MTW WHITE
   - DC VOLTAGE: 16AWG TEW/MTW BLUE
   - OTHER SOURCE: 16AWG TEW/MTW YELLOW

IDT REF:
CAD REF:

REV	DATE	DESCRIPTION
A	09JUL09	ISSUED FOR APPROVAL

REVISIONS

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APPROVAL	NAME	DATE (DD/MM/YY)
DRAWN BY:	M.H.	09JUL09
DESIGNED BY:	M.H.	09JUL09
CHECKED BY:		
APPROVED BY:		

UNLESS OTHERWISE SPECIFIED:
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2. TOLERANCES:
FRACTIONS ± 1/32
2 PLACE DEC. ±.030
3 PLACE DEC. ±.010
ANGLES ±1/2°

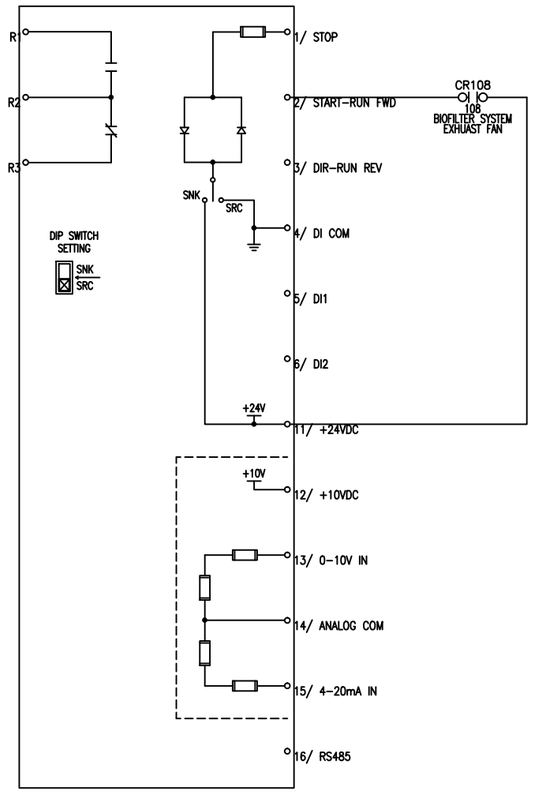
SCALE: N.T.S.

CUSTOMER: SK-450 THERMA-FLITE

TITLE: U500 ODOUR CONTROL SYSTEM ELECTRICAL WIRING DIAGRAM

JOB #: ####X

SIZE: D | DRAWING NUMBER: ####X-E-002 | SH: 2 of 4 | RDN: A



REV	DATE	DESCRIPTION
A	09JUL09	ISSUED FOR APPROVAL

REVISIONS

IDT REF:
CAD REF:

BIOREM TECHNOLOGIES INC.

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APPROVAL	NAME	DATE (DD/MM/YY)
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DESIGNED BY:	M.H.	09JUL09
CHECKED BY:		
APPROVED BY:		

UNLESS OTHERWISE SPECIFIED:
1. DIMENSIONS ARE IN INCHES
2. TOLERANCES
FRACTIONS ± 1/32
2 PLACE DEC. ±.030
3 PLACE DEC. ±.010
ANGLES ±1/2°

SCALE: N.T.S.

CUSTOMER: SK-450 THERMA-FLITE

TITLE: U500 ODOUR CONTROL SYSTEM ELECTRICAL WIRING DIAGRAM

JOB #: ####X

SIZE: D

DRAWING NUMBER: ####X-E-003 SH: 3 of 4

REV: A

DIVIDER:

BLOWER

The New York Blower Company

Fan-to-Size
Fan Selection Data

Project:	
Location:	
Contact:	

Fan Design

Product:	Compact GI	Arrangement:	4
Size/Model:	125	Drive type:	Direct
Wheel Material:	316 SST		
Wheel Width:	100.0 %	Wheel Diameter:	100.0 %

Operating Conditions

Volume Flow Rate:	450 CFM	Fan Speed:	3500 rpm
Fan Static Pressure:	8.92 in wg	Fan Input Power:	1.30 bhp
Outlet Velocity:	2848 ft/min	VP/SP ratio:	0.0522
Altitude (above mean sea level):	0 ft	Operating Temperature:	90 Deg F
Operating Inlet Airstream Density:	0.0690 lb/ft3		
Static Efficiency:	48.48%	Mechanical Efficiency:	51.01%
Maximum Operating Temperature:	90 Deg F	Maximum Safe Operating Speed:	4000 rpm

Operating cost is $213.22 for 2080 hours with a 90% efficient motor when energy unit cost per kW-hr is 0.095

Standard Conditions

Volume Flow Rate:	450 CFM	Fan Speed:	3500 rpm
Fan Static Pressure:	9.7 in wg	Fan Input Power:	1.41 bhp
Density at Mean Sea Level :	0.0750 lb/ft3	Max. Safe Speed at 70 Deg F:	4000 rpm

Sound Power Level Ratings Levels expressed in dB (power levels reference 10^(-12) watts)

Center Frequency (Hz):	**63**	**125**	**250**	**500**	**1000**	**2000**	**4000**	**8000**	
Octave Bands:	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**Overall**
Total Fan Power Levels*:	82.8	96.5	100.5	91.5	87.5	82.8	77.5	76.5	102.6
Inlet Power Levels**:	79.8	93.5	97.5	88.5	84.5	79.8	74.5	73.5	99.6
Outlet Power Levels**:	79.8	93.5	97.5	88.5	84.5	79.8	74.5	73.5	99.6

*As corrected for point of operation (location on fan curve)
**Unsilenced Inlet and Outlet power ratings are 3 dB lower than total fan power levels under the assumption that "half" of the sound power can be attributed to each opening. Silenced power ratings include this 3 dB reduction as well as the silencer attenuation.

Estimated Sound Pressure Levels Expressed in dB (pressure levels reference $2x10^{-7}$ microbar)

Directivity/Reflection Factor (Q) is 1, spherical radiation; Distance is 5 ft.; A-weighting is in use.

The estimated sound pressure level outside the fan due to an open inlet OR outlet is 77.7 dBA at 5.0 feet. The estimated sound pressure level outside the fan when BOTH inlet and outlet are ducted is 66.8 dBA at 5.0 feet (Housing Radiated Noise).

Your Representative:
R J Wondrack Company
300 Stoutenger Street
East Syracuse, NY 13057
Phone: (315) 437-4440
Fax: (315) 437-9783
E-Mail: chris.clarkson@wondrack.com

The New York Blower Company certifies that the Compact GI fan is licensed to bear the AMCA Air Performance Seal. The ratings shown are based on tests and procedures performed in accordance with AMCA Publication 211 and comply with the requirements of the AMCA Certified Ratings program.

AMCA Licensed for Air Performance without Appurtenances (Accessories). Power (bhp) excludes drives.

Performance certified is for installation type: D - ducted inlet, ducted outlet.

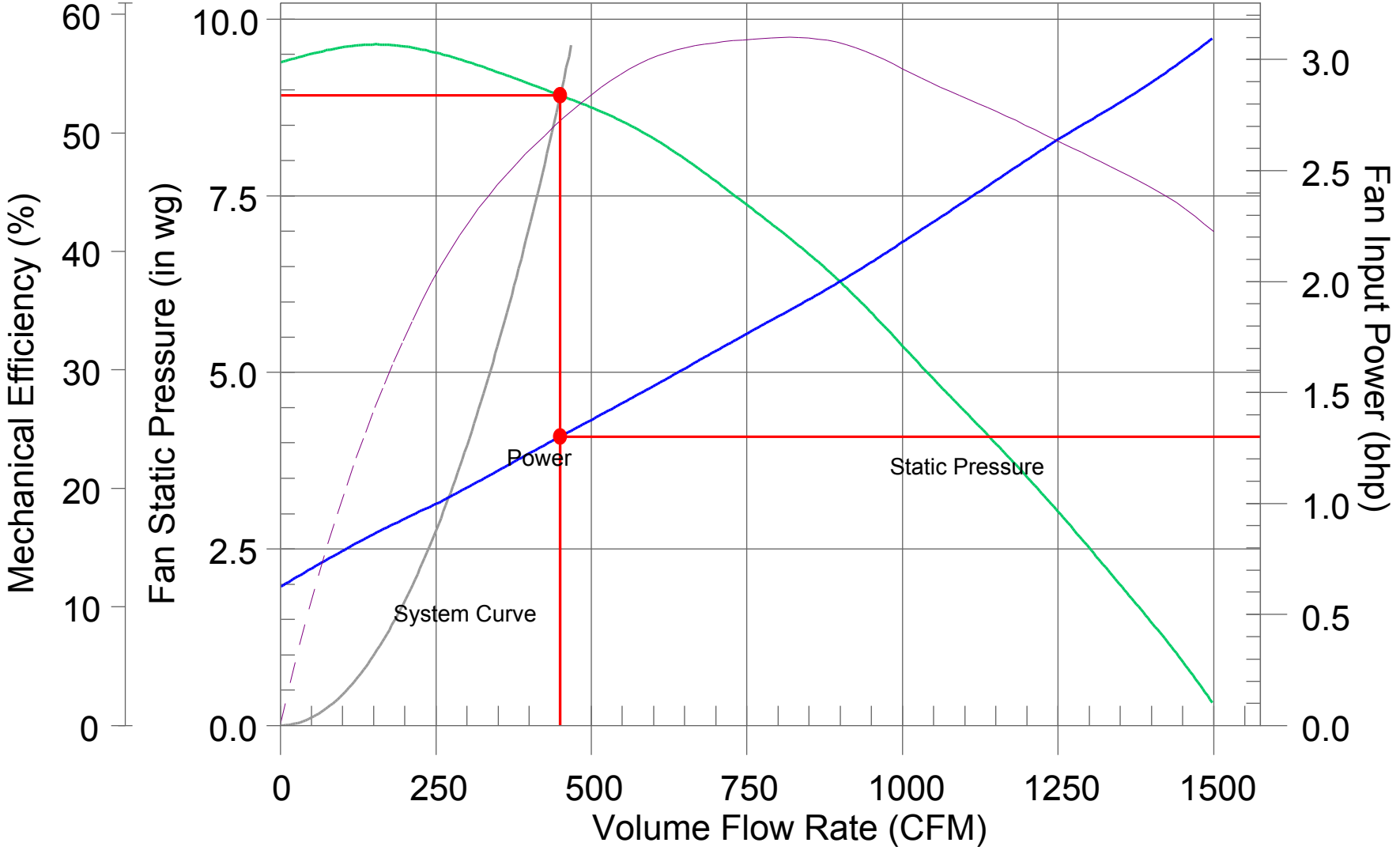
The New York Blower Company

Fan-to-Size

Compact GI
125
Arr.: 4

Volume Flow Rate: 450 CFM
Fan Static Press.: 8.92 in wg
Speed: 3500 rpm
Power: 1.30 bhp

Temp.: 90 Deg F
Altitude: 0 ft
Density: 0.0690 lb/ft3
Outlet Velocity: 2848 ft/min



AMCA Licensed for Air Performance without Appurtenances (Accessories). Power (bhp) excludes drives.
Performance certified is for installation type: D - ducted inlet, ducted outlet.

Customer:
Biorem
SK-250

[v1.75.100-R -- October 2007] Date Printed: 11/6/2009
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Your Sales Representative:
R J Wondrack Company
Phone: (315) 437-4440

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Willowbrook, IL 60527-5530
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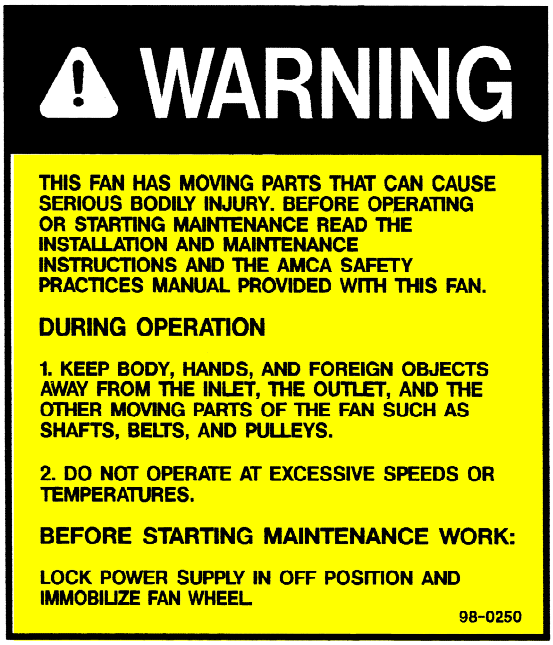
Phone: (800) 208-7918 Email: nyb@nyb.com

INSTALLATION MAINTENANCE, OPERATING INSTRUCTIONS

IM-170

COMPACT GI FANS



WORD ABOUT SAFETY

The above **WARNING** decal appears on all **nyb** fans. Air moving equipment involves electrical wiring, moving parts, sound, and air velocity or pressure which can create safety hazards if the equipment is not properly installed, operated and maintained. To minimize this danger, follow these instructions as well as the additional instructions and warnings on the equipment itself.

All installers, operators and maintenance personnel should study AMCA Publication 410, "Recommended Safety Practices for Air Moving Devices", which is included as part of every shipment. Additional copies can be obtained by writing to New York Blower Company, 7660 Quincy St., Willowbrook, IL 60527.

ELECTRICAL DISCONNECTS

Every motor driven fan should have an independent disconnect switch to isolate the unit from the electrical supply. It should be near the fan and must be capable of being locked by maintenance personnel while servicing the unit, in accordance with OSHA procedures.

MOVING PARTS

All moving parts must have guards to protect personnel. Safety requirements vary, so the number and type of guards needed to meet company, local and OSHA standards must be determined and specified by the user. Never start a fan without having all safety guards installed. Check regularly for damaged or missing guards and do not operate any fan with guards removed. Fans can also become dangerous because of potential “windmilling”, even though all electrical power is disconnected. Always block the rotating assembly before working on any moving parts.

SOUND

Some fans can generate sound that could be hazardous to exposed personnel. It is the responsibility of the system designer and user to determine sound levels of the system, the degree of personnel exposure, and to comply with applicable safety requirements to protect personnel from excessive noise. Consult **nyb** for fan sound power level ratings.

AIR PRESSURE AND SUCTION

In addition to the normal dangers of rotating machinery, fans present another hazard from the suction created at the fan inlet. This suction can draw materials into the fan where they become high velocity projectiles at the outlet. It can also be extremely dangerous to persons in close proximity to the inlet, as the forces involved can overcome the strength of most individuals. Inlets and outlets that are not ducted should be screened to prevent entry and discharge of solid objects.

RECEIVING AND INSPECTION

The fan and accessories should be inspected on receipt for any shipping damage. Turn the wheel by hand to see that it rotates freely and does not bind. If dampers or shutters are provided, check these accessories for free operation of all moving parts.

F.O.B. factory shipping terms require that the receiver be responsible for inspecting the equipment upon arrival. Note damage or shortages on the Bill of Lading and file any claims for damage or loss in transit. **nyb** will assist the customer as much as possible; however, claims must be originated at the point of delivery.

HANDLING AND STORAGE

Fans should be lifted by the base, mounting supports, or lifting eyes only. Never lift a fan by the wheel, shaft, motor, motor bracket, housing inlet, outlet, or any fan part not designed for lifting. A spreader should always be used to avoid damage.

Whenever possible, fans and accessories should be stored in a clean, dry location to prevent rust and corrosion of steel components. If outdoor storage is necessary, protection should be provided. Cover the inlet and outlet to prevent the accumulation of dirt and moisture in the housing. Cover motors with waterproof material. Refer to the bearing section for further storage instructions.

Check dampers for free operation and lubricate moving parts prior to storage. Inspect the stored unit periodically. **Rotate the wheel by hand every two weeks to redistribute grease on internal bearing parts.**

FAN INSTALLATION

nyb wheels are dynamically balanced when fabricated. Complete fans are test run at operating speeds to check the entire assembly for conformance to **nyb** vibration limits. Nevertheless, all units must be adequately supported for smooth operation. **Ductwork or stacks should be independently supported as excess weight may distort the fan housing and cause contact between moving parts.** Where vibration isolators are used, consult the **nyb** certified drawing for proper location and adjustment.

Slab-Mounted Units

A correctly designed and level concrete foundation provides the best means of installing floor-mounted fans. The mass of the base must maintain the fan/driver alignment, absorb normal vibration, and resist lateral loads. The overall dimensions of the concrete base should extend at least six inches beyond the base of the fan. The weight of the slab should be two to three times the weight of the rotating assembly, including the motor. The foundation requires firmly anchored fasteners such as the anchor bolts shown in Figure 1. Hammer-drilled expansion fasteners can be used in less demanding applications

Move the fan to the mounting location and lower it over the anchor bolts. Shim and grout as required to level the fan. Fasten the fan securely. When isolation is used, check the **nyb** certified drawing for installation instructions.

Elevated Units

When an elevated or suspended structural steel platform is used, it must have sufficient bracing to support the unit load and prevent side sway. The platform should be of welded construction to maintain permanent alignment of all members.

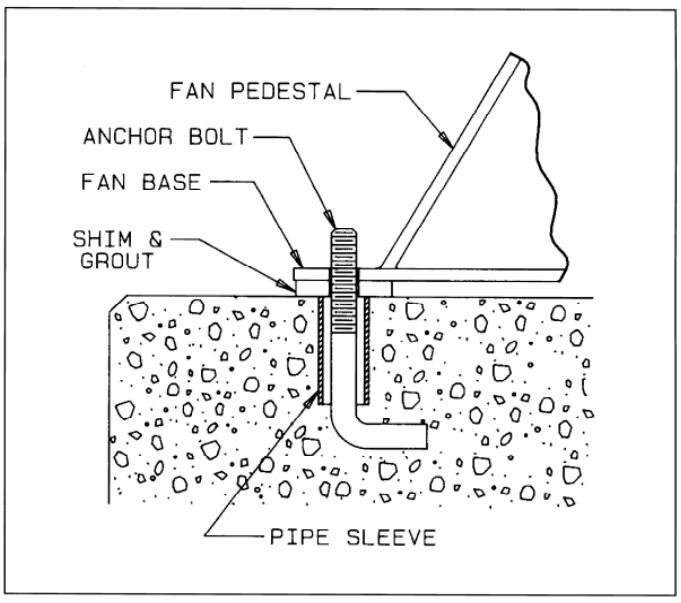


Figure 1

V-BELT DRIVE

Installation

1. Remove all foreign material from the fan and motor shafts. Coat shafts with machine oil for easier mounting. Mount the belt guard backplate at this time if partial installation is required prior to sheave mounting.
2. Mount sheaves on shafts after checking sheave bores and bushings for nicks or burrs. Avoid using force. If resistance is encountered, lightly polish the shaft with emery cloth until the sheave slides on freely.
3. Adjust the motor on its base to a position closest to the fan shaft. Install belts by working each one over the sheave grooves until all are in position. Never pry the belts into place. On **nyb** packaged fans, sufficient motor adjustment is provided for easy installation of the proper size belts.
4. Adjust sheaves and the motor shaft angle so that the sheave faces are in the same plane. Check this by placing a straightedge across the faces of the sheaves. Any gap between the edge and sheave faces indicates misalignment. Important: This method is only valid when the width of the surface between the belt edge and the sheave face is the same for both sheaves. When they are not equal, or when using adjustable-pitch sheaves, adjust so that all belts have approximately equal tension. Both shafts should be at right angles to the center belt.

Belt Tensioning

1. Check belt tension with a tensioning gage and adjust using the motor slide base. Excess tension shortens bearing life while insufficient tension shortens belt life, can reduce fan performance and vay cause vibration. The lowest allowable tension is that which prevents slippage under full load. Belts may slip during start-up, but slipping should stop as soon as the fan reaches full speed. For more precise tensioning methods, consult the drive manufacturer's literature.
2. Recheck setscrews, rotate the drive by hand and check for rubbing, then complete the installation of the belt guard.
3. Belts tend to stretch somewhat after installation. Recheck tension after several days of operation. Check sheave alignment as well as setscrew and/or bushing bolt tightness.

START-UP

Safe operation and maintenance includes the selection and use of appropriate safety accessories for the specific installation. This is the responsibility of the system designer and requires consideration of equipment location and accessibility as well as adjacent components. All safety accessories must be installed properly prior to start-up.

Safe operating speed is a function of system temperature and wheel design. Do not under any circumstances exceed the maximum safe fan speed published in the **nyb** bulletin, which is available from your **nyb** field sales representative.

Procedure

1. If the drive components are not supplied by **nyb,** verify with the manufacturer that the starting torque is adequate for the speed and inertia of the fan.
2. Inspect the installation prior to starting the fan. Check for any loose items or debris that could be drawn into the fan or dislodged by the fan discharge. Check the interior of the fan as well. Turn the wheel by hand to check for binding.

3. Check drive installation and belt tension.
4. Check the tightness of all setscrews, nuts and bolts. When finished, tighten hub setscrews with the wheel oriented such that the setscrew is positioned underneath the shaft.
5. Install all remaining safety devices and guards. Verify that the supply voltage is correct and wire the motor. “Bump” the starter to check for proper wheel rotation.
6. Use extreme caution when testing the fan with ducting disconnected. Apply power and check for unusual sounds or excessive vibration. If either exists, see the section on Common Fan Problems. To avoid motor overload, do not run the fan for more than a few seconds if ductwork is not fully installed. On larger fans, normal operating speed may not be attained without motor overload unless ductwork is attached. Check for correct fan speed and complete installation. Ductwork and guards must be fully installed for safety.
7. Setscrews should be rechecked after a few minutes, eight hours and two weeks of operation (see Tables 1 & 2 for correct tightening torques).

NOTE: Shut the fan down immediately if there is any sudden increase in fan vibration.

Table 1 - WHEEL SETSCREW TORQUES

Setscrew Size Diameter (in.)	Carbon Steel Setscrew Torque*	
	lb.-in.	lb.-ft.
1/4	75	6.2
5/16	144	12

*** Stainless Steel setscrews are not hardened and should not be tightened to more than 1/2 the values shown.**

Table 2 - BEARING SETSCREW TORQUE, lb.-in.

Setscrew Diameter		Manufacturer			
	Link-Belt	Sealmaster	SKF	McGill	Dodge
1/4	90	65	50	85	--
5/16	185	125	165	165	160

FAN MAINTENANCE

nyb fans are manufactured to high standards with quality materials and components. Proper maintenance will ensure a long and trouble-free service life.

Do not attempt any maintenance on a fan unless the electrical supply has been completely disconnected and locked. In many cases, a fan can windmill despite removal of all electrical power. The rotating assembly should be blocked securely before attempting maintenance of any kind.

The key to good fan maintenance is regular and systematic inspection of all fan parts. Inspection frequency is determined by the severity of the application and local conditions. Strict adherence to an inspection schedule is essential.

Regular fan maintenance should include the following:

1. Check the fan wheel for any wear or corrosion, as either can cause catastrophic failures. Check also for the build-up of material which can cause unbalance resulting in vibration, bearing wear and serious safety hazards. Clean or replace the wheel as required.
2. Check the V-belt drive for proper alignment and tension (see section on V-belt drives). If belts are worn, replace them as a set, matched to within manufacturer’s tolerances.
3. Lubricate the bearings, but do not over lubricate (see the bearing section for detailed specifications).
4. Ceramic-felt shaft seals require no maintenance, although worn seals should be replaced. When lip-type shaft seals are provided, lubricate them with “NEVER-SEEZ” or other anti-seize compound.
5. During any routine maintenance, all setscrews and bolts should be checked for tightness. See the table for correct torques.
6. When installing a new wheel, the wheel should be centered in the housing between the inlet and drive sides.

WHEEL BALANCE

Airstreams containing particulate or chemicals can cause abrasion or corrosion of the fan parts. This wear is often uneven and can lead to significant wheel imbalance over time. When such wear is discovered, a decision must be made as to whether to rebalance or replace the wheel.

The soundness of all parts should be determined if the original thickness of components is reduced. Be sure there is no hidden structural damage. The airstream components should also be cleaned to remove any build-up of foreign material. Specialized equipment can be used to rebalance a cleaned wheel that is considered structurally sound.

Balance weights should be rigidly attached at a point that will not interfere with the housing nor disrupt airflow. Remember that centrifugal forces can be extremely high at the outer radius of a fan wheel. Welding is the preferred method of balance weight attachment. Weld material for standard Compact GI wheels should be a nickel, aluminum bronze alloy. Be sure to ground the welder directly to the fan wheel. Otherwise, the welding current could pass through the fan bearings and damage them.

BEARINGS

Storage

Any stored bearing can be damaged by condensation caused by temperature variations. Therefore, **nyb** fan bearings are filled with grease at the factory to exclude air and moisture. Such protection is adequate for shipment and subsequent immediate installation.

For long term or outdoor storage, mounted bearings should be regreased and wrapped with plastic for protection. **Rotate the fan wheel by hand at least every two weeks to redistribute grease on internal bearing parts.** Each month the bearings should be purged with new grease to remove condensation, since even a filled bearing can accumulate moisture. Use caution when purging, as excessive pressure can damage the seals. Rotate the shaft while slowly adding grease.

Operation

Check the setscrew torque before start-up (see table for correct values). Since bearings are completely filled with grease at the factory, they may run at an elevated temperature during initial operation. Surface temperatures may reach 180°F. and grease may bleed from the bearing seals. This is normal and no attempt should be made to replace lost grease. Bearing surface temperatures will decrease when the internal grease quantity reaches a normal operating level. Relubrication should follow the recommended schedule.

Lubrication

Use the following table for bearing lubrication interval, according to operating speed. Bearings should be lubricated with a premium quality lithium-based grease conforming to NLGI Grade 2. Examples are:

Mobil	-	Mobilgrease XHP
Texaco	-	Premium RB
Chevron	-	Amolith #2
Shell	-	Alvania #2

Do not use “high temperature” greases, as many are not formulated for the high speeds associated with fan bearings.

Add grease to the bearing while running the fan or rotating the shaft by hand. Be sure all guards are in place if lubrication is performed while the fan is operating. Add just enough grease to cause a slight purging at the seals. Do not over lubricate.

BEARING LUBRICATION INTERVAL [months]

	RPM				
Shaft	1-1000	1001-2000	2001-3000	3001-4000	4001-5000
1”	6	5-6	4-6	3-4	2

Sealmaster, McGill, Link-Belt, and SKF

NOTE:

1. **These are general recommendations only; specific manufacturer’s recommendations may vary slightly.**
2. **Assumes clean environment, -20°F. to 120°F.**
   a. **Consult The New York Blower Company for operation below -20°F. ambient.**
   b. **Ambient temperatures greater than 120°F. will shorten bearing life.**
   c. **Under extremely dirty conditions, lubricate more frequently.**
3. **Assumes horizontal mounting configuration. For vertically mounted applications, lubricate twice as frequently.**

COMMON FAN PROBLEMS

Excessive Vibration

A common complaint regarding industrial fans is “excessive vibration”. **nyb** is careful to ensure that each unit is precisely balanced prior to shipment; however, there are many other causes of vibration including:

1. Loose mounting bolts, setscrews, bearings or couplings.
2. Misalignment or excessive wear of couplings or bearings.
3. Misaligned or unbalanced motor.
4. Bent shaft due to mishandling or material impact.
5. Accumulation of foreign material on the wheel.
6. Excessive wear or erosion of the wheel.
7. Excessive system pressure or restriction of airflow due to closed dampers.
8. Inadequate structural support, mounting procedures or materials.
9. Externally transmitted vibration.

Inadequate Performance

1. Incorrect testing procedures or calculations.
2. Fan running too slowly.
3. Fan wheel rotating in wrong direction or installed backwards on shaft.
4. Wheel not properly centered relative to inlet cone.
5. Poor system design, closed dampers, air leaks, clogged filters, or coils.
6. Obstructions or sharp elbows near inlets.
7. Sharp deflection of airstream at fan outlet.

Excessive Noise

1. Fan operating near “stall” due to incorrect system design or installation.
2. Vibration originating elsewhere in the system.
3. System resonance or pulsation.
4. Improper location or orientation of fan intake and discharge.
5. Inadequate or faulty design of supporting structures.
6. Nearby sound reflecting surfaces.
7. Loose accessories or components.
8. Loose drive belts.
9. Worn bearings.

Premature Component Failure

1. Prolonged or major vibration.
2. Inadequate or improper maintenance.
3. Abrasive or corrosive elements in the airstream or surrounding environment.
4. Misalignment or physical damage to rotating components or bearings.
5. Bearing failure from incorrect or contaminated lubricant or grounding through the bearings while arc welding.
6. Excessive fan speed.
7. Extreme ambient or airstream temperatures.
8. Improper belt tension.
9. Improper tightening of wheel setscrews.

LIMITED PRODUCT WARRANTY

All products are warranted by **nyb** to be free from defects in materials and workmanship for a period of one (1) year after shipment from its plant, provided buyer demonstrates to satisfaction of **nyb** that the product was properly installed and maintained in accordance with **nyb**'s instructions and recommendations and that it was used under normal operating conditions.

This warranty is limited to the replacing and/or repairing by **nyb** of any part or parts which have been returned to **nyb** with **nyb**'s written authorization and which in **nyb**'s opinion are defective. Parts not manufactured by **nyb** but installed by **nyb** in equipment sold to the buyer shall carry the original manufacturer's warranty only. All transportation charges and any and all sales and use taxes, duties, imports or excises for such part or parts shall be paid for by the buyer. **nyb** shall have the sole right to determine whether defective parts shall be repaired or replaced.

This warranty does not cover any customer labor charges for replacement of parts, adjustments or repairs, or any other work unless such charges shall be assumed or authorized in advance, in writing, by **nyb.**

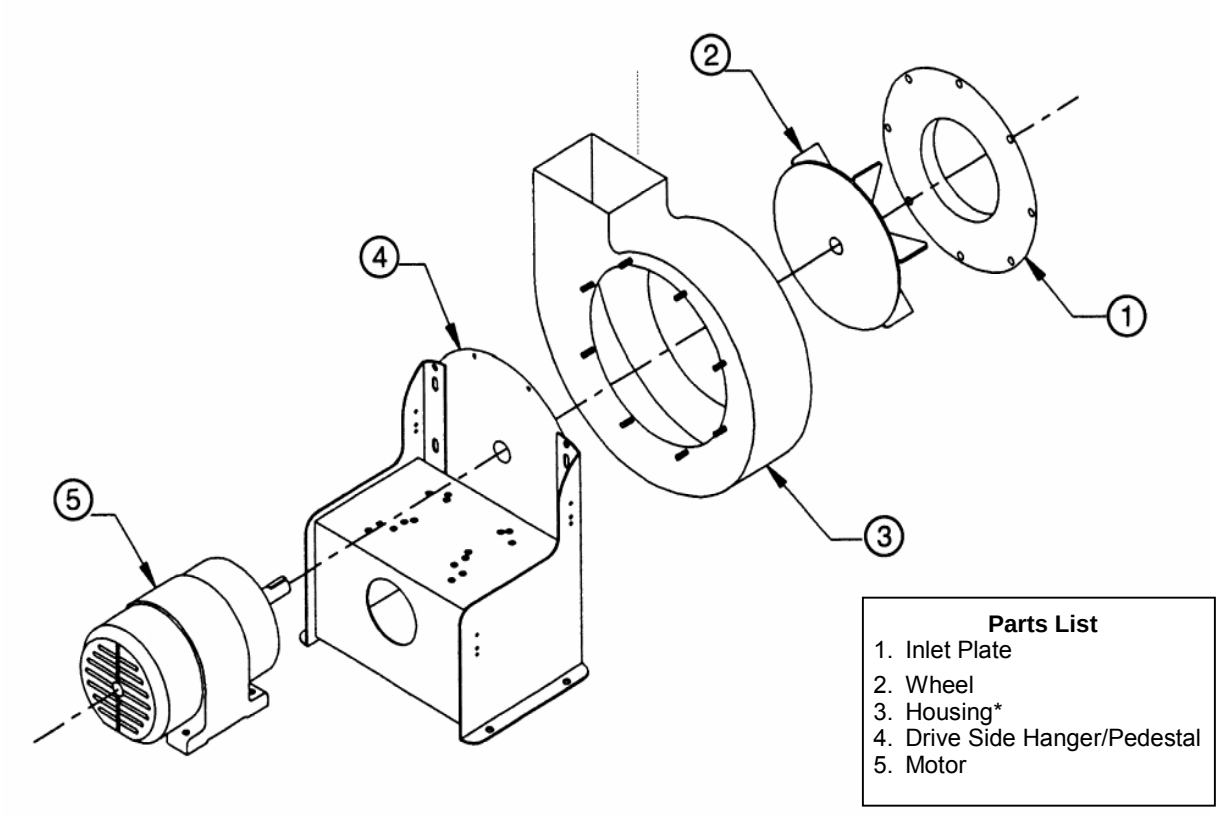
This warranty does not cover any product which, in the judgement of **nyb,** has been subject to misuse or neglect, or which has been repaired or altered outside **nyb's** plant in any way which may have impaired its safety, operation or efficiency, or any product which has been subject to accident.

This warranty shall be null and void if any part not manufactured or supplied by **nyb** for use in any of its products shall have been substituted and used in place of a part manufactured or sup-plied by **nyb** for such use.

There are no warranties, other than those appearing on the acknowledgement form **INCLUDING NO WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE,** given in connection with the sale of the goods sold hereunder. The buyer agrees that his sole and exclusive remedy, and the limit of **nyb**'s liability for loss from any cause whatsoever, shall be the purchase price of the goods sold hereunder for which a claim is made.

The New York Blower Company – 7660 Quincy Street – Willowbrook, Illinois 60527-5530

DIRECT DRIVE COMPACT GI FANS

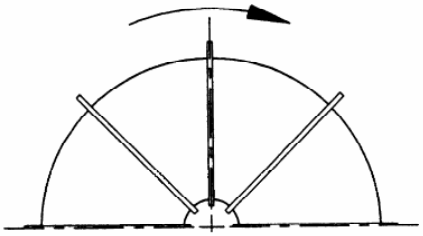


Parts List

1. Inlet Plate
2. Wheel
3. Housing*
4. Drive Side Hanger/Pedestal
5. Motor

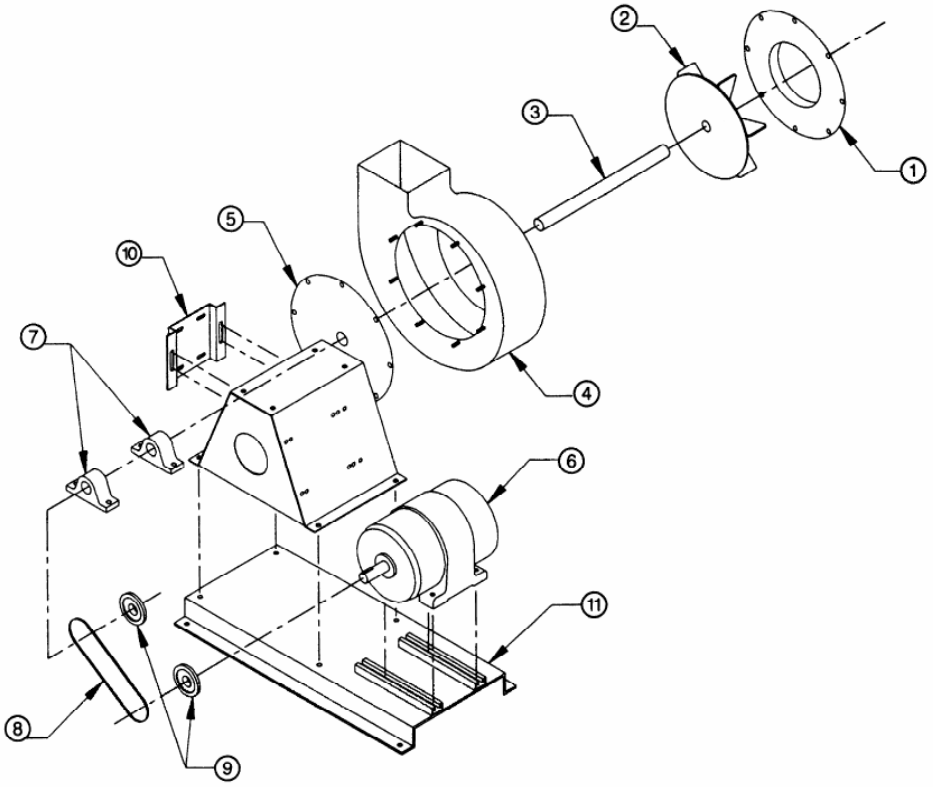
* Order for parts must specify rotation.

SPECIFY ROTATION AS VIEWED FROM DRIVE SIDE



ARROW INDICATES CLOCKWISE ROTATION

BELT DRIVE COMPACT GI FANS



REPLACEMENT PARTS

It is recommended that only factory-supplied replacement parts be used. **nyb** fan parts are built to be fully compatible with the original fan, using specific alloys and tolerances. These parts carry a standard **nyb** warranty.

When ordering replacement parts, specify the part name, **nyb** shop and control number, fan size, type, rotation (viewed from drive end), arrangement and bearing size or bore. Most of this information is on the metal nameplate attached to the fan base.

For assistance in selecting replacement parts, contact your local **nyb** representative or visit: http://www.nyb.com.

Example: Part required: Wheel
Shop/control number: B-10106-100
Fan description: Size 125 Compact GI Fan
Rotation: Clockwise
Arrangement: 9

Suggested replacement parts include:

Wheel	Component parts:	Damper
Shaft		Motor
Bearings		Sheaves
Shaft Seal		V-Belts

Parts List

1. Inlet Plate
2. Wheel
3. Shaft
4. Housing*
5. Drive Side Hanger/Pedestal
6. Motor
7. Bearings
8. Belt
9. Sheaves
10. Arr. 9 Motor Mounting Base
11. Arr. 9X Motor Mounting Base

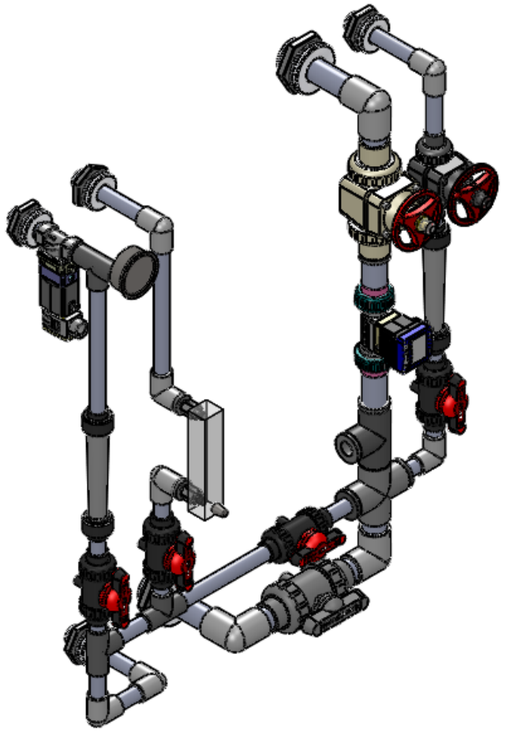
* Orders for parts must specify rotation.

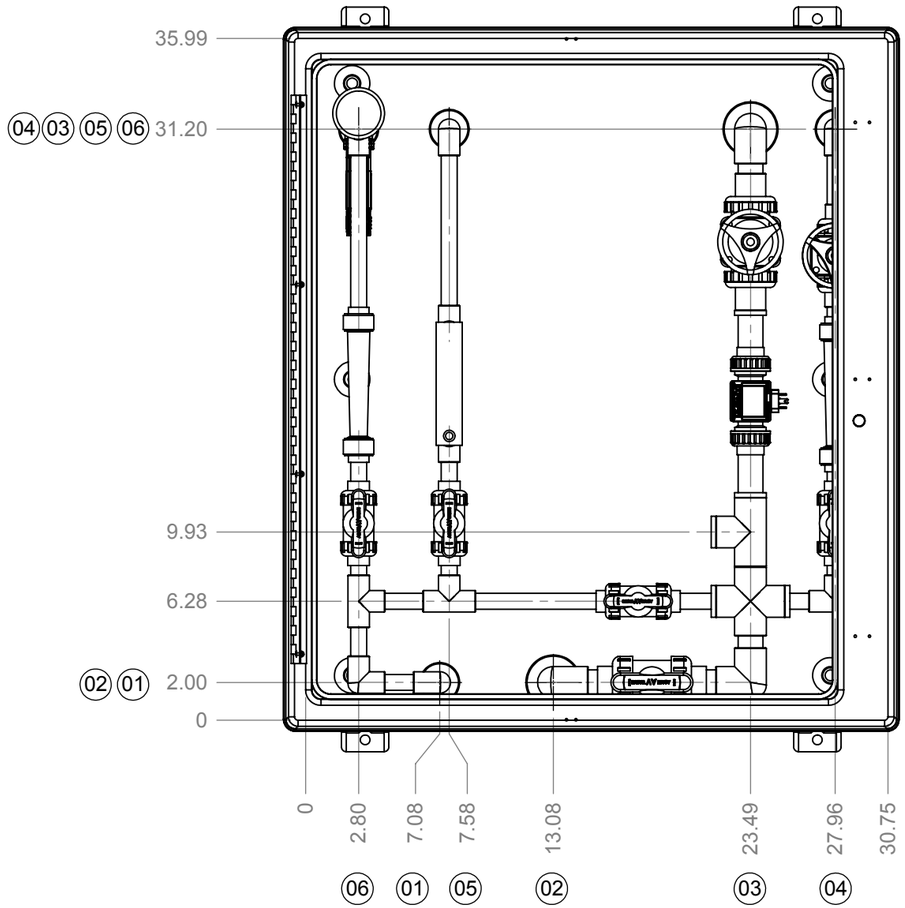
For assistance in selecting replacement parts, contact your local **nyb** representative or visit: http://www.nyb.com.

DIVIDER:

SYSTEM COMPONENTS

REVISIONS			
REV.	DATE	DESCRIPTION	BY
00	06/11/2009	FOR REVIEW AND APPROVAL	BAD





T.P.	SIZE	TYPE	DESCRIPTION
01	0.5"	FNPT	CLIENT WATER INLET
02	1"	FNPT	RECIRCULATION WATER FROM P-170
03	1"	FNPT	RECIRCULATION TO NZ-370
04	0.5"	FNPT	BLOWDOWN TO DRAIN
05	0.5"	FNPT	MAKE-UP WATER TO SUMP
06	0.5"	FNPT	IRRIGATION WATER TO MEDIA

BIOREM
Breathe Easy...

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APPROVAL	NAME	DD/MM/YY
DRAWN BY:	B.D.	6/11/09
DESIGNED BY:	B.D.	6/11/09
CHECKED BY:		6/11/09
APPROVED BY:		6/11/09

UNLESS OTHERWISE SPECIFIED

1. DIMENSIONS IN INCHES
2. TOLERANCES:
   FRACTIONS ± 1/32
   2 PLACE DEC. ±.030
   3 PLACE DEC. ±.010
   ANGLES ±1.0°

SCALE: 1:8

CLIENT: SK450/250 WATERBOX

TITLE: WATERBOX PANEL

PROJECT: XXXXF

SIZE: B

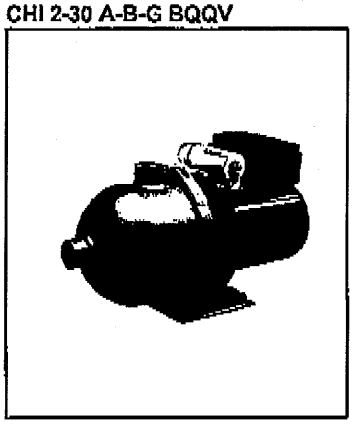
DRAWING NUMBER: SK250_450-SA-000 SHT 1 OF 4

REV: 00

GRUNDFOS

Company name: -
Created by: -
Phone: -
Fax: -
Date: -

Position	Count	Description	Unit price
	1	**CHI 2-30 A-B-G BQQV**	0 0



Product photo could vary from the actual product

Product No.: 4H513463
Horizontal, multi-stage, non-self-priming, centrifugal pump with axial suction port and radial discharge port.

The compact unit has mechanical shaft seal according to DIN 24960 and through-going motor/pump shaft.

Pump and motor are mounted on a common baseplate and all pump components in contact with the pumped liquid are made of stainless steel.

The motor is a 3-phase motor.

Liquid:

Liquid temperature range:	5 .. 230 °F

Technical:

Shaft seal:	BQQV
Approvals on nameplate:	UL Listed
Curve tolerance:	ISO 9906 Annex A

Materials:

Pump housing:	Stainless steel DIN W.-Nr. 1.4401 AISI 316
Impeller:	Stainless steel DIN W.-Nr. 1.4401 AISI 316

Installation:

Range of ambient temperature:	5 .. 104 °F
Maximum operating pressure:	145 psi
Max pressure at stated temperature:	145 psi / 230 °F
Pipe connection:	1" NPT

GRUNDFOS

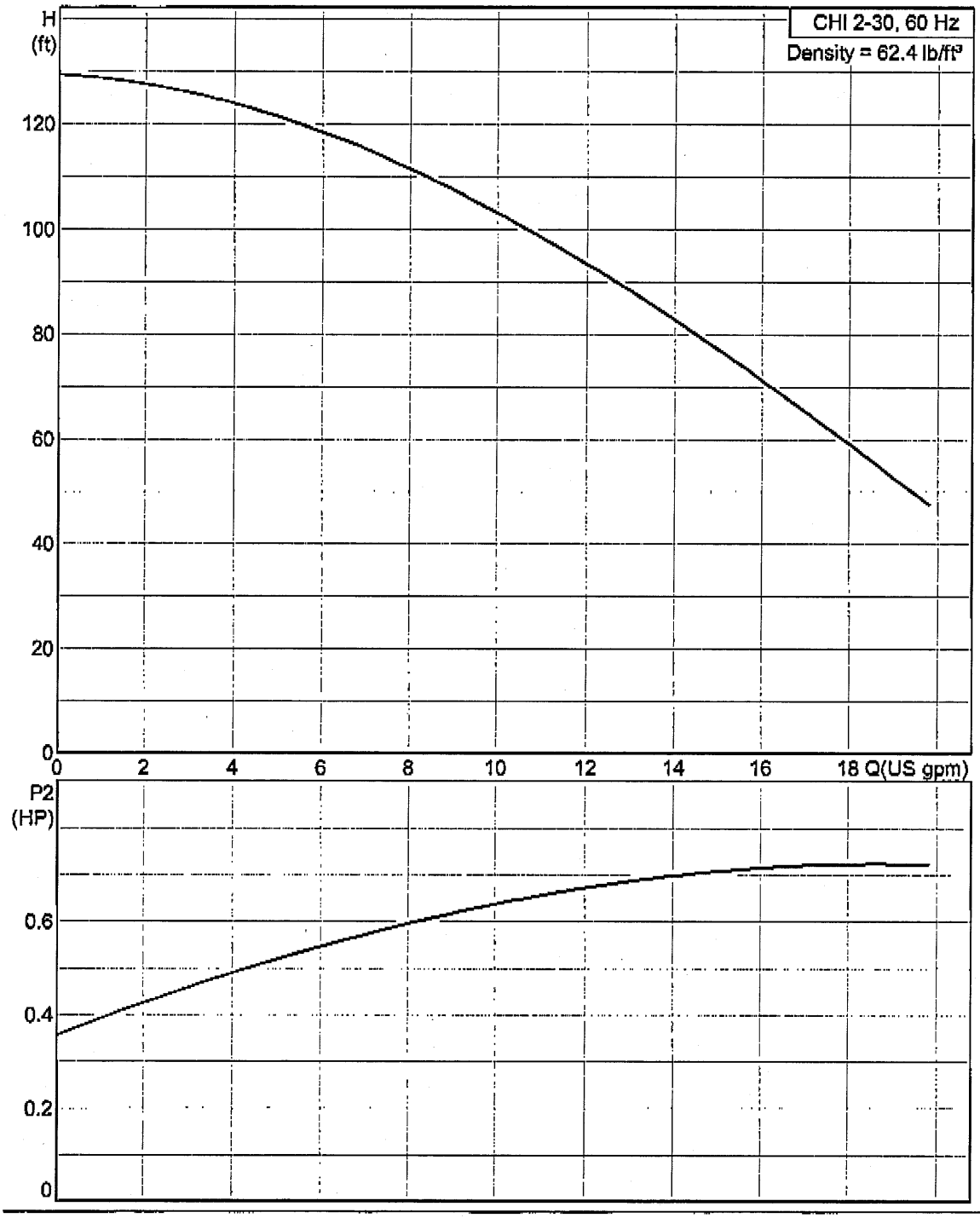
Company name: -
Created by: -
Phone: -
Fax: -
Date: -

Position	Count	Description		Unit price
		Electrical data:		
		Main frequency:	60 Hz	
		Rated voltage:	3 x 208-230D / 440-480Y V	
		Rated current:	2.3 / 1.2 A	
		Enclosure class (IEC 34-5):	55	
		Insulation class (IEC 85):	F	
		Others:		
		Net weight:	20.3 lb	
		Gross weight:	25.1 lb	
		Shipping volume:	1.73 ft³	

GRUNDFOS

Company name: -
Created by: -
Phone: -
Fax: -
Date: -

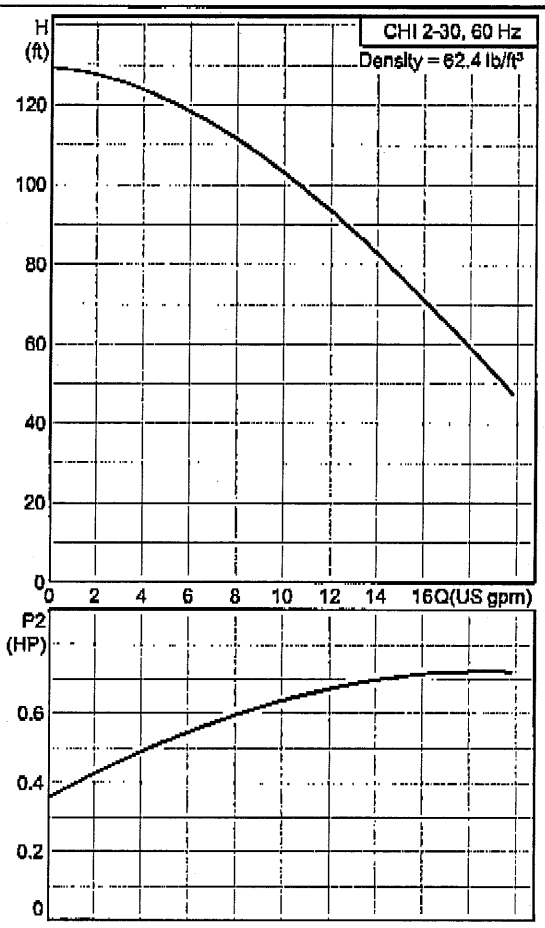
4H513463 CHI 2-30 60 Hz



GRUNDFOS

Company name: -
Created by: -
Phone: -
Fax: -
Date: -

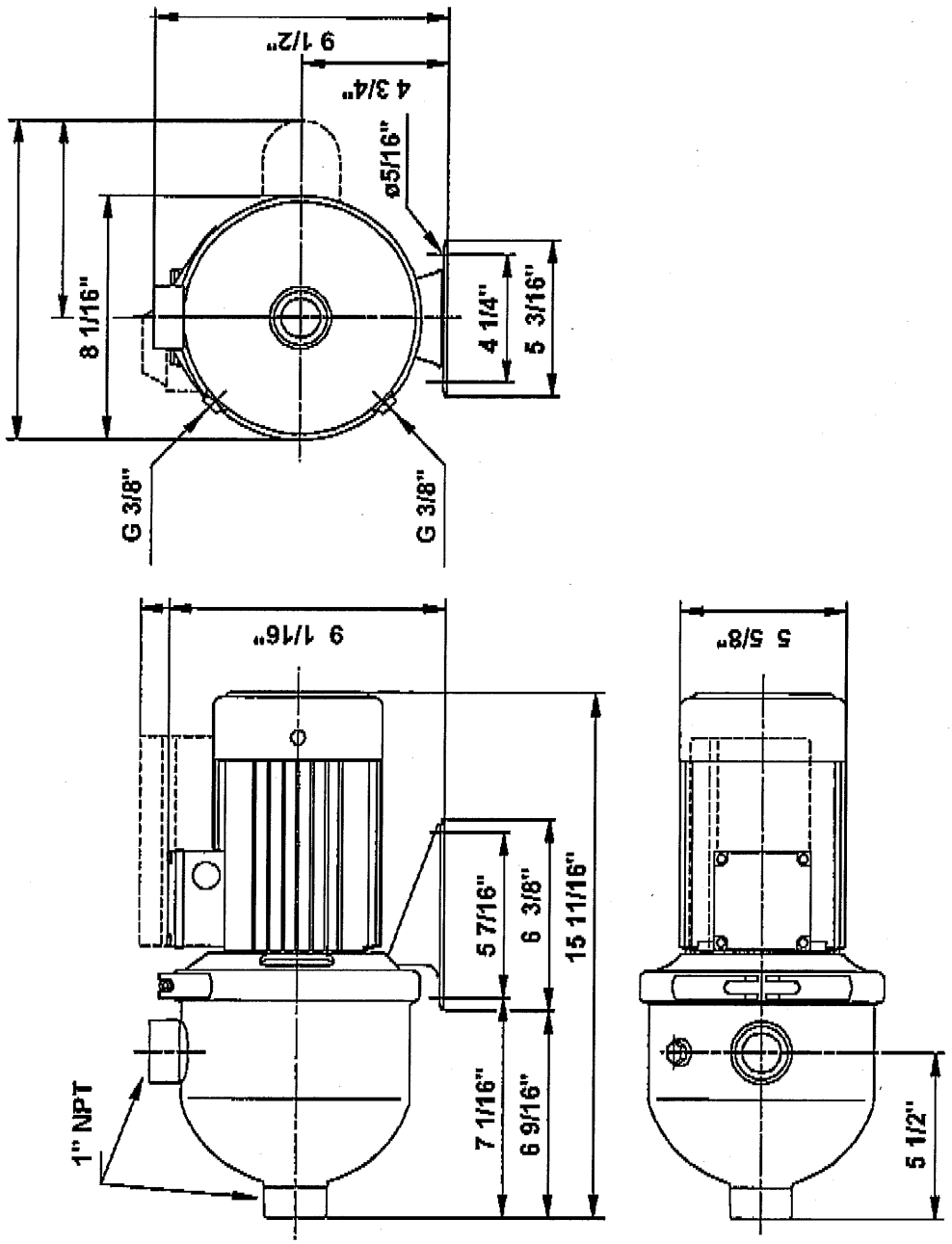
Description	Value
Product name:	CHI 2-30 A-B-G BQQV
Product No.:	4H513463
EAN:	5700391590085
Price:	$ 944.00
Technical:	
Impeller 90 mm:	3
Shaft seal:	BQQV
Approvals on nameplate:	UL Listed
Curve tolerance:	ISO 9906 Annex A
Pump version:	A
Model:	C
Materials:	
Pump housing:	Stainless steel DIN W.-Nr. 1.4401 AISI 316
Impeller:	Stainless steel DIN W.-Nr. 1.4401 AISI 316
Material code:	G
Installation:	
Range of ambient temperature:	5 .. 104 °F
Maximum operating pressure:	145 psi
Max pressure at stated temperature:	145 psi / 230 °F
Connect code:	B
Pipe connection:	1" NPT
Liquid:	
Liquid temperature range:	5 .. 230 °F
Electrical data:	
Main frequency:	60 Hz
Rated voltage:	3 x 208-230D / 440-480Y V
Rated current:	2.3 / 1.2 A
Enclosure class (IEC 34-5):	55
Insulation class (IEC 85):	F
Motor protection:	NONE
Others:	
Net weight:	20.3 lb
Gross weight:	25.1 lb
Shipping volume:	1.73 ft³
Sales region:	Namreg



GRUNDFOS

Company name: -
Created by: -
Phone: -
Fax: -
Date: -

4H513463 CHI 2-30 60 Hz



Note! All units are in [mm] unless others are stated.
Disclaimer: This simplified dimensional drawing does not show all details.

CHI and CHIE
Stainless Steel Horizontal Multistage End Suction Pumps

Installation and operating instructions

CONTENTS

1.	Pre-installation Checklist	2
2.	General data	2
3.	Technical data	2
4.	Installation	3
5.	Electrical connections	3
6.	CHIE-Plus – Additional instructions	3
7.	Start-up	3
8.	Operation and Maintenance	4
9.	Preliminary Checks	4
10.	Fault-finding chart	4
11.	Disposal	4

Before beginning installation procedures, these installation and operating instructions should be studied carefully. The installation and operation should also be in accordance with local regulations and accepted codes of good practice.

PLEASE LEAVE THESE INSTRUCTIONS WITH THE PUMP FOR FUTURE REFERENCE.

1. Pre-installation Checklist

1.1 Confirm you have the right pump

Read the pump nameplate to make sure it is the one you ordered.

1.2 Check the condition of the pump

The shipping carton your pump came in is specially designed around your pump during production to prevent damage. As a precaution, it should remain in the carton until you are ready to install it. At that point look at the pump and examine it for any damage that may have occurred during shipping.

2. General data

2.1 CHI & CHIE...What is the difference?

CHI and CHIE pump end components are identical. The difference between the two models is the stator and terminal box. CHI pumps are standard 1 phase and 3 phase, 60 HZ, constant speed pumps. CHIE and CHIE-Plus pumps are powered by 1 phase, 230 volts, 60 HZ, variable speed motors with an integrated variable frequency drive (VFD) and system controller ("PI" type). Consult the Grundfos "CRE...CHIE Installation and Operating Instructions," included with the pump, for electrical installation and motor operation. Refer to these instructions for pump end installation and operation.

2.2 Applications

Grundfos pumps, type CHI, are horizontal multi-stage centrifugal pumps of the non-self-priming type designed for pumping thin non-explosive liquids.

CAUTION - This pump is intended for use with water only.

The pump with integral motor is fitted to a base plate.

The pump is made of corrosion-resistant materials, which makes it ideally suited for water supply and a wide range of applications in industry, agriculture and in the food industry.

The pump must not be used for the transfer of flammable liquids such as diesel oil, gasoline, or similar liquids.

The pump is designed for pumping clean water, domestic hot water, aqueous solutions, cleaning solutions, suspensions or light oils and other liquids with a density and viscosity corresponding to those of water. The liquids must not contain abrasive particles or fibers.

When pumping liquids with a density or viscosity higher than that of water, motors with correspondingly higher outputs must be used.

As standard, the mechanical shaft seal for the CHI pump is available in six versions with different material combinations; see the stamping code on the pump nameplate.

Example: Type CHI 4-50 A-B-G-**BQQE**.

Code	Shaft seal materials	
	Seal faces	Rubber parts
BUBE **BUBV**	Tungsten carbide/ carbon	EPDM FKM
BQQE **BQQV**	SiC/SiC*	EPDM FKM
BUUE **BUUV**	Tungsten carbide/ Tungsten carbide	EPDM FKM

*SiC: Silicon carbide.

3. Technical data

3.1 Ambient temperature

+5°F to +104° F (-15°C to +40° C) at a relative air humidity of maximum 95%.

3.2 Liquid temperature

+5°F to +230°F (-15°C to 110°C).

3.3 Maximum operating pressure

145 psi (10 bar).

3.4 Maximum Inlet Pressure

The actual inlet pressure plus the pressure when the pump is operating against a closed valve should always be lower than the "maximum operating pressure."

3.5 Sound pressure level

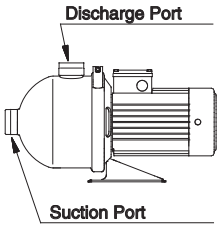
The sound pressure level of the pump is less than 70 dB(A) at a distance of 3 feet from the pump.

4. Installation

4.1 Pump location

The pump must be installed with the motor shaft horizontal, see fig. 1, and so that adequate air supply reaches the motor cooling fan.

Fig. 1



A solid foundation should be provided for the pump, which can be secured by bolts, if required.

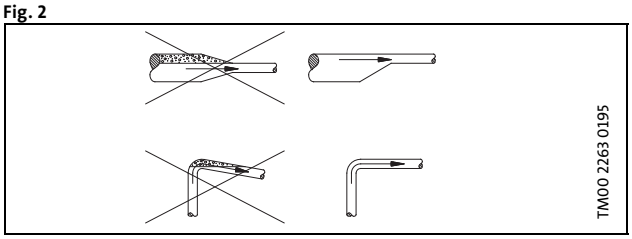
Pipe connections:

Suction and discharge ports:

CHI 2:	1" NPT
CHI 4:	1 1/4" NPT
CHI 8:	1 1/2" NPT
CHI 12:	1 1/2" NPT

Install the pipes so that air pockets are avoided, especially on the suction side of the pump, shown in fig. 2.

Fig. 2



Isolating valves should be fitted on either side of the pump to avoid draining the system if the pump needs to be cleaned or repaired.

If pumps are installed close to living accommodation, it is advisable to fit anti-vibration mountings on either side of the pump and between the foundation and pump to prevent vibration being transmitted through the pipework. This applies especially to pumps installed in concrete buildings.

Install the pump so that it is not stressed or strained by the pipework, especially tension caused by variations in temperature. If pumps are installed in long pipes, these should be adequately supported before and after the pump.

If there is any danger of the pump running against a closed valve in the discharge pipe, a bypass should be installed on the discharge side of the pump to ensure that adequate cooling and lubrication water is circulated through the pump (a minimum flow equal to 10% of the nominal flow is needed at all times).

This is less for CHIE pumps. CHIE pumps can automatically stop at no-flow conditions.

5. Electrical connections

The electrical connection and protection should be carried out in accordance with local regulations. The connections are shown in the wiring diagram inside the terminal box cover.

Never make any connections in the pump terminal box unless the electricity supply has been switched off.

The pump must be connected to an external main switch.

The operating voltage and frequency are marked on the nameplate. Please make sure that the motor is suitable for the electricity supply on which it will be used.

CHI single-phase motors DO NOT incorporate a thermal overload switch and require additional motor protection. (CHIE motors do not require this, only fuses or circuit breakers per instructions in the "CRE...CHIE Installation and Operating Instructions.")

Three-phase motors must be connected to an approved motor starter. The set nominal current of which must correspond to the electrical data on the pump nameplate.

- Do not start the pump until it has been filled with liquid.
- Connections should be made as shown on the inside of the terminal box cover.
- Choose one of the two CHI cable entries and knock out the pre-cut disk. CHIE instructions are in the "CRE...CHIE Installation and Operating Instructions."

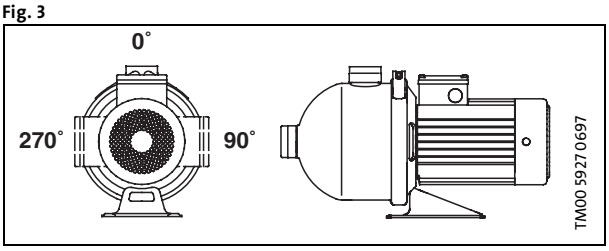
On pumps with the *base plate fitted to the pump,* the terminal box can be turned to three positions, in 90° steps, see fig. 3.

To change the position of the terminal box, proceed as follows:

1. Remove the four screws securing the motor to the motor stool.
2. Turn the motor to the required position.

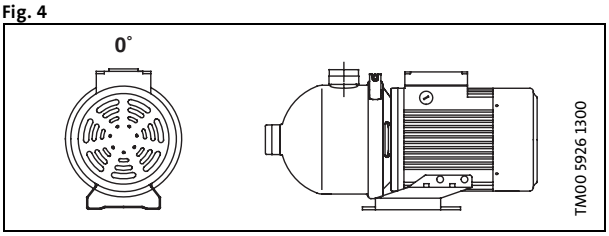
Replace and tighten the four screws.

Fig. 3



Pumps with the base plate fitted to the motor must be installed with the terminal box in position 0°, see fig. 4.

Fig. 4



6. CHIE-Plus – Additional instructions

- Attach the transducer/tank assembly to the pump. The mating half-union is already installed on the pump. Position the assembly such that the tank points in the same direction as the pump inlet.
- Install the check valve at or near the suction port and a pressure gauge down line from the pump discharge.
- Prime the pump through the priming plug on the cross fitting.
- At start-up, make sure fluid is supplied to the inlet of the pump. Adjust the pump by pressing the "+" or "-" buttons until the desired setpoint is achieved. Open the priming plug slightly to allow residual air to escape. If the fluid is something other than water, take care to make sure escaping air/fluid does not cause harm to the installer or adjacent equipment. Tighten the priming plug.
- To test the "stop function," close the pump discharge (isolation valve or demand fixtures). The pump should stop within two minutes. If it does not stop, check for plumbing leaks.
- To test the constant pressure function, open the discharge slightly and adjust the "+" or "-" buttons to the desired setpoint. As the flow is varied, the pump will change speed to maintain the desired pressure. If the pressure drops as you increase the flow, you may have exceeded the maximum capacity of the pump.
- The desired pressure is only maintained when the demand point is under the maximum pump curve.

7. Start-up

At high system temperatures, the pump may be extremely hot. Do not touch it.

7.1 Priming

Before startup, or if the pump has been drained, the pump must be filled with liquid and vented.

Proceed as follows:

In closed systems or open systems where the liquid level is above the pump inlet:

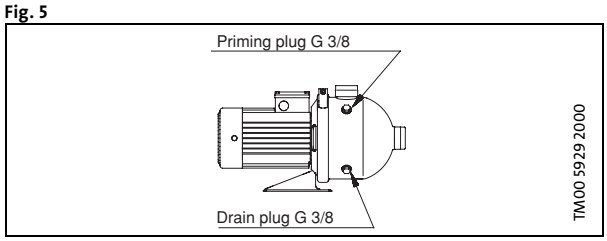
1. Close the discharge isolating valve.
2. Remove the priming plug in the pump sleeve, see fig. 5.

Slowly open the isolating valve in the suction pipe until a steady stream of liquid runs out of the priming port.

The escaping liquid may be scalding hot. Therefore, care must be taken to ensure that the liquid does not cause personal injury or damage to other components.

3. Start the pump and slowly open the discharge valve until it is fully open.
4. Completely open the isolating valve(s).

Fig. 5



In open systems where the liquid level is below the pump inlet, the suction pipe must also be filled with liquid and vented before the pump is started:

1. Close the discharge isolating valve.
2. Remove the priming plug in the pump sleeve.
3. Pour water through the priming hole until the suction pipe and the pump are completely filled with liquid.
   - If the suction pipe does not slope downwards away from the pump, air must be purged from the suction pipe while the pump is being filled.
   - Filling may take place at the highest point of the suction pipe if this is above the priming plug of the pump.
4. Replace the priming plug and tighten securely.

7.2 Checking direction of rotation (CHI three-phase)

Arrows on the fan cover indicate the correct direction of rotation. The pump should rotate counter-clock-wise when seen from the motor fan. To reverse rotation, switch off electricity supply and interchange any two of the incoming supply wires.

8. Operation and Maintenance

8.1 Frequency of starts and stops

Maximum 100 starts per hour.

8.2 Maintenance

Pump and motor are maintenance free.

8.3 Freeze protection

Pumps which are not being used during periods of freezing should be drained to avoid damage.

Remove the priming and drain plugs and allow the pump to drain. Do not replace the plugs until the pump is to be used again.

The escaping liquid may be scalding hot. Therefore, care must be taken to ensure that the liquid does not cause personal injury or damage to other components.

8.4 Cleaning

If the pump has been used for pumping aggressive or polluted liquids, it should be flushed through with clean water to avoid corrosion or sediment in case the pump is not being used for some time.

8.5 Service

If a pump has been used for a liquid which is injurious to health or toxic, the pump will be classified as contaminated.

If GRUNDFOS is requested to service the pump, GRUNDFOS must be contacted with details about the pumped liquid, etc., *before* the pump is returned for service. Otherwise GRUNDFOS can refuse to accept the pump for service.

Possible costs of returning the pump are paid by the customer.

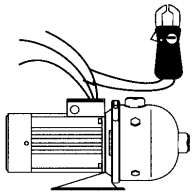
9. Preliminary Checks

9.1 Measuring Voltage

Use a volt meter, (set to the proper scale) measure the voltage at the pump terminal box or starter.

On single-phase units, measure between power leads L1 and L2 or L1 and N for 115 volt units). On three-phase units, measure between:

- Power leads L1 and L2
- Power leads L2 and L3
- Power leads L3 and L1



What it means

When the motor is under load, the voltage should be within +/- 10% of the nameplate voltage. Larger voltage variation may cause winding damage.

Large variations in the voltage indicate a poor electrical supply and the pump should be not operated until these variations have been corrected. If the voltage constantly remains high or low, the motor should be changed.

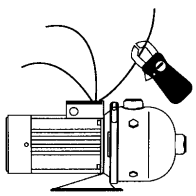
9.2 Measuring Current

Use an ammeter (set on the proper scale) to measure the current on each power lead at the terminal box or starter. See the motor nameplate for amp draw information.

Current should be measured when the pump is operating at constant discharge pressure.

What it means

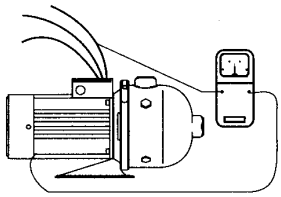
If the amp draw exceeds the listed service factor amps (SFA) or if the current imbalance is greater than 5% between each leg on three-phase units, check the following:



- Burned contacts on motor starter.
- Loose terminals in starter or terminal box or possible wire defect.
- Too high or too low supply voltage.
- Motor windings are shorted or grounded. Check winding and insulation resistances.
- Pump is damaged causing a motor overload.

9.3 Measuring Resistance

Turn off power and disconnect the supply power leads in the pump terminal box. Using an ohm or mega ohm meter, set the scale selector to Rx 100K and zero adjust the meter. Measure and record the resistance between each of the terminals and ground.



What it means

Motors of all HP, voltage, phase and cycle duties have the same value of insulation resistance. Resistance values for new motors must exceed 1,000,000 ohms. If they do not, motor should be repaired or replaced.

10. Fault-finding chart

Before removing the terminal box cover make sure that the electricity supply has been switched off. The pumped liquid may be scalding hot and under high pressure. Before any removal or dismantling of the pump, the system must therefore be drained or the isolating valves on either side of the pump must be closed.

Fault	Cause
1. Motor does not start when the motor starter is operated.	a. Supply failure. b. Fuses blown. c. Motor starter overload has tripped out. d. Main contacts in starter are not making contact or the coil is faulty. e. Control circuit fuses are defective.
2. Starter overload trips out immediately when supply is switched on.	a. One fuse is blown. b. Contacts in overload are faulty. c. Cable connection is loose or faulty. d. Motor winding is defective. e. Pump stiff and not free to run. f. Overload setting too low.
3. Motor starter overload trips out occasionally.	a. Overload setting too low. b. Periodic supply failure. c. Low voltage at peak times.
4. Pump does not run when starter is operated.	a. Check 1 a), b), d), and e).
5. Pump capacity not constant.	a. Pump inlet pressure is too low. b. Suction pipe partly blocked by impurities. c. Pump takes in air.
6. Pump runs but gives no water.	a. Suction pipe blocked by impurities. b. Foot or non-return valve blocked in closed position. c. Leakage in suction pipe. d. Air in suction pipe or pump.
7. Pump runs backwards when switched off.	a. Leakage in suction pipe. b. Foot or non-return valve defective. c. Foot valve blocked in open or partly open position.

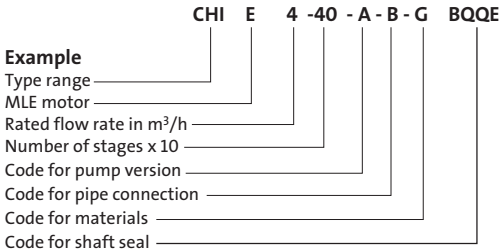
4. Disposal

Disposal of this product or parts of it must be carried out according to the following guidelines:

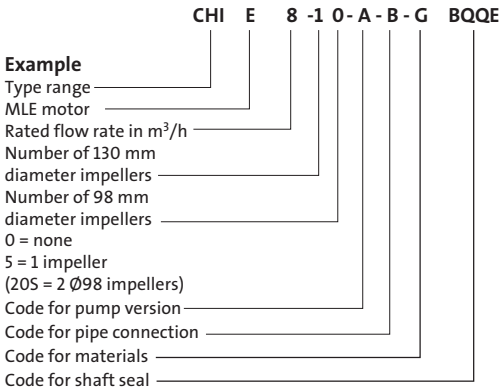
1. Use the local public or private waste collection service.
2. In case such waste collection service does not exist or cannot handle the materials used in the product, dispose of the product according to local regulations.

Type Keys Grundfos CHI(E)

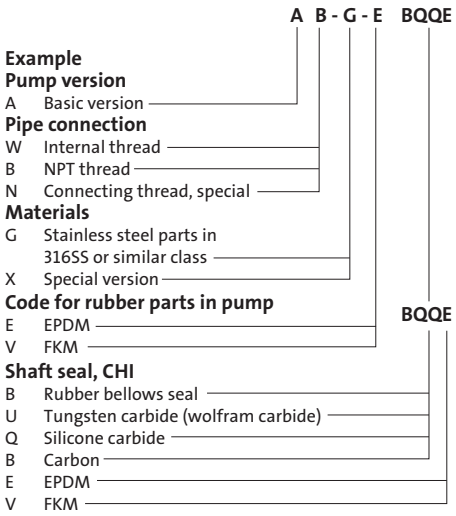
CHI(E) 2 and CHI(E) 4



CHI(E) 8 and CHI(E) 12



Codes



LIMITED WARRANTY

Products manufactured by GRUNDFOS PUMPS CORPORATION (GRUNDFOS) are warranted to the original user only to be free of defects in material and workmanship for a period of 24 months from date of installation, but not more than 30 months from date of manufacture. GRUNDFOS' liability under this warranty shall be limited to repairing or replacing at GRUNDFOS' option, without charge, F.O.B. GRUNDFOS' factory or authorized service station, any product of GRUNDFOS' manufacture. GRUNDFOS will not be liable for any costs of removal, installation, transportation, or any other charges which may arise in connection with a warranty claim. Products which are sold but not manufactured by GRUNDFOS are subject to the warranty provided by the manufacturer of said products and not by GRUNDFOS' warranty. GRUNDFOS will not be liable for damage or wear to products caused by abnormal operating conditions, accident, abuse, misuse, unauthorized alteration or repair, or if the product was not installed in accordance with GRUNDFOS' printed installation and operating instructions.

To obtain service under this warranty, the defective product must be returned to the distributor or dealer of GRUNDFOS' products from which it was purchased together with proof of purchase and installation date, failure date, and supporting installation data. Unless otherwise provided, the distributor or dealer will contact GRUNDFOS or an authorized service station for instructions. Any defective product to be returned to GRUNDFOS or a service station must be sent freight prepaid; documentation supporting the warranty claim and/or a Return Material Authorization must be included if so instructed.

GRUNDFOS WILL NOT BE LIABLE FOR ANY INCIDENTAL OR CONSEQUENTIAL DAMAGES, LOSSES, OR EXPENSES ARISING FROM INSTALLATION, USE, OR ANY OTHER CAUSES. THERE ARE NO EXPRESS OR IMPLIED WARRANTIES, INCLUDING MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE, WHICH EXTEND BEYOND THOSE WARRANTIES DESCRIBED OR REFERRED TO ABOVE.

Some jurisdictions do not allow the exclusion or limitation of incidental or consequential damages and some jurisdictions do not allow limitations on how long implied warranties may last. Therefore, the above limitations or exclusions may not apply to you. This warranty gives you specific legal rights and you may also have other rights which vary from jurisdiction to jurisdiction.

Type 21 Ball Valve

Standard Features (Sizes 1/2" – 6")

- Pressure rated up to 230 psi (PVC, CPVC, PVDF)
- Double O-ring seals on stem for added protection.
- Full bore, sizes 1/2" – 2"
- Full vacuum rated, all sizes
- Blocks in two directions, upstream and downstream, leaving full pressure on the opposite end of the valve
- Integrally molded ISO mounting pad for both manual and actuated operations
- Integrally molded base pad to mount valves securely or panel mounting
- PTFE seats with elastomeric backing cushions ensure bubble-tight shut-off and a low fixed torque, while at the same time compensating for wear
- True Union design for easier installation or repairs without expanding the pipe system
- Built-in spanner wrench on the handle for valve disassembly and assembly
- Two sets of end connectors (socket and threaded) included with all PVC and CPVC valves in sizes 1/2"– 2"
- CPVC threaded end connectors on sizes 1/2" – 1" come with stainless steel reinforcing rings

Options

- Pneumatic and electric actuators & accessories
- Stem extensions
- 2" square operating nut or "T" nut
- Locking and/or spring return handles
- Limit switches
- Vented Ball

Specifications

Sizes:	1/2" – 6"
Models:	PVC & CPVC: Socket, Threaded and Flanged (ANSI) PP & PVDF: IPS and Metric (DIN) Socket, Threaded, Butt and Flanged (ANSI)
Bodies:	PVC, CPVC, PP and PVDF
Seats:	PTFE backed with EPDM or FKM
Seals:	EPDM or FKM or AFLAS®‡

Sizes 1/2" - 4" PVC/EPDM/FKM Models available with NSF-61 Certification

‡ Trademark of Asahi Glass Co., Ltd.

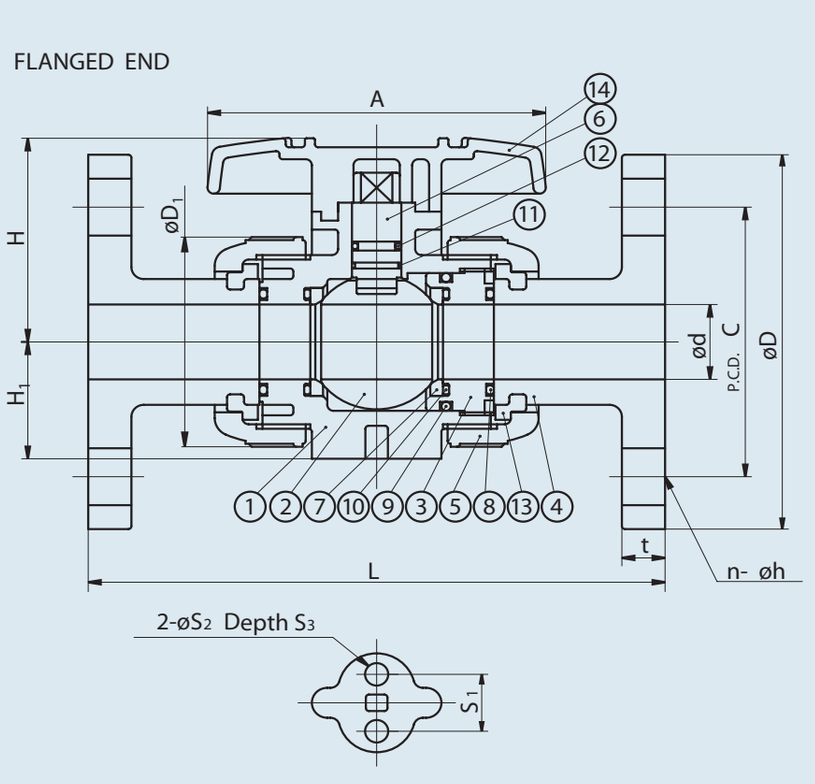
Parts List (Sizes 1/2" – 2")

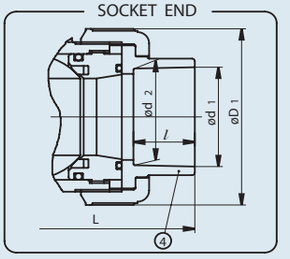
PARTS			
NO.	DESCRIPTION	PCS.	MATERIAL
1	Body	1	PVC, CPVC, PP, PVDF
2	Ball	1	PVC, CPVC, PP, PVDF
3	Carrier	1	PVC, CPVC, PP, PVDF
4	End Connector	2	PVC, CPVC, PP, PVDF
5	Union Nut	2	PVC, CPVC, PP, PVDF
6	Stem	1	PVC, CPVC, PP, PVDF
7	Seat	2	PTFE
8	O-Ring (A)	2	EPDM, FKM, Others
9	O-Ring (B)	1	EPDM, FKM, Others
10	O-Ring (C)	2	EPDM, FKM, Others
11	O-Ring (D)	1	EPDM, FKM, Others
12	O-Ring (E)	1	EPDM, FKM, Others
13	Stop Ring*	2	PVDF
14	Handle	1	ABS
4a	Ring**	2	304 Stainless Steel

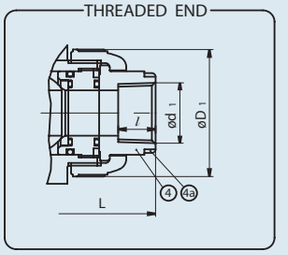
* Used for flanged end

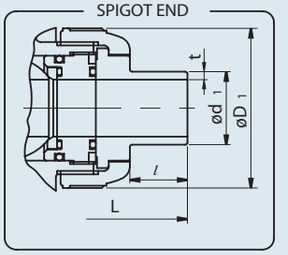
**Used for CPVC body, threaded end, 1/2"–1"

Type 21 Ball Valves









Dimensions (Sizes 1/2" – 2")

NOMINAL SIZE			FLANGED						SOCKET										
			ANSI CLASS 150						PVC, CPVC				PP, PVDF (DIN)				PP, PVDF (IPS)		
									ASTM SCH 80				DIN 16962						
INCHES	mm	d	D	C	n	h	L	t	d1	d2	l	L	d1	d2	l	L	d1	l	L
1/2	15	0.59	3.50	2.38	4	0.62	5.63	0.47	0.848	0.836	0.875	4.45	0.768	0.760	0.57	3.90	0.83	0.87	4.45
3/4	20	0.79	3.88	2.75	4	0.62	6.77	0.55	1.058	1.046	1.000	5.08	0.965	0.957	0.63	4.49	1.03	1.00	5.08
1	25	0.98	4.25	3.12	4	0.62	7.36	0.55	1.325	1.310	1.125	5.75	1.240	1.232	0.71	4.84	1.30	1.13	5.75
1 1/4	32	1.26	4.62	3.50	4	0.62	7.48	0.63	1.670	1.655	1.250	6.46	1.553	1.543	0.81	5.47	1.65	1.25	6.46
1 1/2	40	1.57	5.00	3.88	4	0.62	8.35	0.63	1.912	1.894	1.375	7.24	1.947	1.937	0.93	5.83	1.89	1.37	7.24
2	50	2.01	6.00	4.75	4	0.75	9.21	0.63	2.387	2.369	1.500	8.23	2.461	2.445	1.08	6.93	2.36	1.50	8.23

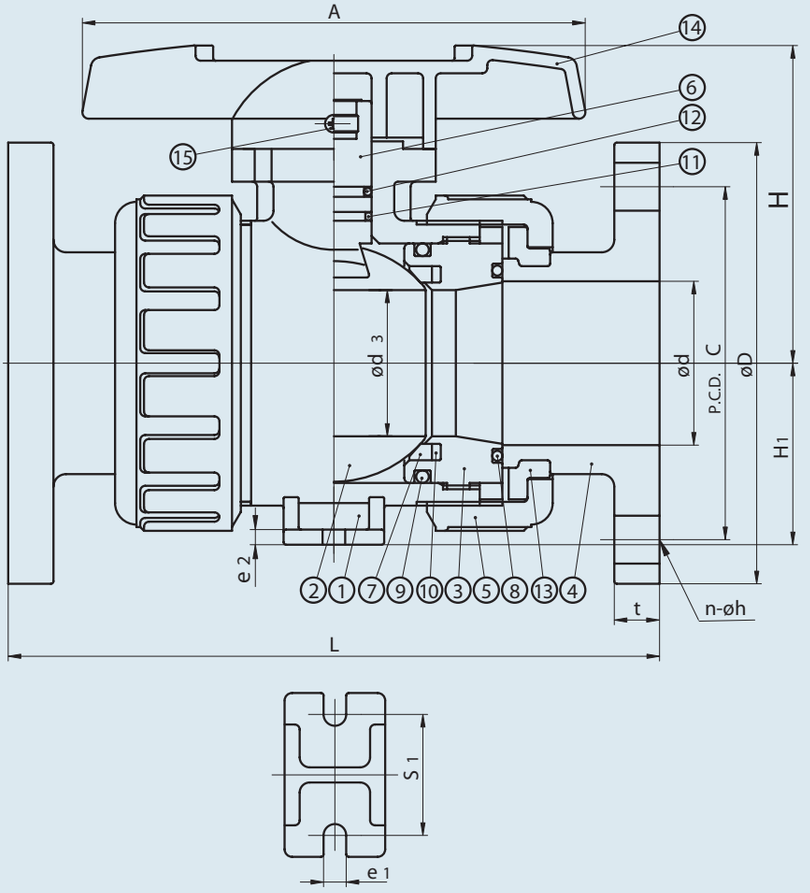
NOMINAL SIZE		THREADED							SPIGOT (BUTT END)							
									PP,PVDF							
									DIN 3442		PP	PVDF				
INCHES	mm	d1	l	L	D1	H	H1	A	d1	l	t	t	L	S1	S2	S3
1/2	15	1/2-14 NPT	0.59	4.02	1.89	2.03	1.14	3.62	0.787	0.728	0.098	0.075	4.882	0.75	0.29	0.43
3/4	20	3/4-14 NPT	0.67	4.72	2.36	2.34	1.38	3.94	0.984	0.866	0.106	0.075	5.670	0.75	0.29	0.43
1	25	1-11 1/2 NPT	0.79	5.16	2.76	2.68	1.54	4.33	1.260	0.886	0.118	0.094	6.063	0.75	0.29	0.43
1 1/4	32	1 1/4-11 1/2 NPT	0.87	5.91	3.23	3.17	1.85	4.76	1.575	1.024	0.146	0.094	6.850	1.18	0.35	0.59
1 1/2	40	1 1/2-11 1/2 NPT	0.98	6.42	3.94	3.50	2.17	5.16	1.969	1.260	0.181	0.118	7.638	1.18	0.35	0.59
2	50	2-11 1/2 NPT	1.10	7.76	4.96	4.04	2.60	6.26	2.480	1.417	0.228	0.118	8.819	1.18	0.35	0.59

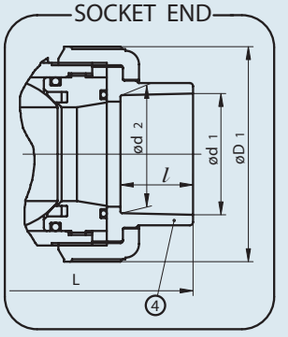
Type 21 Ball Valves

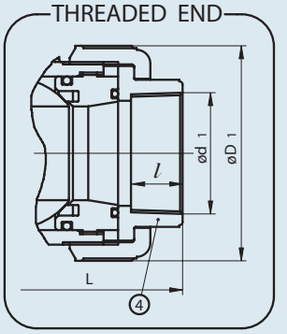
PARTS (DIFFERENT NUMBERS FROM 1/2" – 2")			
NO.	DESCRIPTION	PCS.	MATERIAL
10	Cushion	2	EPDM, FKM, Others
15	Screw	1	304 Stainless Steel

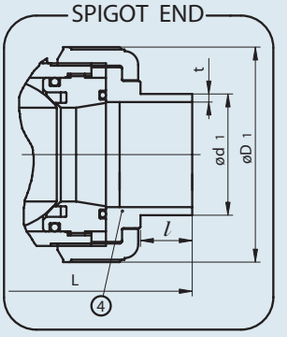
FLANGED END

NOTE: Quantity on Nos. 3 and 9 (see p. 6) is 2.









Dimensions (Sizes 2-1/2" – 4") FOR 6" SIZE CONSULT FACTORY

NOMINAL SIZE			FLANGED						SOCKET										
			ANSI CLASS 150						PVC, CPVC				PP, PVDF (DIN)				PP, PVDF (IPS)		
									ASTM SCH 80				DIN 16962						
INCHES	mm	d	D	C	n	h	L	t	d_1	d_2	l	L	d_1	d_2	l	L	d_1	l	L
21/2	65	2.56	7	5.5	4	0.75	10.2	0.71	2.889	2.868	1.75	9.45	2.923	2.911	1.22	8.15	2.88	1.752	9.45
3	80	3.07	7.5	6	4	0.75	11.97	0.71	3.516	3.492	1.875	11.1	3.512	3.498	1.4	9.88	3.48	1.874	11.1
4	100	3.94	9	7.5	8	0.75	14.65	0.71	4.518	4.491	2	13.9	4.293	4.278	1.63	12.2	4.48	2.252	14.37

NOMINAL SIZE		THREADED								SPIGOT (BUTT END)							
										PP,PVDF							
										DIN 3442		PP	PVDF				
INCHES	mm	d_1	l	L	d_3	D1	H	H_1	A	d_1	l	t	t	L	e_1	e_2	S_1
21/2	65	2 1/2 - 8NPT	1.26	8.46	2.28	5.24	4.96	2.83	7.87	2.953	1.496	0.272	0.142	9.72	0.35	0.24	1.89
3	80	3 - 8NPT	1.38	10.39	2.70	5.98	5.51	3.35	9.45	3.543	1.496	0.323	0.169	11.61	0.43	0.28	2.17
4	100	4 - 8NPT	1.77	14.17	3.54	8.27	7.01	4.33	11.81	4.331	1.752	0.394	0.209	12.72	0.43	0.31	2.56

Type 21 Ball Valves

Pressure vs. Temperature (PSI, WATER, NON-SHOCK)

NOMINAL SIZE		PVC				CPVC						PP				PVDF				
INCHES	mm	30° F 70° F	71° F 105° F	106° F 120° F	121° F 140° F	30° F 70° F	71° F 105° F	106° F 120° F	121° F 140° F	141° F 175° F	176° F 195° F	-5° F 85° F	86° F 120° F	121° F 140° F	141° F 175° F	-5° F 70° F	71° F 105° F	106° F 140° F	141° F 175° F	176° F 210° F
1/2-2	15-50	230	170	150	30	230	170	150	120	75	55	150	110	90	55	230	185	150	115	85
2 1/2	65	230	170	150	NA	230	170	150	120	75	55	150	95	70	40	230	185	150	115	85
3	80	230	170	150	NA	230	170	150	85	55	40	150	95	70	40	230	185	150	100	70
4-6	100-150	150	150	150	NA	150	150	150	85	55	40	150	95	70	40	150	150	150	100	70

Sample Specification

All TYPE 21 Ball Valves, sizes 1/2" to 4", shall be of true union design with two-way blocking capability. All O-rings shall be EPDM or FKM with PTFE seats. PTFE seats shall have elastomeric backing cushion of the same material as the valve seals. Stem shall have double O-rings and be of blowout-proof design. The valve handle shall double as carrier removal and/or tightening tool. ISO mounting pad shall be integrally molded to valve body for actuation. PVC conforming to ASTM D1784 Cell Classification 12454-A, CPVC conforming to ASTM D1784 Cell Classification 23567-A, PP Conforming to ASTM D4101 Cell Classification PP0210B67272 and PVDF conforming to ASTM D3222 Cell Classification Type II. The ball valves, except PP, shall have a pressure rating of 230 psi for sizes 1/2" to 3" and 150 psi for 4" (150 psi for PP, all sizes) at 70 ° F. Type 21 Ball Valves must carry a two-year guarantee, as manufactured by Asahi/America, Inc.

Cv Values

NOMINAL SIZE		Cv
INCHES	mm	
1/2	15	14
3/4	20	29
1	25	47
1 1/4	32	72
1 1/2	40	155
2	50	190
2 1/2	65	365
3	80	410
4	100	680

Weight (POUNDS)

NOMINAL SIZE		SOCKET THREADED	FLANGED
INCHES	mm		
1/2	15	0.44	1.10
3/4	20	0.66	1.54
1	25	1.10	2.70
1 1/4	32	1.54	3.30
1 1/2	40	2.64	4.40
2	50	4.40	8.15
2 1/2	65	6.17	8.80
3	80	9.70	13.00
4	100	24.00	26.67

Caution

- Never remove valve from pipeline under pressure.
- Always wear protective gloves and goggles.
- Watch out for trapped fluid in valve. It is safe to close valve before removing it from the pipeline.

Caution

- Do not use ball valves where media has suspended particles. Use the following valves: *Butterfly Valves* – PVDF disc is most abrasion resistant and make sure of chemical compatibility. *Diaphragm Valves* – Elastomeric diaphragm is designed for handling suspended particles.
- Volatile fluids such as sodium hypochlorite (NaClO) and hydrogen peroxide (H_2O_2) could be trapped and gasified within the valve. We can provide you with a Type 21 ball valve with a *vented ball* to relieve pressure build-up inside the valve.

Troubleshooting

What if the fluid still flows when valve is closed?

1. Carrier is not properly tightened. Tighten it.
2. PTFE seat is damaged or worn. Replace seat.
3. Foreign material is caught between ball and PTFE seat. Remove material and clean.
4. Ball is damaged or worn. Change ball.

What if fluid leaks outside of valve?

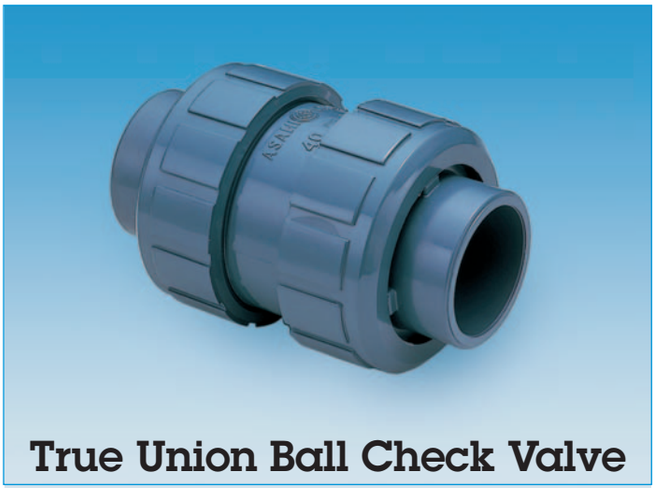
1. Union nut not properly tightened. Retighten.
2. Carrier is not properly tightened. Thread it in firmly.
3. Carrier or face O-ring is damaged, worn, or missing. Replace O-ring.

What if handle does not rotate smoothly?

1. Foreign material has formed on the ball or seat. Clean both.
2. Internal part(s) chemically attacked or swollen. Refer to Asahi/America Chemical Resistance Chart for compatibility. Replace part(s) as required.
3. Carrier over-tightened. Retighten properly.

What if handle rotates too freely?

1. Stem is damaged. Replace stem.
2. Handle is not engaged with stem. Disassemble and reengage. Inspect.



True Union Ball Check Valve

Specifications

Sizes: True Union : 1 /2" – 2"
Single Union: 3" – 4"

Models: Socket, Threaded, Flanged (ANSI), Butt End

Bodies: PVC, CPVC, PP and PVDF

Seats: EPDM, FKM, PTFE

Seals: EPDM, FKM, PTFE

Option: Foot Valve

Sizes 1/2" - 4" PVC/EPDM/FKM Models are available with NSF-61 Certification

Standard Features (Sizes 1/2" – 2")

- Uniseat/seal of EPDM or FKM
- Ball is the only moving part. It unseats to permit flow in one direction but seals against seat to prevent backflow.
- May be used vertically or horizontally
- Minimum shut-off of 5 psi
- All sizes rated for full vacuum service
- Solid thermoplastic ball

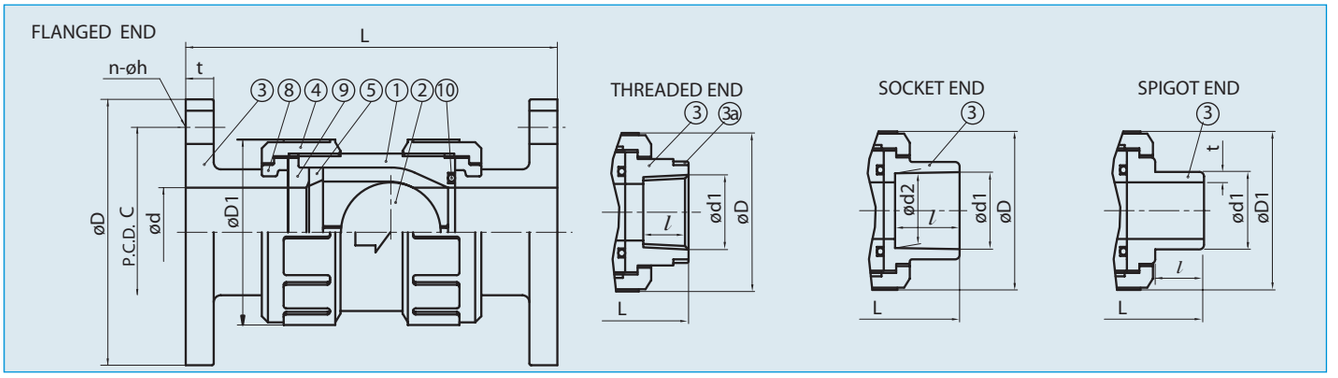
Options:

- PTFE coated FKM uniseat/seal
- Spring-loaded ball to assist ball in seating faster

Parts List – True Union (Sizes 1/2" – 2")

PARTS			
NO.	DESCRIPTION	PCS.	MATERIAL
1	Body	1	PVC, CPVC, PP, PVDF
2	Ball	1	PVC, CPVC, PP, PVDF
3	End Connector	2	PVC, CPVC, PP, PVDF
4	Union Nut	2	PVC, CPVC, PP, PVDF
5	Stop Ring (A)	1	PVC, CPVC, PP, PVDF
8	Stop Ring (B)*	1	PVDF
9	Seat	1	EPDM, FKM, PTFE
10	O-Ring	1	EPDM, FKM, PTFE
3a	Ring**	1	Stainless Steel 304

* Used for flanged end
** Used for CPVC body, threaded end; 1/2" – 1"



Dimensions (Sizes 1/2" – 2")

NOMINAL SIZE		FLANGED						THREADED					SOCKET											SPIGOT(BUTT END)				
		ANSI CLASS 150											PVC, CPVC				PP, PVDF (DIN)				PP, PVDF (IPS)			PP, PVDF				
													PP, PVDF				DIN 16962							DIN 3442	PP	PVDF		
INCHES	mm	D	C	n	h	L	t	d1	l	L	d	D1	d1	d2	l	L	d1	d2	l	L	d1	l	L	d1	l	t	t	L
1/2	15	3.50	2.38	4	0.62	5.12	0.47	1/2-14NPT	0.59	3.39	0.59	1.89	0.848	0.836	0.688	3.43	0.768	0.760	0.57	3.19	0.83	0.87	3.31	0.787	0.728	0.098	0.075	4.00
3/4	20	3.88	2.75	4	0.62	6.10	0.55	3/4-14NPT	0.67	4.06	0.79	2.36	1.058	1.046	0.719	3.86	0.965	0.957	0.63	3.70	1.03	1.00	4.43	0.984	0.866	0.106	0.075	4.35
1	25	4.25	3.12	4	0.62	6.50	0.55	1-11 1/2NPT	0.79	4.45	0.98	2.76	1.325	1.310	0.875	4.37	1.240	1.232	0.71	4.13	1.30	1.13	4.35	1.260	0.866	0.118	0.094	4.75
1 1/4	32	-	-	-	-	-	-	1 1/4-11 1/2NPT	0.87	5.00	1.22	3.78	1.670	1.655	0.938	4.92	-	-	-	-	-	-	-	-	-	-	-	-
1 1/2	40	5.00	3.88	4	0.62	7.56	0.63	1 1/2-11 1/2NPT	0.98	5.94	1.57	3.78	1.912	1.894	1.094	5.94	1.947	1.937	0.93	5.62	1.89	1.37	5.57	1.969	1.260	0.181	0.118	5.75
2	50	6.00	4.75	4	0.75	8.43	0.63	2-11 1/2NPT	1.10	6.97	2.01	4.17	2.387	2.369	1.156	6.77	2.461	2.445	1.08	6.69	2.36	1.50	6.49	2.480	1.417	0.228	0.118	6.50

Ball Check — Single Union

Parts List – Single Union (Sizes 3" – 4")

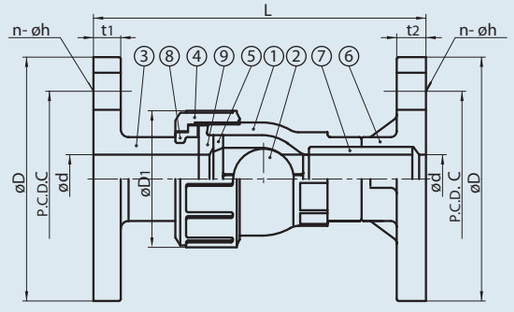
PARTS			
NO.	DESCRIPTION	PCS.	MATERIAL
1	Body	1	PVC, CPVC, PP, PVDF
2	Ball	1	PVC, CPVC, PP, PVDF
3	End Connector	1	PVC, CPVC, PP, PVDF
4	Union Nut	1	PVC, CPVC, PP, PVDF
5	Stop Ring (A)	1	PVC, CPVC, PP, PVDF
6	Flange		PVC, CPVC, PVDF
7	Stub		PVC, CPVC, PVDF
8	Stop Ring (B)*	1	PVDF
9	Seat	1	EPDM, FKM, PTFE

* Used for flanged end

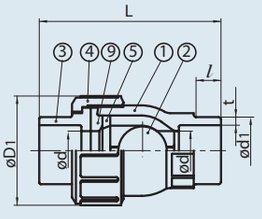
Dimensions (Sizes 3" – 4")

NOMINAL SIZE				FLANGED							SOCKET											THREADED			SPIGOT (BUTT END)				
				ANSI Class 150							PVC, CPVC				PP, PVDF (DIN)				PP, PVDF (IPS)						PP, PVDF				
											ASTM SCH40				DIN 16962										DIN 3442		PP	PVDF	
INCHES	mm	d	D1	D	C	n	h	L	t1	t2	d1	d2	l	L	d1	d2	l	L	d1	l	L	d1	l	L	d1	l	t	t	L
3	80	3.07	5.98	7.50	6.00	4	0.75	12.20	0.71	0.87	3.516	3.492	1.875	9.57	3.512	3.498	1.40	8.46	3.480	1.874	9.55	3-8 NPT	1.38	8.74	3.543	1.496	0.323	0.169	11.67
4	100	3.94	8.27	9.00	7.50	8	0.75	15.63	0.71	0.87	4.518	4.491	2.000	12.20	4.293	4.278	1.63	11.46	4.480	2.252	12.60	4-8 NPT	1.77	12.09	4.331	1.752	0.394	0.209	13.93

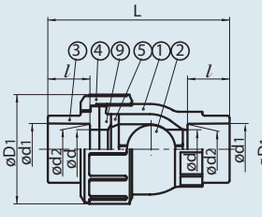
FLANGED END



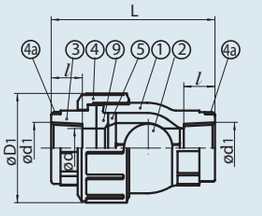
SPIGOT END



SOCKET END



THREADED END



True Union, Single Union, and Foot Valve Weight (POUNDS)

NOMINAL SIZE		SOCKET	FLANGED
INCHES	mm		
1/2	15	0.22	0.66
3/4	20	0.44	1.10
1	25	0.66	1.54
1 1/2	40	1.54	2.20
2	50	2.20	3.31
3	80	6.17	9.92
4	100	14.99	24.25

Cv Values

NOMINAL SIZE		Cv
INCHES	mm	
1/2	15	6.5
3/4	20	17
1	25	25
1 1/2	40	86
2	50	130
3	80	280
4	100	500

Sample Specification – (BALL CHECK VALVES)

All ball check valves and foot valves shall be of solid thermoplastic construction, and shall be designed with an elastomeric uniseat/seal for tight shut-off under pressure. Sizes 1/2" through 2" shall be of True Union design, while 3" & 4" shall be Single Union design. The same seal shall function as both the ball seat and the union seal. PVC shall conform to ASTM D1784 Cell Classification 12454-A, CPVC shall conform to ASTM D1784 Cell Classification 23567-A, PP shall conform to ASTM D4101 Cell Classification PP0210B67272 and PVDF shall conform to ASTM D3222 Cell Classification Type II. Ball Check valves and foot valves sizes 1/2"– 2" shall be rated 150 psi at 70 degrees F, 3" and 4" rated 100 psi at 70 degrees F, as manufactured by Asahi/America, Inc.

Ball Check Foot Valve Option

Parts List Foot Valve (Sizes 1/2" – 2")

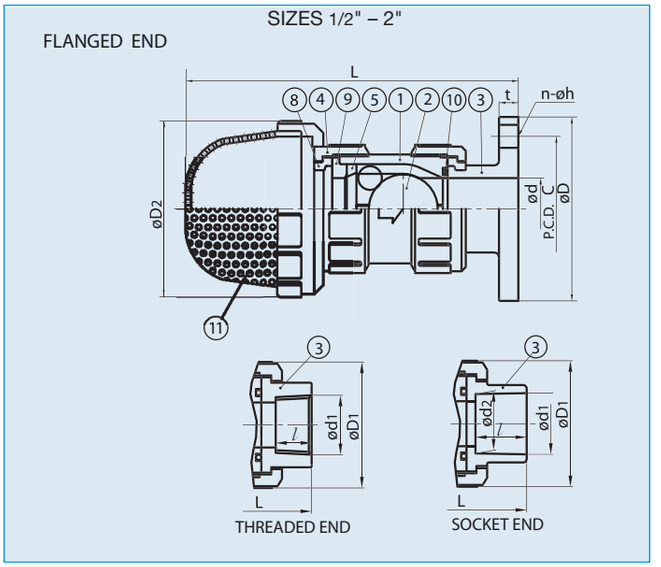
PARTS			
NO.	DESCRIPTION	PCS.	MATERIAL
1	Body	1	PVC
2	Ball	1	PVC
3	End Connector	1	PVC
4	Union Nut	1	PVC
5	Stop Ring (A)	1	PVC
8	Stop Ring (B)*	1	PVDF
9	Seat	1	EPDM, FKM, PTFE
10	O-Ring	2	EPDM, FKM, PTFE
11	Screen	1	PVC

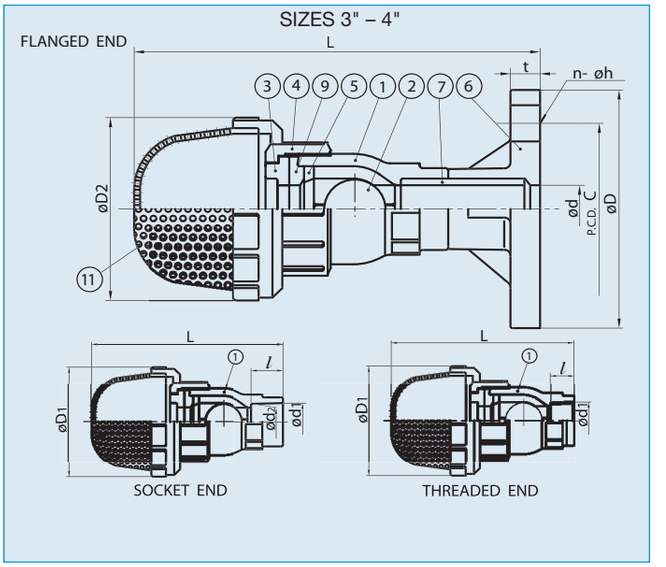
* Used for flanged end

Parts List Foot Valve (Sizes 3" – 4")

PARTS			
NO.	DESCRIPTION	PCS.	MATERIAL
1	Body	1	PVC
2	Ball	1	PVC
3	End Connector	1	PVC
4	Union Nut	1	PVC
5	Stop Ring (A)	1	PVC
6	Flange*	1	PVC
7	Stub*	1	PVC
9	Seat	1	EPDM, FKM, PTFE
11	Screen	1	PVC

* Used for flanged end





Pressure vs. Temperature – BALL CHECK AND FOOT VALVES (PSI, WATER, NON-SHOCK)

NOMINAL SIZE		PVC	CPVC				PP			PVDF			
INCHES	mm	30° F 120° F	30° F 120° F	121° F 140° F	141° F 175° F	176° F 195° F	-5° F 85° F	86° F 140° F	141° F 175° F	-30° F 140° F	141° F 175° F	176° F 195° F	196° F 210° F
1/2 - 2	15-50	150	150	120	90	60	150	90	60	150	125	110	90
3 - 4	80-100	100	100	90	60	45	75	60	45	100	90	60	45

Foot Valve Wt. (LBS)

NOMINAL SIZE		SOCKET	FLANGED
INCHES	mm		
1/2	15	0.22	0.66
3/4	20	0.44	0.88
1	25	0.66	1.32
1 1/2	40	1.54	3.31
2	50	2.20	3.31
3	80	7.71	11.02
4	100	15.43	23.14

Dimensions (1/2"– 4")

NOMINAL SIZE			SOC.	THR'D	FLG.
INCHES	mm	D2	L	L	L
1/2	15	2.36	4.73	4.69	5.40
3/4	20	2.76	5.32	5.52	6.40
1	25	3.78	6.24	6.32	6.90
1 1/2	40	5.24	8.33	8.33	8.50
2	50	5.24	8.97	9.17	10.50
3	80	11.80	12.60	11.80	14.60
4	100	18.25	18.25	18.25	20.25

Caution

- Never remove valve from pipeline under pressure.
- Always wear protective gloves and goggles.

Type 14 True Union Diaphragm

Specifications

Sizes: 1/2" – 2"
Body Materials: PVC, CPVC, PP and PVDF
Bonnet Materials: PVC, PP, PPG and PVDF
End Connectors: PVC, CPVC: IPS Soc. or Thr'd
PP, PVDF: IPS & Metric(DIN)
Socket, Threaded, Butt
Diaphragms: EPDM and
3-Layer EPDM/PVDF/PTFE
Also available in Nitrile and
FKM.
Operator: Handwheel

Standard Features

- True Union design permits installation or repairs without expanding pipeline
- Rugged square body and bonnet are of solid thermoplastic for maximum corrosion resistance
- Uniquely designed body and bonnet together with diaphragms of new sealing designs by the state-of-the-art computer aided analysis for superior sealing
- Weir design for excellent throttling
- Full vacuum rated
- Bubble-tight sealing, even in applications such as slurries or suspended particles
- Bonnet seals to protect internals from corrosive environments
- Adjustable travel stop to prevent diaphragm from being over-tightened
- Bayonet structure to connect compressor and diaphragm for quick maintenance
- Integrally molded bottom stand for simple yet firm panel mounting
- Indicator at the top for valve position
- PVDF gas barrier, which protects EPDM backing cushion from gas permeation, is standard for all valves with PTFE diaphragm
- Low profile

Options

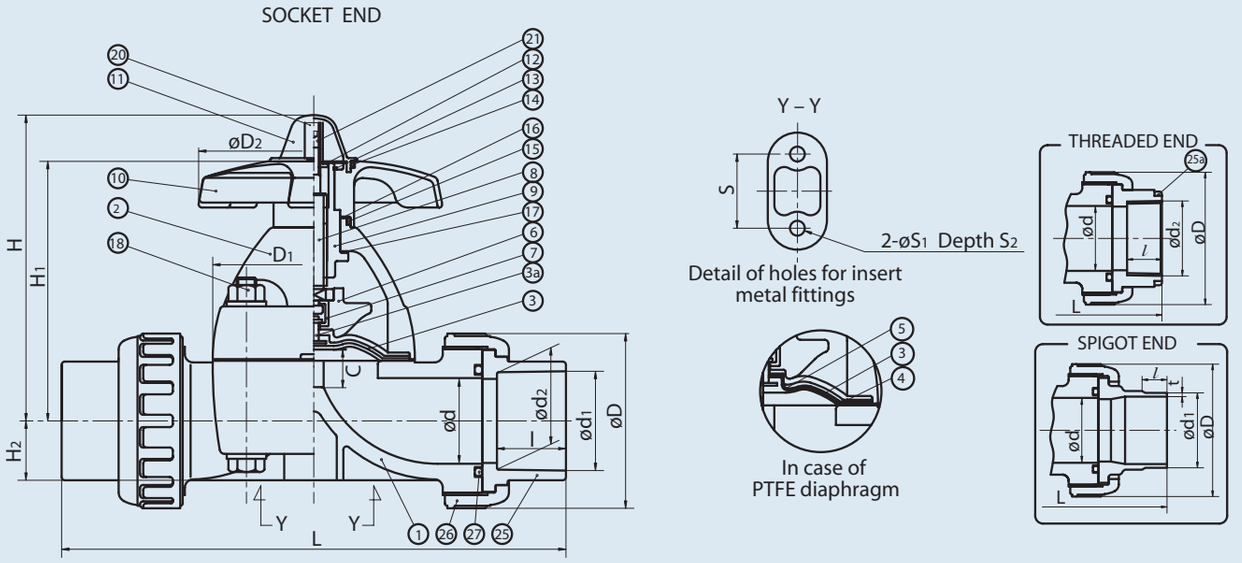
- 2" square operating nut for remote operation
- Stem extensions
- Locking device for tamper-proofing
- Teflon encapsulated FKM or FKM end connector o-ring seals.
- Pneumatic or electric actuation
- Manual limit switches for remote position indication by lights or for sequencing of other equipment

Parts Type 14 True Union (1/2" – 2")

PARTS			
NO.	DESCRIPTION	PCS.	MATERIAL
1	Body	1	PVC, CPVC, PP, PVDF
2	Bonnet	1	PVC, PPG, PP, PVDF
25	End Connector	2	PVC, CPVC, PP, PVDF
26	Union Nut	2	PVC, CPVC, PP, PVDF
3	Diaphragm	1	EPDM, PTFE, Others
3a	Diaphragm Metal Insert	1	Stainless Steel 304
4	Cushion*	1	EPDM
5	PVDF Gas Barrier*	1	PVDF
6	Compressor	1	PVDF
7	Joint	1	Stainless Steel 304
8	Stem	1	Copper Alloy
9	Sleeve	1	Copper Alloy
10	Hand Wheel	1	PP
11	Gauge Cover	1	PC
12	Name Plate	1	PVC
13	Retaining Ring C Type	1	Stainless Steel 304
14	O-Ring (A)	1	EPDM
15	O-Ring (B)	1	EPDM
16	Thrust Ring (A)	1	UHMWPE
17	Thrust Ring (B)	1	UHMWPE
18	Bolt, Nut, Washer	4 Sets	Stainless Steel 304, Others
20	Stopper (A)	1	Copper Alloy
21	Screw	1	Stainless Steel 304
27	O-Ring (C)	2	EPDM, FKM, Others
25a	RING**	2	Stainless Steel 304

* Used for PTFE diaphragm
** Used for CPVC body, threaded end, 1/2" through 1"

Type 14 True Union Diaphragm Valves



Dimensions Type 14 True Union (Sizes 1/2" – 2")

NOMINAL SIZE			SOCKET											THREADED			
			PVC, CPVC				PP, PVDF (DIN)				PP, PVDF (IPS)					L	
			ASTM SCH 80				DIN 16962										
INCHES	mm	d	d1	d2	l	L	d1	d2	l	L	d1	l	L	d1	l	PVC CPVC	PP PVDF
1/2	15	0.63	0.848	0.836	0.875	5.47	0.768	0.760	0.57	4.92	0.83	0.87	5.43	1/2-14NPT	O.59	5.04	5.04
3/4	20	0.79	1.058	1.046	1.000	6.18	0.965	0.957	0.63	5.55	1.03	1.00	6.09	3/4-14NPT	0.67	5.83	5.83
1	25	0.98	1.325	1.310	1.125	7.32	1.240	1.232	0.71	6.46	1.30	1.13	7.24	1-111/2NPT	0.79	6.77	6.77
1 1/4	32	1.26	1.670	1.655	1.250	7.95	1.553	1.543	0.81	6.97	1.65	1.25	7.80	11/4-111/2NPT	0.87	7.40	7.40
1 1/2	40	1.57	1.912	1.894	1.375	10.47	1.947	1.937	0.93	9.09	1.89	1.37	10.28	11/2-111/2NPT	0.98	9.65	9.65
2	50	2.05	2.387	2.369	1.500	11.54	2.461	2.445	1.08	10.79	2.36	1.50	11.54	2-111/2NPT	1.10	10.95	10.95

NOMINAL SIZE		SPIGOT (BUTT END)														
		PP, PVDF														
		DIN 3442		PP	PVDF											
INCHES	mm	d1	l	t	t	L	D	D1	D2	C (LIFT)	H	H1	H2	S	S1	S2
1/2	15	0.787	0.728	0.098	0.075	5.906	1.89	2.13 X 2.60	3.46	0.39	4.09	3.39	0.49	0.98	0.28	0.51
3/4	20	0.984	0.866	0.106	0.075	6.772	2.36	2.13 X 2.60	3.46	0.39	4.17	3.46	0.57	0.98	0.28	0.51
1	25	1.260	0.886	0.118	0.094	7.677	2.76	2.64 X 3.15	3.46	0.47	4.37	3.66	0.73	0.98	0.28	0.51
1 1/4	32	1.575	1.024	0.146	0.094	8.346	3.23	2.64 X 3.15	3.46	0.47	4.57	3.82	0.89	0.98	0.28	0.51
1 1/2	40	1.969	1.260	0.181	0.118	10.866	3.94	4.25 X 4.25	6.14	0.83	6.97	5.67	1.08	1.77	0.35	0.59
2	50	2.480	1.417	0.228	0.118	12.087	4.17	4.84 X 4.84	6.14	0.98	7.52	6.22	1.42	1.77	0.35	0.59

Caution

- Never remove valve from pipeline under pressure.
- Always wear protective gloves and goggles.

Type 14 True Union Diaphragm Valves

Pressure vs. Temperature PSI, WATER, NON-SHOCK

NOMINAL SIZE		PVC		CPVC				PP			PVDF		
		ALL DIAPHRAGMS		ALL DIAPHRAGMS				ALL DIAPHRAGMS			PTFE DIAPHRAGM		
INCHES	mm	30° F 105° F	106° F 140° F	30° F 105° F	106° F 140° F	141° F 175° F	176° F 195° F	-5° F 105° F	106° F 140° F	141° F 175° F	-40° F 140° F	141° F 175° F	176° F 210° F
1/2	15	150	130	150	115	85	40	150	115	85	150	120	95
3/4	20	150	130	150	115	85	40	150	115	85	150	120	95
1	25	150	130	150	115	85	40	150	115	85	150	120	95
1 1/4	32	150	130	150	115	85	40	150	115	85	150	120	95
1 1/2	40	150	130	150	115	85	40	150	115	85	150	120	95
2	50	150	130	150	115	85	40	150	115	85	150	120	95

Cv Values/Wt.

NOMINAL SIZE		Cv	WT. Soc (lbs)
INCHES	mm		
1/2	15	4.8	1.1
3/4	20	5.3	1.3
1	25	8.5	2.0
1 1/4	32	11	2.4
1 1/2	40	26	5.8
2	50	43	6.4

Note:

Working temperature is different from flanged version.

Troubleshooting

What if fluid leaks when valve is fully closed?

1. Travel stop not set correctly. Adjust it per the Asahi *Operation and Maintenance* manual.
2. Solids build up inside valve. Clean inside, including weir and diaphragm.
3. Diaphragm and/or weir are worn or damaged. Change the part(s).

What if valve cannot be fully opened?

1. Diaphragm is not properly engaged with compressor. Check engagement per *Operation and Maintenance* manual.

What if fluid leaks to atmosphere?

1. Bonnet bolts not properly torqued. Retorque according to *Operation and Maintenance* manual.
2. Line pressure exceeds maximum recommended line pressure. Check or reduce system line pressure.
3. Diaphragm has ruptured or has been chemically attacked. Replace diaphragm.

Sample Specification

All Type 14 True Union diaphragm valves shall be of solid thermoplastic construction for body and bonnet with socket, threaded or butt end connectors. The valves shall come standard with a position indicator, travel stop and bonnet O-ring sealing arrangement. The valve shall be weir type with a square bonnet body sealing design and bayonet connection diaphragm. All PTFE diaphragms shall be supplied with a PVDF gas barrier between the layers of EPDM and PTFE for aggressive chemical service. PVC conforming to ASTM D1784 Cell Classification 12454-A, CPVC conforming to ASTM D1784 Cell Classification 23567-A, PP conforming to ASTM D4101 Cell Classification PP0210B67272, PPG (Bonnet Only) conforming to ASTM D4101 Cell Classification PP0110M20A21130, and PVDF conforming to ASTM D3222 Cell Classification Type II. PVC, CPVC, PP and PVDF shall be rated to 150 psi for elastomeric and PTFE diaphragms at 70 degrees F, as manufactured by Asahi/America, Inc.

Specifications

Size:	1/4"
Bodies:	PVC
Seats:	EPDM
Seals:	EPDM
Models:	Male Thread x Male Thread
	Male Thread x Hose (ID 3/8")
	Male Thread x Female Thread
	Hose x Hose / Male Thread x Hose
	Female Thread x Female Thread
	Male Thread x Elbow (OD .63")

Sizes 1/4" PVC/EPDM Models available with NSF-61 Certification

Standard Features

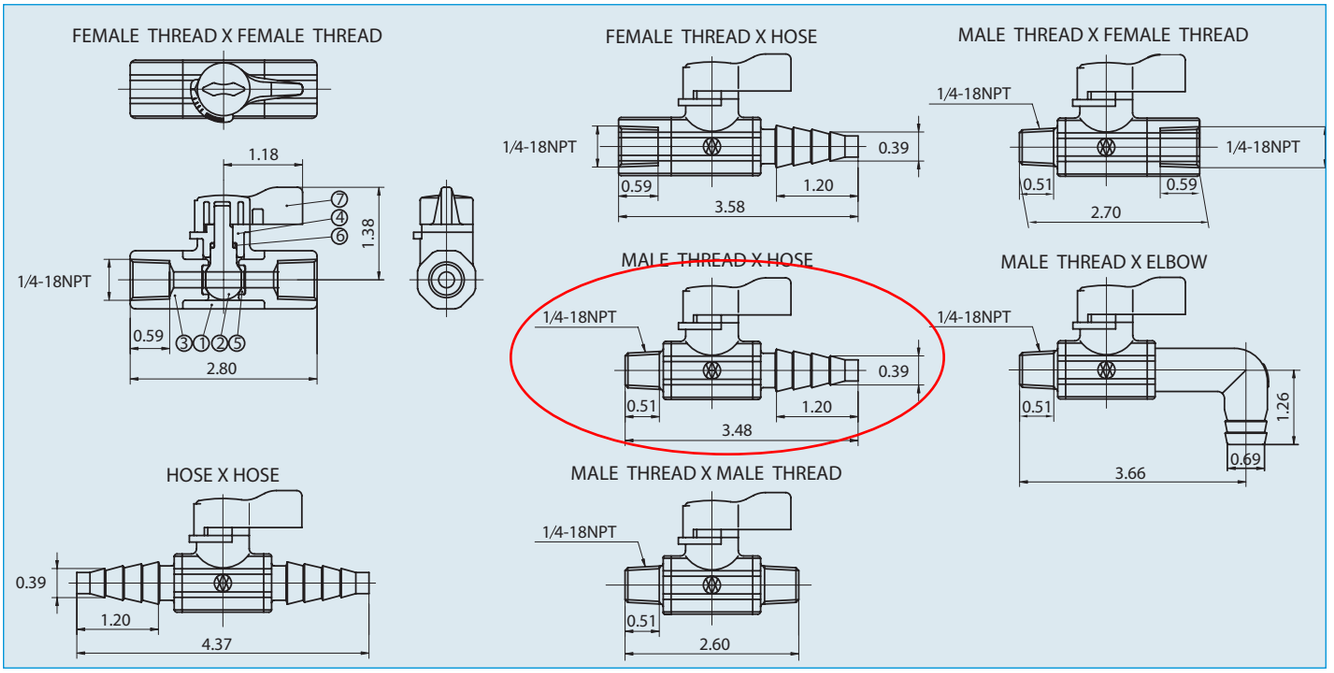
- Pressure rated at 150 psi at 120° F (water)
- Precise fingertip control
- Calibrated flow indicator
- Rugged unibody construction, sturdy stem
- Full vacuum rated, 29.9" Hg
- 90° turn operation with lever handle
- Cv = 1.6
- Optional FKM seats and stem O-ring

Sample Specification

All LABCOCK® valves shall be of compact, unibody construction having a lever handle, calibrated flow indicator and male threads, female threads, hose ends or elbow as part of the valves' integral construction. Valves shall be constructed of PVC conforming to ASTM D1784 Cell Classification 12454-A. All O-rings shall be EPDM or FKM. LABCOCK® valves are rated to 150 psi at 70° F, as manufactured by Asahi/America, Inc.

Parts List (Size 1/4")

PARTS			
NO.	DESCRIPTION	PCS.	MATERIAL
1	Body	1	PVC
2	Ball and Stem	1	PVC
3	End Connector	2	PVC
4	Gland	1	PVC
5	Seat	2	EPDM, Others
6	O-Ring	1	EPDM, Others
7	Handle	1	ABS



S4 TRUE UNION INLINE STRAINER, PVC

SPECIFICATIONS:

- Sizes: DN 10 / d16 - DN 80 / d 90, 3/8" - 3"
- Seal: EPDM
- Body material: PVC
- Screen:

Natural polypropylene - 1800 micron -course
Stainless steel - 1000, 750 micron - medium
Stainless steel - 500 micron - fine

Operating pressure:

3/8" (DN 10) - 2 1/2" (DN 65) 232 psi (16bar)
3", 4" (DN 80) 145 psi (10 bar)

Valve ends:

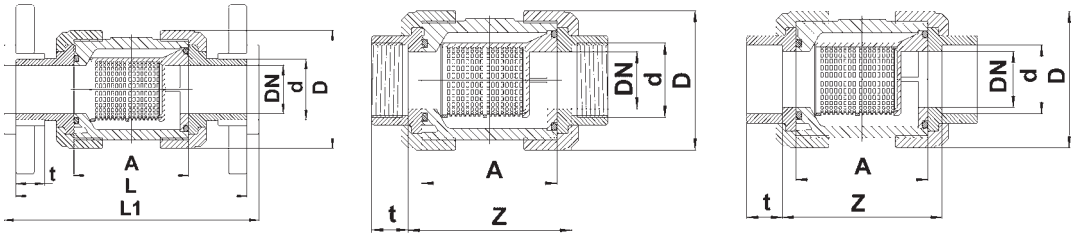
- Solvent cement socket (ASTM, DIN, JIS)
- Solvent cement spigot (DIN)
- Threaded socket (BSP, NPT)
- Flange (ANSI, ASA, DIN, JIS)

FEATURES:

- radial installation or removal
- transparent body
- ideal flow characteristics
- easy service

Sample Specification:

All Praher s4 series inline strainers, sizes 3/8" - 3" shall be of true union design. The PHE internal spring loaded check design shall guarantee leak tight seating in extreme low pressure and vertical installations. Minimum spring load of 1 lbs., spring shall be 304 stainless steel, teflon encapsulated stainless steel or Hastelloy-c. All O-rings and check seals shall be EPDM or VITON and shall meet NSF61 criteria. Union ends shall be interchangeable with s4 series ball valves. PVC shall be NSF61 listed and meet ASTM d1764-cell cass 12454. PP shall be conforming to ASTM d4101, cell class ppo2120b67272.



d	mm	16	20	25	32	40	50	63	75	90	110
DN	mm	10	15	20	25	32	40	50	65	80	80
G	inches	3/8"	1/2"	3/4"	1"	1 1/4"	1 1/2"	2"	2 1/2"	3"	4"
L	mm	114,0	124,0	144,0	154,0	174,0	194,0	224,0	284,0	300,0	340,0
L1	mm	120,0	130,0	150,0	160,0	180,0	200,0	230,0	290,0	310,0	350,0
A	mm	62,0	62,0	70,0	74,0	84,0	95,0	109,0	137,0	163,0	163,0
Z	mm	67,5	67,5	76,0	81,0	90,0	104,0	121,0	148,0	183,0	176,0
t	mm	16,5	16,5	19,5	22,5	26,5	31,5	38,5	45,0	55,5	64,0
D	mm	53,0	53,0	63,0	70,0	85,0	101,0	121,5	155,0	188,0	188,0
PN	bar	16	16	16	16	16	16	16	16	10	10

all dimensions in mm, all pressure ratings PN in BAR

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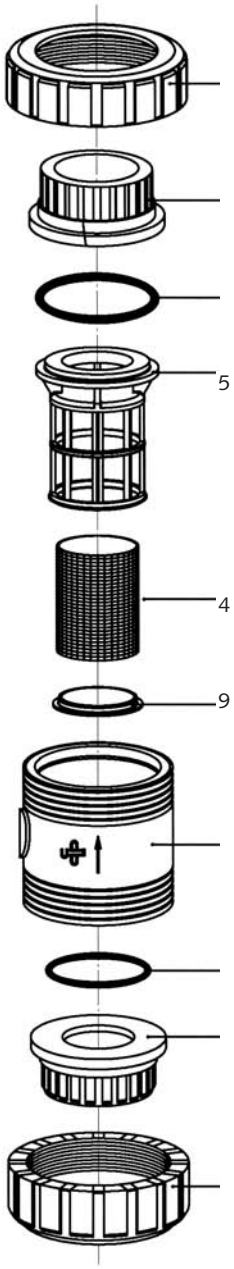
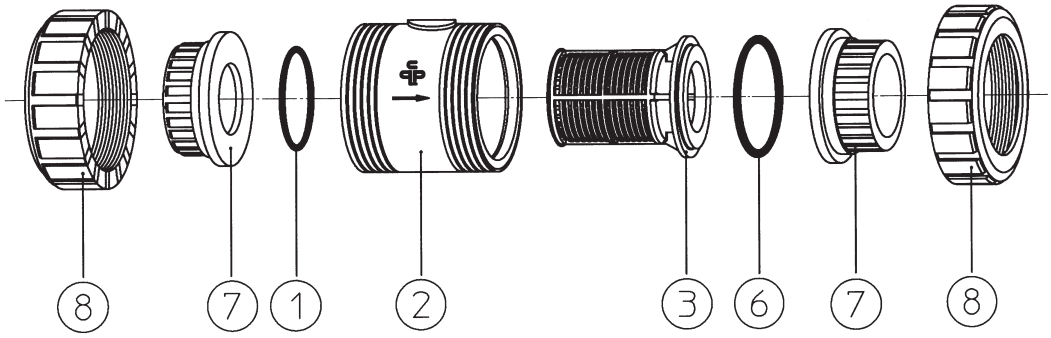
PRAHER VALVES

S4 TRUE UNION INLINE STRAINER, PVC



500, 750, 1000 MICRON



1800 MICRON

Parts:
01. O-Ring
02. Body
03. 1800 micron insert
04. 500 or 750 or 1000 micron screen
05. Screen cage
06. O-Ring
07. Socked End Connector
08. Union nut
09. screen retainer ring

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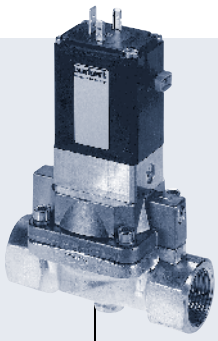
PRAHER VALVES

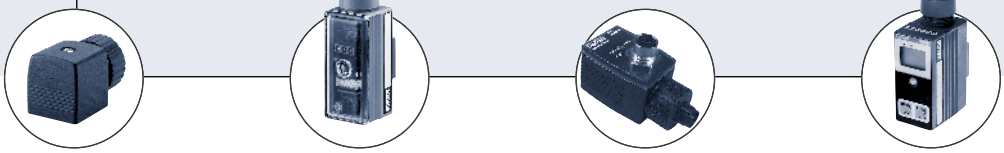
5282

2/2-way Solenoid Valve with servo diaphragm



- Pivoted armature pilot drive with emergency manual operation
- Media separated
- Circuit function can be modified
- Adjustable switching times (waterhammer-free)
- Threaded port or flange connections
- Approvals:

Type 5282 can be combined with...



Type 2508
Cable plug

Type 1078
Timer unit

Type 2511
ASI cable plug

Type 8600
Dosing control

The Type 5282 is a pilot-controlled normally closed solenoid valve with a servo-diaphragm, media separated, for universal use with liquid and gaseous media corresponding to the material resistance. As standard, the 3-way pivoted armature pilot drive has an emergency manual operation. The closing and opening times are continuously adjustable.

Power consumption		
Inrush	Hold	
AC [VA]	AC [VA/W]	DC [W]
24	14/8	8

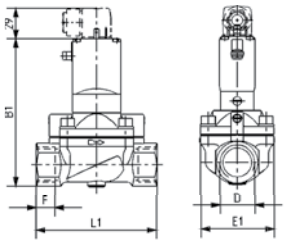
A differential pressure of 7 PSI (0.5 bar) is required to open the full orifice. The response times can be changed by turning the restrictor screws (in the body cover).

Technical data	
Orifice	1/2" - 2" (DN 13 - 65 mm)
Body material Threaded port Flange	 Brass, stainless steel 1.4581 Stainless steel 1.4541
Seal material	NBR, FKM, EPDM (on request)
Media NBR EPDM FKM	 Neutral media, such as compressed air, water, hydraulic oil Oil and fat-free media, incl. alkalis, hot water Hot air, oxygen, per-solutions, hot oil
Media temperature NBR EPDM FKM	 14°F to 194°F (-10°C to +90°C) -22°F to 194°F (-30°C to +90°C) 32°F to 194°F (0°C to +90°C)
Ambient temperature	Max. 131°F (+55°C)
Voltage tolerance	±10%
Duty cycle	100% continuous rating
Electrical connection	Tag connector acc. DIN 43650 Form A for cable plug Type 2508
Protection class	IP 65 with cable plug
Installation	As required, preferably with actuator upright

* See our HazEx™ guide for ATEX and for FM Class 1, Div. 1 versions

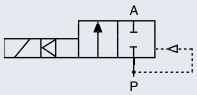
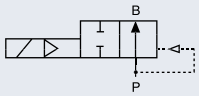
Solenoid valve dimensions

Dimensions [mm]								
Threaded port						Flange port		
DN	D	B1	E1	F	L1	B2	G	L2
13	NPT 1/2	123.0	40	14	65	–	–	–
20	NPT 3/4	131.0	60	16	100	–	–	–
25	NPT 1	141.0	70	18	115	184.5	120	160
32	NPT 1 1/4	147.0	85	20	126	192.0	140	180
40	NPT 1 1/2	156.0	85	22	126	201.0	150	200
50	NPT 2	177.5	115	24	164	225.0	165	230
65	NPT 2 1/2	185.0	115	27	180	–	–	–



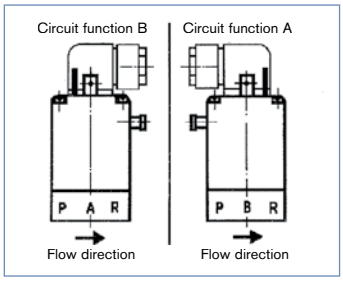
Threaded port

Ordering chart for valves (other versions on request) UL recognized / CSA/ CE
Manual override, supplied without cable plug, different seal materials on request

Circuit function	Orifice [mm]	Port connection [NPT]	Cv value water [GPM]	Nominal pressure [psi]	Voltage/ frequency [V/Hz]	Item no. Seal material NBR Seal Brass Body	Item no. Seal material FKM Seal Stainless Steel Body
A 2/2-way valve, NC 	13.0 (Brass) 20.0 (Stainless steel)	NPT 1/2	4.7	2.8 - 145	024/DC	456 890	456 914
					024/50-60	456 891	456 915
					120/50-60	456 892	456 916
					240/50-60	456 893	456 917
or	20.0	NPT 3/4	5.8	2.8 - 145	024/DC	456 894	456 918
					024/50-60	456 895	456 919
B 2/2-way valve, NO 					120/50-60	456 896	456 920
					240/50-60	456 897	456 921
	25.0	NPT 1	11.7	2.8 - 145	024/DC	456 898	456 922
					024/50-60	456 899	456 923
					120/50-60	456 900	456 924
					240/50-60	456 901	456 925
	32.0	NPT 1 1/4	23.5	2.8 - 145	024/DC	456 902	456 926
					024/50-60	456 903	456 927
					120/50-60	456 904	456 928
					240/50-60	456 905	456 929
	40.0	NPT 1 1/2	23.5	2.8 - 145	024/DC	456 906	456 930
					024/50-60	456 907	456 931
					120/50-60	456 908	56 932
					240/50-60	456 909	456 933
	50.0	NPT 2	47.0	2.8 - 145	024/DC	456 910	456 934
					024/50-60	456 911	456 935
					120/50-60	456 912	456 936
					240/50-60	456 913	456 937

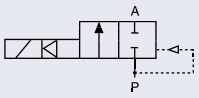
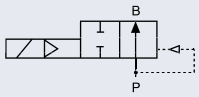
Delivered as circuit function A
Change to the circuit function B by turning the pilot drive through 180°

Mounting instructions:
Arrangement of the pilot control



Solenoid valve ordering chart

Ordering chart for valves (other versions on request) UL listed / FM class / Division 2 / CSA / CE
Manual override, supplied with cable plug type 2509, different seal materials on request

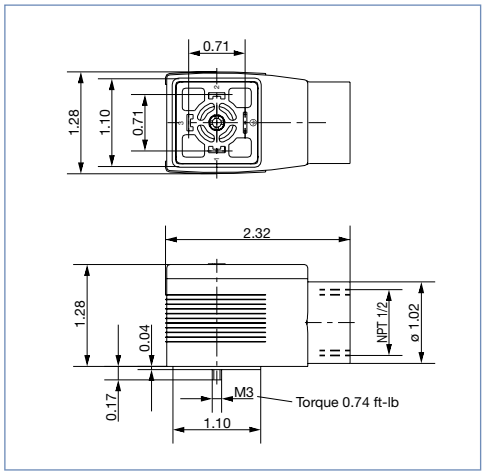
Circuit function	Orifice [mm]	Port connection [NPT]	Cv value water [GPM]	Pressure range [psi]	Voltage/ frequency [V/Hz]	Item no. Threaded port NBR Brass	Item no. Threaded port FKM Stainless Steel
A 2/2-way valve NC 	13.0 (Brass) 20.0 (Stainless steel)	NPT 1/2	4.7	2.8 - 145	024/DC	457 870	457 894
					024/50-60	457 871	457 895
					120/50-60	457 872	457 896
					240/50-60	457 873	457 897
or	20.0	NPT 3/4	5.8	2.8 - 145	024/DC	457 874	457 898
					024/50-60	457 875	457 899
B 2/2-way valve NO 					120/50-60	457 876	457 900
					240/50-60	457 877	457 901
	25.0	NPT 1	11.7	2.8 - 145	024/DC	457 878	457 902
					024/50-60	457 879	457 903
					120/50-60	457 880	457 904
					240/50-60	457 881	457 905
	32.0	NPT 1 1/4	23.5	2.8 - 145	024/DC	457 882	457 906
					024/50-60	457 883	457 907
					120/50-60	457 884	457 908
					240/50-60	457 885	457 909
	40.0	NPT 1 1/2	23.5	2.8 - 145	024/DC	457 886	457 910
					024/50-60	457 887	457 911
					120/50-60	457 888	457 912
					240/50-60	457 889	457 913
	50.0	NPT 2	47.0	2.8 - 145	024/DC	457 890	457 914
					024/50-60	457 891	457 915
					120/50-60	457 892	457 916
					240/50-60	457 893	457 917

Delivered as circuit function A

Change to circuit function B by turning the pilot drive through 180°.

NOTE: All UL listed valves include type 2509 1/2“ conduit cable plug

Type 2509 Dimensions [mm]



TF

Wide Range of Flows and Angles

DESIGN FEATURES

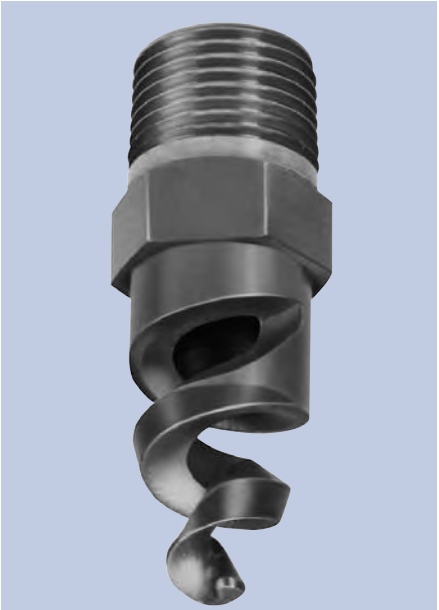
- The original spiral nozzle invented by BETE and continuously improved!
- High energy efficiency
- One-piece/no internal parts
- Clog-resistant performance
- High discharge velocity
- Male connection standard; female connection available by special order
- TF24-150 has FM approval

SPRAY CHARACTERISTICS

- Wide range of flow rates and spray angles
- Fine atomization

Spray patterns: Full and Hollow Cone
Spray angles: 50° to 180°
Flow rates: 0.5 to 3320 gpm (Higher flow rates available)

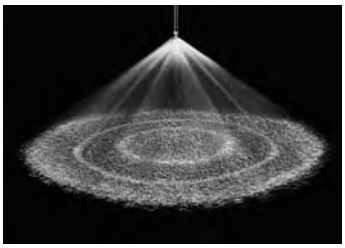
Factory Mutual System



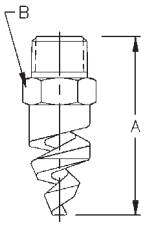
60°, 90°, 120° Metal

Full Cone 60° (NN)

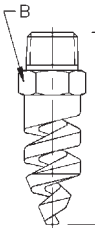
Full Cone 90° (FCN)



Full Cone 150°/170°



90°, 120°



150°, 170°

Dimensions are approximate. Check with BETE for critical dimension applications.

TF Full Cone Flow Rates and Dimensions

Full Cone, 60° (NN), 90° (FCN or FFCN), 120° (FC or FFC), 150° and 170° Spray Angles, 1/8" to 4" Pipe Sizes

Male Pipe Size	Nozzle Number	Available Spray Angles 60° 90° 120° 150° 170°	K Factor	GALLONS PER MINUTE @ PSI 5 PSI	10 PSI	20 PSI	30 PSI	40 PSI	50 PSI	Operation above 60 PSI not recom. for PTFE 60 PSI	High PSI operation recom. for **Metal Only** 80 PSI	100 PSI	200 PSI	400 PSI	Approx. (in.) Orif. Dia.	Free Pass. Dia.	Dim. (in.) for Metal Only* A**	B	C	Wt. (oz.) 60° 90° 120° Metal	Plas.
1/8	TF6	60° 90° 120° 150° 170°	0.221	0.495	0.70	0.99	1.21	**1.40**	1.57	1.71	1.98	2.21	3.13	4.43	0.09	0.09	1.69	0.56	1.69	1.00	0.20
	TF8	60° 90° 120° 150° 170°	0.411	0.919	1.30	1.84	2.25	**2.60**	2.91	3.18	3.68	4.11	5.81	8.22	0.13	0.13	1.69	0.56	2.19		
1/4	TF6	60° 90° 120° 150° 170°	0.221	0.495	0.70	0.99	1.21	**1.40**	1.57	1.71	1.98	2.21	3.13	4.43	0.09	0.09	1.88	0.56	1.88		
	TF8	60° 90° 120° 150° 170°	0.411	0.919	1.30	1.84	2.25	**2.60**	2.91	3.18	3.68	4.11	5.81	8.22	0.13	0.13	1.88	0.56	2.38	1.25	0.20
	TF10	60° 90° 120° 150° 170°	0.632	1.41	2.00	2.83	3.46	**4.00**	4.47	4.90	5.66	6.32	8.94	12.6	0.16	0.13	1.88	0.56	2.38		
3/8	TF6	60° 90° 120°	0.221	0.495	0.70	0.99	1.21	**1.40**	1.57	1.71	1.98	2.21	3.13	4.43	0.09	0.09					
	TF8	60° 90° 120°	0.411	0.919	1.30	1.84	2.25	**2.60**	2.91	3.18	3.68	4.11	5.81	8.22	0.13	0.13					
	TF10	60° 90° 120°	0.632	1.41	2.00	2.83	3.46	**4.00**	4.47	4.90	5.66	6.32	8.94	12.6	0.16	0.13					
	TF12	60° 90° 120° 150° 170°	0.949	2.12	3.00	4.24	5.20	**6.00**	6.71	7.35	8.49	9.49	13.4	19.0	0.19	0.13	1.88	0.69	2.38	1.63	0.25
	TF14	60° 90° 120° 150° 170°	1.28	2.86	4.05	5.73	7.01	**8.10**	9.06	9.92	11.5	12.8	18.1	25.6	0.22	0.13					
	TF16	60° 90° 120° 150° 170°	1.68	3.75	5.30	7.50	9.18	**10.6**	11.9	13.0	15.0	16.8	23.7	33.5	0.25	0.13					
	TF20	60° 90° 120° 150° 170°	2.61	5.83	8.25	11.7	14.3	**16.5**	18.4	20.2	23.3	26.1	36.9	52.2	0.31	0.13					
1/2	TF24	60° 90° 120° 150° 170°	3.81	8.52	12.1	17.0	20.9	**24.1**	26.9	29.5	34.1	38.1	53.9	76.2	0.38	0.19	2.50	0.88	3.06	3.00	0.50
	TF28	60° 90° 120° 150° 170°	5.22	11.7	16.5	23.3	28.6	**33.0**	36.9	40.4	46.7	52.2	73.8	104	0.44	0.19					
3/4	TF32	60° 90° 120° 150° 170°	6.64	14.8	21.0	29.7	36.4	**42.0**	47.0	51.4	59.4	66.4	93.9	133	0.50	0.19	2.75	1.13	3.50	5.50	0.88
1	TF40	60° 90° 120° 150° 170°	10.6	23.7	33.5	47.4	58.0	**67.0**	74.9	82.1	94.8	106	150	212	0.63	0.25	3.63	1.38	4.38	8.50	2.50
	TF48	60° 90° 120° 150° 170°	15.0	33.6	47.5	67.2	82.3	**95.0**	106	116	134	150	212	300	0.75	0.25					
1 1/2	TF56	60° 90° 120° 150° 170°	20.4	45.6	64.5	91.2	112	**129**	144	158	182	204	288	408	0.88	0.31			5.38		
	TF64	60° 90° 120° 150° 170°	26.7	59.7	84.5	120	146	**169**	189	207	239	267	378	534	1.00	0.31	4.38	2.00	5.38	22.0	4.25
	TF72	60° 90° 120° 150° 170°	30.4	67.9	96.0	136	166	**192**	215	235	272	304	429	607	1.13	0.31			5.63		
2	TF88	60° 90° 120° 150° 170°	44.3	99.0	140	**198**	242	280	313	343	396	443	626	885	1.38	0.44	5.63	2.50	5.88	46.0	8.00
	TF96 [1]	60° 90° 120° 150° 170°	55.9	125	177	**250**	306	354	395	433	500	559	791	1120	1.50	0.44	6.88	2.50	7.00	54.0	9.00
3	TF112 [1]	60° 90° 120° 150° 170°	81.0	181	256	**362**	443	512	572	627	724	810	1150	1620	1.75	0.56	8.63	3.50	9.25	114	20.0
	TF128 [1]	60° 90° 120° 150° 170°	107	239	339	**480**	588	679	759	831	960	1070	1510	2150	2.00	0.56					
4	TF160 [1]	60° 90° 120°	166	371	**525**	742	909	1050	1170	1290	1480	1660	2350	3320	2.50	0.63	10.1	4.50		169	27.0

Flow Rate (GPM) $= K\sqrt{PSI}$ *Dimensions are for bar stock, cast sizes may vary. **60° nozzles slightly longer, consult BETE. [1] Three turn nozzles

Standard Materials: Brass, 316 Stainless Steel, PVC, Polypropylene and PTFE (Poly. not available for TF6 thru TF10).

Spray angle performance varies with pressure. Contact BETE for specific data on critical applications.

TO ORDER: *specify pipe size, connection type, nozzle number, spray angle, and material.*

PDF Published June 11, 2008

Variable Area Flow Meters

Chemline F Series Variable Area Flow Meters are ideal for plastic piping. They provide a combination of accurate visual flow rate measurement and clear flow indication from a distance. Optional limit switches allow the units to signal a low or high flow alarm. An optional flow transmitter provides a 4 to 20 mA signal output. These flow meters must be installed vertically with flow upward.

Low Cost Visual Indication

For Water, Chemicals or Gas

CHEMLINE Plastics Limited

Your Pipeline To Quality

SERIES: FC – Compact – 5" Single Scale
FS – Full Size – 7" Dual Scale[1]

MATERIALS:
Tube: Clear PVC, Polyamide (PA), Polysulfone (PSU), or PVDF[2]
Float: PVDF
Ends: PVC, CPVC, PP, PVDF Socket, Threaded, Flanged, Butt or ChemFlare™[3]

O-Rings: EPDM, FPM (Viton®)

CAPACITIES: Up to 220 USGPM (50,000 litres per hour)

CRN REGISTERED
CONSULT CHEMLINE

Features

- **Clear Visual Indication**
  – Large orange float is visible from a distance
  – Range indicators slide along dovetail track
- **Easy Installation and Maintenance**
  Just unscrew union nuts and tube slides out of line
- **Choice of Four Tube Materials for Many Applications:**
  Clear PVC – For Water or Chemicals up to 60°C (140°F) – High Chemical resistance at low cost.
  Polyamide (PA) – For Water or Air up to 75°C (167°F) – High impact strength and optical clarity.
  Polysulfone (PSU) – For Chemicals and Gases up to 100°C (212°F) – High impact strength and good chemical resistance.
  PVDF [2] – For Chemicals and Ultrapure fluids up to 110°C (230°F) – High impact strength and excellent chemical resistance.
- **Ideal for All Types of Plastic Piping**
  All types of end connections in PVC, CPVC, PP & PVDF
- **Low Pressure Drop**
- **Good Measuring Accuracy – Class IV**
  ± 3% of indicated value, plus ± 1% of full scale.
  – Read scale at top (largest diameter) of float
- **Non Fouling** – Float is self supporting in the flow. No guide rod (which can cause the float to jam) is necessary.

Standard Full Size

Compact

[1] USGPM and litres per hour (water) scale is supplied as standard on full size meters.
[2] Because PVDF is translucent, a magnetic float and limit switches are usually used.
[3] For ChemFlare™ end connectors, consult Chemline.

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Variable Area Flow Meters

NOTES:

PVDF flow meters are available in all sizes. Change third letter in item number to **K**.
[1] ΔP = Pressure loss through flow meter with water at 20°C (68°F).
[2] Dimension **L** is for PVC Socket ends.

FC SERIES – COMPACT SIZE – 5" SCALE

Single USGPM (water) scale is supplied standard.

End Conn. Size	Item Number			Flow Range (water)		Dimensions (inches)			Pressure Drop (psi)[1]	
	PVC Tube	Polyamide Tube	Polysulfone Tube	USGPM	Litres per hour	A	L[2]	D	Water	Air
3/8"	FCA00020	FCT00020	FCP00020	0.0132 – 0.106	3 – 24	6.50	8.2	1.38	0.05	0.07
	FCA00060	FCT00060	FCP00060	0.022 – 0.264	5 – 60	6.50	8.2	1.38	0.05	0.07
	FCA00100	FCT00100	FCP00100	0.04 – 0.44	10 – 100	6.50	8.2	1.38	0.05	0.07
	FCA00250	FCT00250	FCP00250	0.11 – 1.10	25 – 250	6.50	8.2	1.38	0.05	0.07
1/2"	FCA00051	FCT00051	FCP00051	0.02 – 0.22	5 – 50	6.69	8.7	1.69	0.04	0.06
	FCA00151	FCT00151	FCP00151	0.07 – 0.66	15 – 150	6.69	8.7	1.69	0.04	0.06
	FCA00251	FCT00251	FCP00251	0.11 – 1.10	25 – 250	6.69	8.7	1.69	0.04	0.06
	FCA00401	FCT00401	FCP00401	0.18 – 1.76	40 – 400	6.69	8.7	1.69	0.04	0.06
3/4"	FCA00152	FCT00152	FCP00152	0.07 – 0.66	15 – 150	7.28	9.6	2.09	0.09	0.12
	FCA00402	FCT00402	FCP00402	0.22 – 1.76	40 – 400	7.28	9.6	2.09	0.09	0.12
	FCA00602	FCT00602	FCP00602	0.26 – 2.64	60 – 600	7.28	9.6	2.09	0.09	0.12
	FCA01002	FCT01002	FCP01002	0.44 – 4.40	100 – 1,000	7.28	9.6	2.09	0.09	0.12
1"	FCA00253	FCT00253	FCP00253	0.11 – 1.10	25 – 250	7.87	10.5	2.36	0.09	0.12
	FCA00403	FCT00403	FCP00403	0.18 – 1.76	40 – 400	7.87	10.5	2.36	0.09	0.12
	FCA01003	FCT01003	FCP01003	0.44 – 4.40	100 – 1,000	7.87	10.5	2.36	0.09	0.12
	FCA01503	FCT01503	FCP01503	0.66 – 6.60	150 – 1,500	7.87	10.5	2.36	0.09	0.12

FS SERIES – STANDARD FULL SIZE – 7" SCALE

Dual USGPM (water) and litres per hour scales are supplied standard.

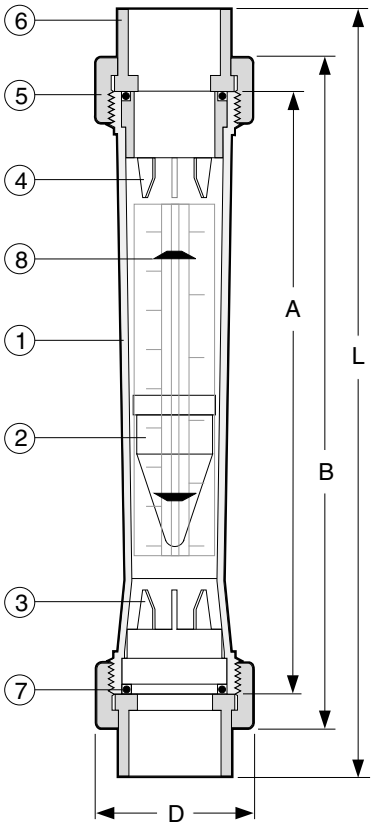
End Conn. Size	Item Number			Flow Range (water)		Dimensions (inches)			Pressure Drop (psi)[1]	
	PVC Tube	Polyamide Tube	Polysulfone Tube	USGPM	Litres per hour	A	L[2]	D	Water	Air
1"	FSA00150	FST00150	FSP00150	0.07 – 0.66	15 – 150	13.78	16.3	2.36	0.18	0.23
	FSA00300	FST00300	FSP00300	0.13 – 1.32	30 – 300	13.78	16.3	2.36	0.18	0.23
	FSA00600	FST00600	FSP00600	0.26 – 2.64	60 – 600	13.78	16.3	2.36	0.18	0.23
	FSA01000	FST01000	FSP01000	0.44 – 4.40	100 – 1,000	13.78	16.3	2.36	0.18	0.23
1-1/4"	FSA01500	FST01500	FSP01500	0.66 – 6.60	150 – 1,500	13.78	16.6	2.83	0.18	0.23
	FSA02500	FST02500	FSP02500	1.10 – 11.00	250 – 2,500	13.78	16.6	2.83	0.18	0.23
1-1/2"	FSA02000	FST02000	FSP02000	0.88 – 8.80	200 – 2,000	13.78	16.8	3.27	0.18	0.23
	FSA03000	FST03000	FSP03000	1.32 – 13.20	300 – 3,000	13.78	16.8	3.27	0.18	0.23
2"	FSA04000	FST04000	FSP04000	1.76 – 17.60	400 – 4,000	13.78	17.2	4.06	0.32	0.39
	FSA06000	FST06000	FSP06000	2.64 – 26.40	600 – 6,000	13.78	17.2	4.06	0.32	0.39
	FSA10000	FST10000	FSP10000	4.40 – 44.00	1,000 – 10,000	13.78	17.2	4.06	0.32	0.39
2-1/2"	FSA15000	FST15000	FSP15000	6.60 – 66.00	1,500 – 15,000	13.78	17.7	4.80	0.49	0.58
	FSA25000	FST25000	FSP25000	11.00 – 110.00	2,500 – 25,000	13.78	17.7	4.80	0.49	0.58
	FSA50000	FST50000	FSP50000	44.00 – 220.00	10,000 – 50,000	13.78	17.7	4.80	0.49	0.58

CONVERSION CHART – FLOW UNITS

From To	m^3/hr	litres/hr	USGPM	ImpGPM	ft^3/min
m^3/hr	1	1000	4.4029	3.6662	0.5886
litres/hr	0.001	1	.004403	.003666	.000589
USGPM	0.2271	227.12	1	0.8327	0.1337
ImpGPM	0.2728	272.77	1.2009	1	0.1605
ft^3/min	1.6990	1699	7.4806	6.2289	1

†Values based on water at 20°C (68°F).

Variable Area Flow Meters



PARTS

▲ Recommended Spare Parts

No.	Part	Pcs.	Materials
1	Tube	1	Polyamide (PA), Polysulfone (PSU), Clear PVC, PVDF
2	Float	1	PVDF (standard or magnetic)
3	Lower Float Stop	1	PVDF
4	Upper Float Stop	1	PVDF
5	Union Nut	2	PVC, PPG, PVDF
6	End Connector	2	PVC, CPVC, PP or PVDF
7▲	O-Rings	2	EPDM, FPM (Viton®)
8▲	Range Indicator	2	ABS

ACCESSORIES

- **Limit Switches** – One switch for both maximum or minimum. A magnetic float is required.
- **Switch Ratings** – P (max) = 10 VA, E (max) = 470VAC, I (max) = 0.5A
- **Throttling Valve** for flow control
- **4–20 mA Output Signal Unit** must be factory calibrated for specific service

OPTIONS

- **Custom Direct Reading Scale** for services other than water
- **Alternate O-Rings** – ie. FPM (Viton®)
- **End Size Reduction** – Accuracy is not significantly affected by end reduction
- **Other Ends** – Threaded, socket or flanged end connections in PVC, CPVC, PP or PVDF. Butt ends in PP or PVDF.

MAXIMUM WORKING PRESSURES AND TEMPERATURE RANGES

Construction (‡ = Optional Materials)				Maximum	
Tube	O-Rings	Union Nuts	Ends	Pressure[2]	Temperature Range
PVC	EPDM	PVC	PVC	150 psi	0 to 60°C (32 to 140°F)
Polyamide (PA)	EPDM	PVC	PVC	150 psi	0 to 60°C (32 to 140°F)
Polyamide (PA)	EPDM	PPG‡	PP or CPVC‡	150 psi	0 to 75°C (32 to 167°F)
Polysulfone (PSU)	EPDM	PVC	PVC	150 psi	0 to 60°C (32 to 140°F)
Polysulfone (PSU)	EPDM	PPG‡	PP or CPVC‡	150 psi	0 to 90°C (32 to 194°F)
PVDF	FPM(Viton®)	PVDF	PVDF	150 psi	–40 to 110°C (–40 to 230°F)

[2] 150 psi is not recommended at maximum temperatures. Consult Chemline.

Flow Meter Sizing – Liquid Flow

Standard Scale values are for clean water flow at 20°C (68°F). For liquids with densities and viscosities similar to water (ie. specific gravity of 1.0 and viscosities between 0.5 cP and 1.3 cP) the standard water scale will be accurate enough.

The table below shows correction factors to be applied for liquids with specific gravities other then 1.0. Multiply the correction factor by the water scale value to obtain actual flow rate. Example: For a liquid of specific gravity of 1.66, the correction factor is 0.740. For water flow range of 100 to 1000 litres/hr, corrected range becomes 74 to 740 litres/hr. Viscosity should be between 0.5 cP and 1.3 cP for standard scales to be accurate.

For "sizing" liquid flows ie. determining actual flow range of a tube, please advise the **chemical name, concentration, temperature, specific gravity** and **viscosity.** Custom direct reading scales in any units are available special order.

SCALE CORRECTION FACTORS – FOR LIQUIDS WITH SPECIFIC GRAVITIES OTHER THAN 1.00

Specific Gravity	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
	Scale Correction Factor									
0.4	1.647	1.626	1.605	1.585	1.565	1.548	1.529	1.513	1.495	1.479
0.5	1.462	1.447	1.433	1.418	1.404	1.391	1.377	1.364	1.351	1.339
0.6	1.326	1.316	1.304	1.292	1.282	1.271	1.259	1.250	1.239	1.229
0.7	1.220	1.211	1.202	1.192	1.183	1.175	1.167	1.157	1.149	1.142
0.8	1.134	1.125	1.117	1.111	1.104	1.096	1.089	1.082	1.075	1.068
0.9	1.062	1.055	1.048	1.042	1.035	1.030	1.024	1.017	1.011	1.005
1.0	1.000	0.994	0.988	0.982	0.978	0.972	0.967	0.962	0.956	0.951
1.1	0.947	0.943	0.936	0.932	0.927	0.923	0.917	0.913	0.909	0.904
1.2	0.900	0.895	0.891	0.887	0.883	0.878	0.874	0.870	0.866	0.862
1.3	0.858	0.854	0.850	0.846	0.842	0.838	0.835	0.831	0.827	0.824
1.4	0.820	0.818	0.814	0.810	0.806	0.803	0.800	0.797	0.794	0.791
1.5	0.787	0.784	0.781	0.778	0.776	0.773	0.770	0.767	0.764	0.759
1.6	0.756	0.754	0.751	0.748	0.745	0.742	0.740	0.737	0.734	0.730
1.7	0.728	0.726	0.723	0.720	0.717	0.714	0.712	0.709	0.706	0.704
1.8	0.701	0.699	0.696	0.694	0.691	0.689	0.686	0.684	0.682	0.679
1.9	0.677	0.674	0.672	0.669	0.667	0.665	0.663	0.661	0.658	0.657
2.0	0.654	0.652	0.650	0.648	0.646	0.644	0.641	0.604	0.637	0.636

Variable Area Flow Meters

Flow Meter Sizing – Gas Flow

FLOW RANGES FOR AIR – AT STANDARD CONDITIONS (atmospheric pressure 14.7 psia/20°C).

FC SERIES – COMPACT SIZE – 5" SCALE

Flow Meter Item No.	Normal m^3/hr	Standard CFM
FCT00020	0.2 – 1.0	0.1 – 0.6
FCT00060	0.2 – 2.5	0.1 – 1.5
FCT00100	0.6 – 3.6	0.4 – 2.1
FCT00250	0.5 – 9.0	0.3 – 5.3
FCT00051	0.4 – 2.8	0.2 – 1.6
FCT00151	0.8 – 6.2	0.5 – 3.6
FCT00251	0.9 – 9.5	0.5 – 5.6
FCT00401	2.0 – 15.0	1.2 – 8.8
FCT00152	0.5 – 5.5	0.3 – 3.2
FCT00402	2.0 – 14.0	1.2 – 8.2
FCT00602	2.5 – 22.0	1.5 – 12.9
FCT01002	4.0 – 34.0	2.4 – 20.0
FCT00253	1.0 – 8.0	0.6 – 4.7
FCT00403	2.0 – 14.0	1.2 – 8.2
FCT01003	4.0 – 34.0	2.4 – 20.0
FCT01503	5.0 – 50.0	2.9 – 29.4

FS SERIES – STANDARD FULL SIZE – 7" SCALE

Flow Meter Item No.	Normal m^3/hr	Standard CFM
FST00150	0.7 – 5.5	0.4 – 3.2
FST00300	1 – 10	0.6 – 5.9
FST00600	2.5 – 20	1.5 – 12
FST01000	4 – 34	2.4 – 20
FST01500	5 – 50	2.9 – 29
FST02000	8.5 – 76	5.0 – 45
FST02500	8 – 70	4.7 – 41
FST03000	10 – 90	5.9 – 53
FST04000	14 – 125	8.2 – 74
FST06000	22 – 190	13 – 112
FST10000	35 – 300	21 – 177
FST15000	50 – 500	29 – 294
FST25000	80 – 720	47 – 424
FST50000	400 – 1,500	234 – 883

SCALE CORRECTION FACTORS – FOR AIR AT NON-STANDARD TEMPERATURES AND PRESSURES

Air density is dependent on the actual pressure and temperature.
Calculate the Scale Correction Factor using either Method 1 or 2. Multiply the standard air flow ranges above by the Factor to obtain actual flow rates.

Method 1

Calculate the Factor with the following formula.

$$\text{Factor} = \frac{1}{3.7005}\sqrt{\frac{\text{psia}}{(1+0.00367t)}}$$

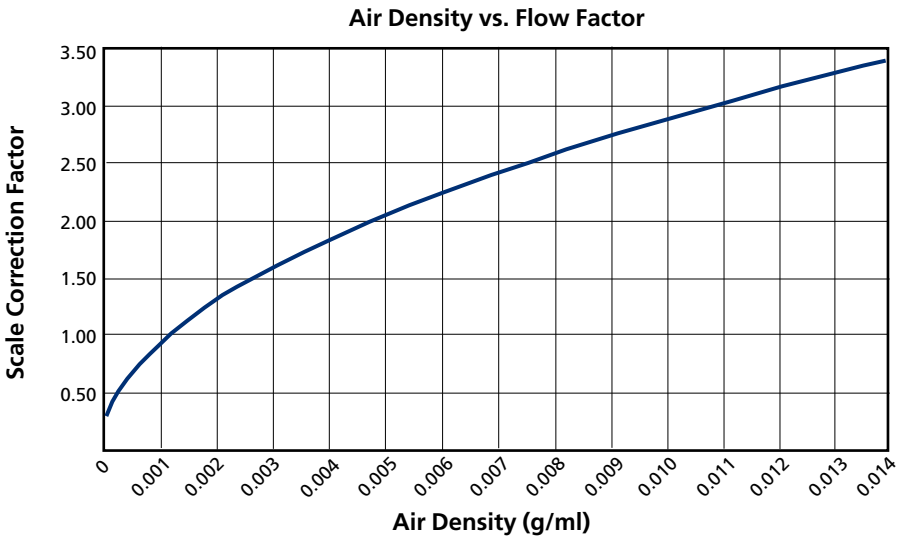
psia = pressure of the air absolute
= psig + 14.7 (atmospheric pressure = 14.7 psia)
t = temperature of the air °C

Method 2

Calculate the density of the air at conditions and find factor from the chart below.

$$\text{Air Density (g/ml)} = \frac{\text{psia}}{11{,}360\,(1+0.00367t)}$$

psia = pressure of the air absolute
= psig + 14.7 (atmospheric pressure = 14.7 psia)
t = temperature of the air °C



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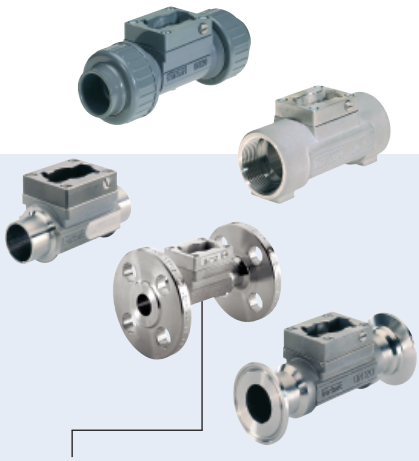
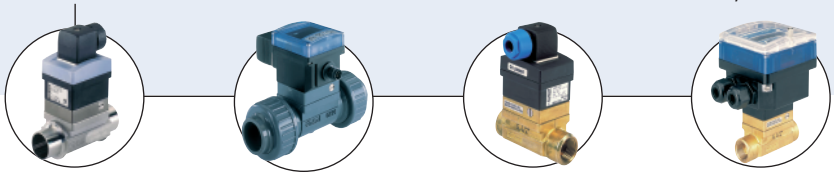
FLUID CONTROL SYSTEMS



INLINE fitting with paddle-wheel for flow measurement

- DN 06 to DN 65
- Closed pipe system, i.e. sensor inside fitting
- Quarter-turn technology
- Electronics available for
  - Indication, Monitoring, Transmitting
  - On/Off control, Batch control

Type S030 can be combined with...



Type 8030
Flow sensor

Type 8032
On/Off flow sensor/switch

Type SE30 Ex
Flow sensor ATEX version

Type 8035
Flow transmitter

The fitting S030 has a built-in paddle-wheel to measure the flowrate. When liquid flows through the pipe, the paddle-wheel is set in rotation producing pulses which frequency is proportional to the flowrate. This leads to a very leak-proof construction, called the "INLINE Quarter-turn" technology.
The paddle-wheel rotation is detected contactless through the fitting wall. The sensor unit can be snapped-on or removed without opening the pipe or interrupting the process.

The Bürkert Quarter-turn technology

General data	
Pipe diameter	DN 06 up to DN 65
Measurement range	from 0.5 up to 1200 l/min
Flow velocity	0.3 up to 10 m/s (see flow diagram)
Accuracy[1)]	Individual works calibration (Teach-In, via a remote transmitter) or standard mean K-factor, see accuracy chart on next page.
Linearity[1)]	≤ ±0.5% of F.S.* (at 10 m/s)
Repeatability	≤ 0.4% of Reading*
Fitting port connection	
Metal	Internal or external thread, weld ends, Clamp or flange
Plastic	True union, spigot or external thread
Materials	
Seal	FKM or EPDM (depending on version, see ordering chart)
Body	Stainless steel (316L -1.4435), brass (CuZn39Pb2), PVC, PP, PVDF
Screws	Stainless steel (316L -1.4435)
Paddle-wheel	PVDF (PP on request or stainless steel, see data sheet 8030HT)
Shaft and bearing	Ceramics (Al_2O_3)
Medium data	
Fluid temperature	0 up to 50°C *(32 to 122°F)* for fitting in PVC 0 up to 80°C *(32 to 176°F)* for fitting in PP -15 up to 100°C *(5 to 212°F)* for fitting in stainless steel, brass or PVDF
Fluid pressure (max.)	see pressure / temperature chart
Metal	PN 16 *(232.16 PSI)* (PN40 *(580.4 PSI)* on request)
Plastic	PN 10 *(145.1 PSI)*
Fluid	clean, neutral or slightly aggressive, solid-free liquids
Solid particles rate	max. 1%, size of particles 0.5 mm max.
Viscosity	300 cSt. max.

* F.S. = Full scale (10 m/s)
1) Under reference conditions i.e. measuring fluid = water, ambient and water temperature = 20°C, applying the minimum inlet and outlet pipe straights, matched inside pipe dimensions.

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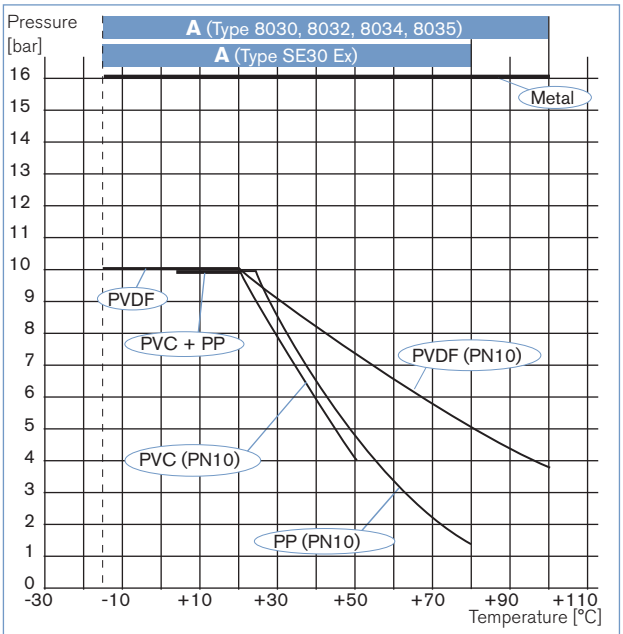
Environment	
Ambient temperature	-15 up to +60°C *(5 to 140°F)* (depending on associated electronics)
Storage temperature	-15 up to +60°C *(5 to 140°F)*
Approvals	
Approval / Certificate on request	3.1 Certificate; 2.2 Certificate; Rugosity Certificate; Calibration Certificate; FDA (with EPDM seal) - stainless steel fitting only

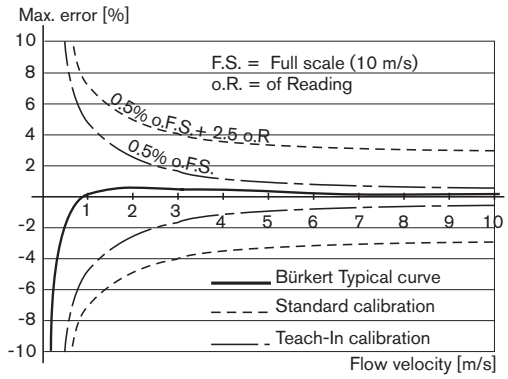
Pressure / temperature chart



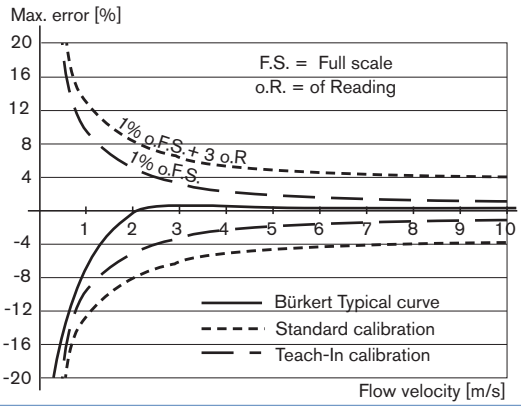
A: Application range for complete device (fitting + sensor)

Accuracy diagram

For Type 8030, SE30 Ex, 8035



For Type 8032

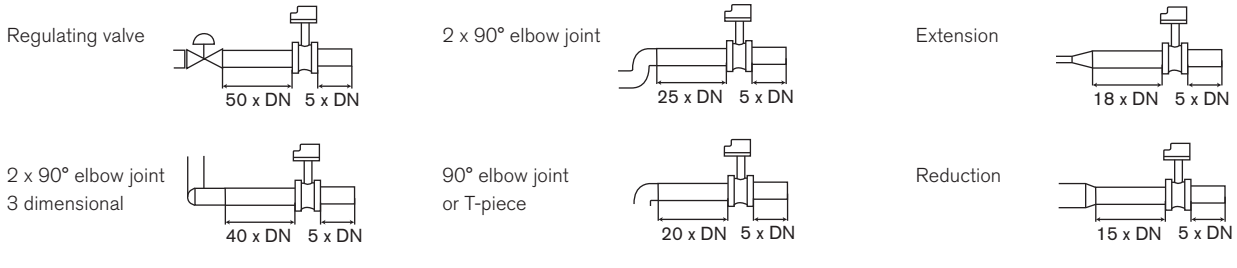


Installation

Minimum straight upstream and downstream distances must be observed. According to the pipe's design, necessary distances can be bigger or use a flow conditioner to obtain the best accuracy. For more information, please refer to EN ISO 5167-1.

EN ISO 5167-1 prescribes the straight inlet and outlet distances that must be complied with when installing fittings in pipe lines in order to achieve calm flow conditions. The most important layouts that could lead to turbulence in the flow are shown below, together with the associated prescribed minimum inlet and outlet distances. These ensure calm, problem-free measurement conditions at the measurement point.

DN = orifice **Fluid direction -->**



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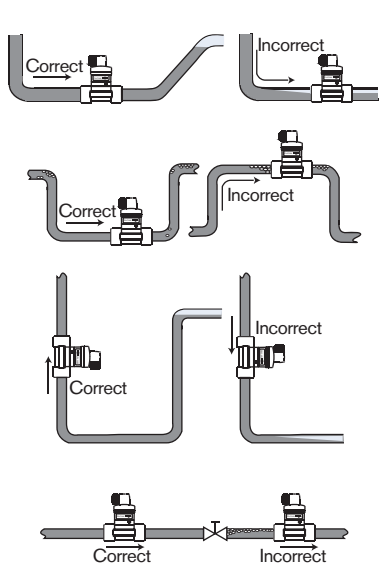
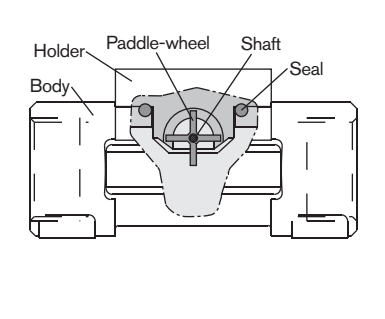
Installation

The flow rate sensor, transmitter can be installed into either horizontal or vertical pipes.



Pressure and temperature ratings must be respected according to the selected fitting material.
The suitable pipe size is selected using the diagram Flow / Velocity / DN.

Conception

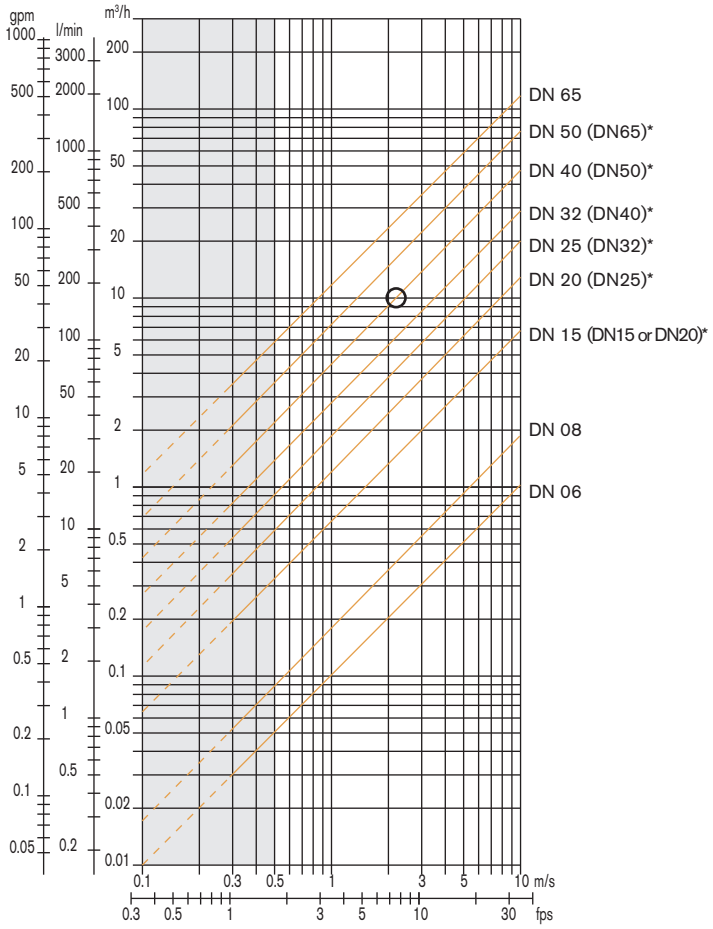


Selection fitting / pipe size

Example:

- Specification of nominal flow: 10 m³/h
- Ideal flow velocity: 2...3 m/s
- For these specifications, the diagram indicates a pipe size of DN40 [or DN50 for (*) mentioned fittings]

Flow rate



Flow velocity

*** for following fittings:**
- with external threads acc. to SMS 1145
- with weld-ends acc. to SMS 3008, BS 4825 / ASME BPE or DIN 11850 Series 2
- Clamp acc. to SMS 3017 / ISO 2852, BS 4825 / ASME BPE or DIN 32676

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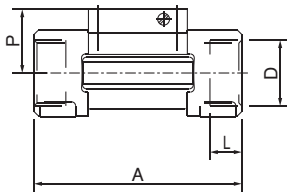
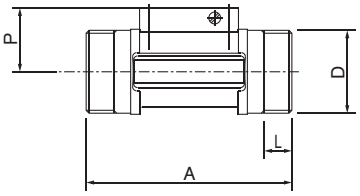
INLINE fitting dimensions

Internal thread connection
G, NPT or Rc
in stainless steel (316L - 1.4435) or
brass (CuZn39Pb2)



DN [mm]	P [mm]	A [mm]	D [inch]	L [mm]
15	34.5	84.0	G 1/2 NPT 1/2 Rc 1/2	16.0 17.0 15.0
20	32.0	94.0	G 3/4 NPT 3/4 Rc 3/4	17.0 18.3 16.3
25	32.2	104.0	G 1 NPT 1 Rc 1	23.5 18.0 18.0
32	35.8	119.0	G 1 1/4 NPT 1 1/4 Rc 1 1/4	23.5 21.0 21.0
40	39.6	129.0	G 1 1/2 NPT 1 1/2 Rc 1 1/2	23.5 20.0 19.0
50	45.7	148.5	G 2 NPT 2 Rc 2	27.5 24.0 24.0

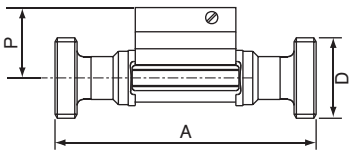
External thread connection
G, NPT or Rc
in stainless steel (316L - 1.4435),
brass (CuZn39Pb2),
PVC (only DN 6 and DN 8)
or PVDF (only DN 8)



DN [mm]	P [mm]	A [mm]	D [inch]	[mm]	L [mm]
06	29.5	90.0	G1/4 or G1/2	-	14.0
08	29.5	90.0	1/2**	M 16 x 1.5	14.0
15	34.5	84.0	G 3/4	-	11.5
20	32.0	94.0	G 1	-	13.5
25	32.2	104.0	G 1 1/4	-	14.0
32	35.8	119.0	G 1 1/2	-	18.0
40	39.6	129.0	-	M 55 x 2	19.0
50	45.7	148.5	-	M 64 x 2	20.0

** G, NPT, RC according to fitting version

External thread connection
SMS 1145,
in stainless steel (316L - 1.4435)



DN [mm]	P [mm]	A [mm]	D
25	32.0	130	Rd 40 x 1/6”
40	35.8	164	Rd 60 x 1/6”
50	39.6	173	Rd 70 x 1/6”

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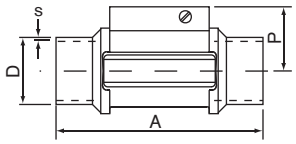
INLINE fitting dimensions

Weld ends connection
EN ISO 1127/ ISO 4200, SMS 3008,
BS 4825 / ASME BPE or DIN 11850 Series 2
in stainless steel (316L - 1.4435)



DN [mm]	P [mm]	A [mm]	Standard	D [mm]	s [mm]
08	-	-	EN ISO 1127 / ISO 4200	-	-
	-	-	SMS 3008	-	-
	-	-	ASME BPE	-	-
	29.5	90.0	DIN 11850 Series 2	13.00	1.50
15	34.5	84.0	EN ISO 1127 / ISO 4200	21.30	1.60
	-	-	SMS 3008	-	-
	-	-	ASME BPE	-	-
	34.5	84.0	DIN 11850 Series 2	19.0	1.50
20	32.0	94.0	EN ISO 1127 / ISO 4200	26.9	1.60
	-	-	SMS 3008	-	-
	34.5	84.0	ASME BPE	19.05	1.65
	34.5	84.0	DIN 11850 Series 2	23.00	1.50
25	32.2	104.0	EN ISO 1127 / ISO 4200	33.70	2.00
	32.0	94.0	SMS 3008	25.00	1.20
	32.0	94.0	BS 4825 / ASME BPE	25.40	1.65
	32.0	94.0	DIN 11850 Series 2	29.00	1.50
32	35.8	119.0	EN ISO 1127 / ISO 4200	42.40	2.00
	-	-	SMS 3008	-	-
	32.2	104.0	BS 4825 / ASME BPE	32.00	1.65
	32.2	104.0	DIN 11850 Series 2	35.00	1.50
40	39.6	129.0	EN ISO 1127 / ISO 4200	48.30	2.00
	35.8	119.0	SMS 3008	38.00	1.20
	35.8	119.0	BS 4825 / ASME BPE	38.10	1.65
	35.8	119.0	DIN 11850 Series 2	41.00	1.50
50	45.7	148.5	EN ISO 1127 / ISO 4200	60.30	2.60
	39.6	128.0	SMS 3008	51.00	1.20
	39.6	128.0	BS 4825 / ASME BPE	50.80	1.65
	39.6	128.0	DIN 11850 Series 2	53.00	1.50
65	-	-	EN ISO 1127 / ISO 4200	-	-
	45.7	147.0	SMS 3008	63.50	1.60
	45.7	147.0	BS 4825 / ASME BPE	63.50	1.65
	-	-	DIN 11850 Series 2	-	-

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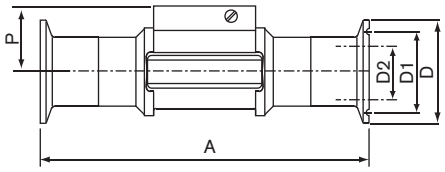
INLINE fitting dimensions

Clamp connection

ISO (for pipe EN ISO 1127 / ISO 4200), SMS 3017 / ISO 2852*, BS 4825 / ASME BPE* or DIN 32676 in stainless steel (316L - 1.4435)

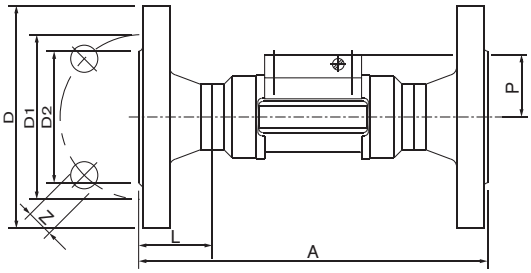
* Available with internal surface finish Ra = 0.8 µm



DN [mm]	P [mm]	A [mm]	Standard	D2 [mm]	D1 [mm]	D [mm]
08	-	-	ISO (for pipe EN ISO 1127 / ISO 4200)	-	-	-
	-	-	SMS 3017 / ISO 2852	-	-	-
	-	-	ASME BPE	-	-	-
	29.5	125	DIN 32676	10.00	27.5	34.0
15	34.5	130	ISO (for pipe EN ISO 1127 / ISO 4200)	18.10	27.5	34.0
	-	-	SMS 3017 / ISO 2852	-	-	-
	-	-	ASME BPE	-	-	-
	29.5	119	DIN 32676	16.00	27.5	34.0
20	32.0	150	ISO (for pipe EN ISO 1127 / ISO 4200)	23.70	43.5	50.5
	-	-	SMS 3017 / ISO 2852	-	-	-
	34.5	119	ASME BPE	15.75	19.6	25.0
	34.5	119	DIN 32676	20.00	27.5	34.0
25	32.2	160	ISO (for pipe EN ISO 1127 / ISO 4200)	29.70	43.5	50.5
	32.0	129	SMS 3017 / ISO 2852	22.60	43.5	50.5
	32.0	129	BS 4825 / ASME BPE	22.10	43.5	50.5
	32.0	136	DIN 32676	26.00	43.5	50.5
32	35.8	180	ISO (for pipe EN ISO 1127 / ISO 4200)	38.40	43.5	50.5
	-	-	SMS 3017 / ISO 2852	-	-	-
	-	-	BS 4825 / ASME BPE	-	-	-
	-	-	DIN 32676	-	-	-
40	39.6	200	ISO (for pipe EN ISO 1127 / ISO 4200)	44.30	56.5	64.0
	35.8	161	SMS 3017 / ISO 2852	35.60	43.5	50.5
	35.8	161	BS 4825 / ASME BPE	34.80	43.5	50.5
	35.8	161	DIN 32676	38.00	43.5	50.5
50	45.7	230	ISO (for pipe EN ISO 1127 / ISO 4200)	55.10	70.5	77.5
	39.6	192	SMS 3017 / ISO 2852	48.60	56.5	64.0
	39.6	192	BS 4825 / ASME BPE	47.50	56.5	64.0
	39.6	170	DIN 32676	50.00	56.5	64.0
65	-	-	ISO (for pipe EN ISO 1127 / ISO 4200)	-	-	-
	45.7	216	SMS 3017 / ISO 2852	60.30	70.5	77.5
	45.7	216	BS 4825 / ASME BPE	60.20	70.5	77.5
	-	-	DIN 32676	-	-	-

Flange connection

EN1092-1 (ISO PN16), ANSI B16-5-1988 or JIS 10 K in stainless steel (316L - 1.4435)



DN [mm]	P [mm]	A [mm]	Stand-ard	L [mm]	Z [mm]	D2 [mm]	D1 [mm]	D [mm]
15	34.5	130	EN	23.5	4x14.0	45.0	65.0	95.0
		130	ANSI		4x15.8	34.9	60.3	89.0
		152	JIS		4x15.0	51.0	70.0	95.0
20	32.0	150	EN	28.5	4x14.0	58.0	75.0	105.0
		150	ANSI		4x15.8	42.9	69.8	99.0
		178	JIS		4x15.0	56.0	75.0	100.0
25	32.2	160	EN	28.5	4x14.0	68.0	85.0	115.0
		160	ANSI		4x15.8	50.8	79.4	108.0
		216	JIS		4x19.0	67.0	90.0	125.0
32	35.8	180	EN	31.0	4x18.0	78.0	100.0	140.0
		180	ANSI		4x15.8	63.5	88.9	117.0
		229	JIS		4x19.0	76.0	100.0	135.0
40	39.6	200	EN	36.0	4x18.0	88.0	110.0	150.0
		200	ANSI		4x15.8	73.0	98.4	127.0
		241	JIS		4x19.0	81.0	105.0	140.0
50	45.7	230	EN	41.0	4x18.0	102.0	125.0	165.0
		230	ANSI		4x19.0	92.1	120.6	152.0
		267	JIS		4x19.0	96.0	120.0	155.0

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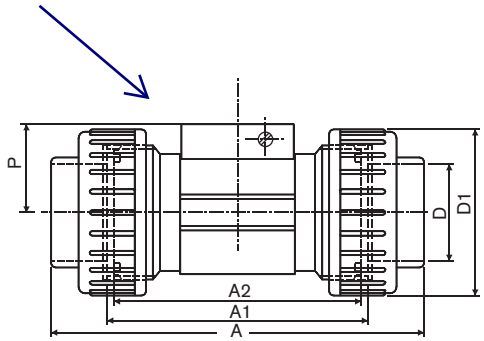
INLINE fitting dimensions

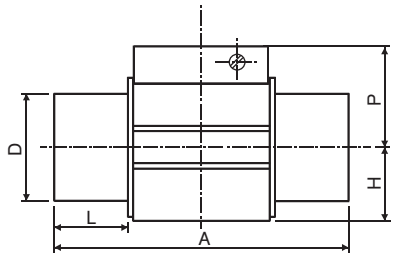
True union connection
DIN 8063, ASTM D 1785/76 or JIS K in PVC,
DIN 16962 in PP or
ISO 10931 in PVDF



DN [mm]	P [mm]	A [mm]	Standard	A1 [mm]	A2 [mm]	D [mm]	D1 [mm]
08*	29.5	122.0 - -	DIN / ISO ASTM JIS	92 - -	90 - -	12.00 - -	- - -
15	34.5	128.0 130.0 129.0	DIN / ISO ASTM JIS	96	90	20.00 21.30 18.40	43
20	32.0	144.0 145.6 145.0	DIN / ISO ASTM JIS	106	100	25.00 26.70 26.45	53
25	32.2	160.0 161.4 161.0	DIN / ISO ASTM JIS	116	110	32.00 33.40 32.55	60
32	35.8	168.0 170.0 169.0	DIN / ISO ASTM JIS	116	110	40.00 42.20 38.60	74
40	39.6	188.0 190.2 190.0	DIN / ISO ASTM JIS	127	120	50.00 48.30 48.70	83
50	45.7	212.0 213.6 213.0	DIN / ISO ASTM JIS	136	130	63.00 60.30 60.80	103

* Only available in PVC

Spigot connection
DIN 8063 in PVC
DIN 16962 in PP or
ISO 10931 in PVDF



DN [mm]	P [mm]	A [mm]	Standard	L [mm]	D [mm]	H [mm]
15	34.5	90 85 85	DIN 8063 DIN 16962 ISO 10931	16.5 14.0 14.0	20	17.5
20	32.0	100 92 92	DIN 8063 DIN 16962 ISO 10931	20.0 16.0 16.0	25	17.5
25	32.2	110 95 95	DIN 8063 DIN 16962 ISO 10931	23.0 18.0 18.0	32	21.5
32	35.8	110 100 100	DIN 8063 DIN 16962 ISO 10931	27.5 20.0 20.0	40	27.5
40	39.6	120 106 106	DIN 8063 DIN 16962 ISO 10931	30.0 23.0 23.0	50	31.5
50	45.7	130 110 110	DIN 8063 DIN 16962 ISO 10931	37.0 27.0 27.0	63	39.5

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Ordering chart for fitting S030

Port connection	Seal	Standard	Item no. DN 06 ** - 1/4"	Item no. DN 06** - 1/2"	Item no. DN 08** - 1/2"	Item no. DN 15	Item no. DN 20	Item no. DN 25	Item no. DN 32	Item no. DN 40	Item no. DN 50	Item no. DN 65
Brass - with PVDF paddle-wheel - Temperature max. 100°C, PN16												
Internal thread	FKM	G	-	-	-	423 980	423 981	423 982	423 983	423 984	423 985	-
		NPT	-	-	-	423 986	423 987	423 988	423 989	423 990	423 991	-
		Rc (ISO7)	-	-	-	423 992	423 993	423 994	423 995	423 996	423 997	-
External thread	FKM	G	552 557	552 527	444 023	423 998	423 999	424 000	424 001	424 002	424 003	-
		NPT	-	-	449 182	-	-	-	-	-	-	-
		Rc (ISO7)	-	-	448 668	-	-	-	-	-	-	
Metric	FKM		-	-	16 x 1.5 mm 552 526	-	-	-	-	-	-	-
Stainless steel - with PVDF paddle-wheel - Temperature max. 100°C, PN16												
Internal thread	FKM	G	-	-	-	424 004	424 005	424 006	424 007	424 008	424 009	-
		NPT	-	-	-	424 010	424 011	424 012	424 013	424 014	424 015	-
		Rc (ISO7)	-	-	-	424 016	424 017	424 018	424 019	424 020	424 021	-
External thread	FKM	G	552 733	552 559	444 029	424 022	424 023	424 024	424 025	424 026	424 027	-
		NPT	-	-	449 050	-	-	-	-	-	-	-
		Rc (ISO7)	-	-	448 669	-	-	-	-	-	-	-
	EPDM	SMS 1145	-	-	-	-	-	443 306	-	443 307	443 308	-
Weld ends	FKM	EN ISO 1127 / ISO 4200	-	-	552 845[1]	424 028	424 029	424 030	424 031	424 032	424 033	-
	EPDM	SMS 3008	-	-	-	-	-	443 298	-	443 299	443 300	443 374
		BS 4825/ ASME BPE	-	-	-	-	443 369[2]	443 370	443 371	443 372	443 373	443 374
		DIN 11850 S2	-	-	551 788	551 789	551 790	551 791	-	551 792	551 793	-
Clamp	FKM	ISO (for pipe EN ISO 1127/ISO4200)	-	-	-	424 034	424 035	424 036	424 037	424 038	424 039	-
	EPDM	SMS 3017 / ISO 2852	-	-	-	-	-	443 302	-	443 303	443 304	443 399
		SMS 3017 / ISO 2852*	-	-	-	-	-	443 387	-	443 388	443 389	443 720
		BS 4825 / ASME BPE	-	-	-	-	443 395	443 396	-	443 397	443 398	443 399
		BS 4825 / ASME BPE*	-	-	-	-	443 400	443 717	-	443 718	443 719	443 720
		DIN 32676	-	-	551 794	551 795	551 796	551 797	-	551 798	551 799	-
Flange	FKM	EN1092-1	-	-	-	424 040	424 041	424 042	424 043	424 044	424 045	-
		ANSI B16-5-1988	-	-	-	424 046	424 047	424 048	424 049	424 050	424 051	-
		JIS 10K	-	-	-	430 108	430 109	430 110	430 111	430 112	430 113	-
Stainless steel - with PVDF paddle-wheel - Temperature max. 100°C, PN40												
Internal thr.	FKM	G	-	-	-	427 138	425 737	425 729	427 152	427 153	427 154	-
PVC - with PVDF paddle-wheel - Temperature max. 50°C, PN10												
True union	FKM	DIN 8063	-	-	444 022	423 938	423 939	423 940	423 941	423 942	423 943	-
		ASTM D 1785/76	-	-	-	423 950	423 951	423 952	423 953	423 954	423 955	-
		JIS K	-	-	-	429 072	429 073	429 074	429 075	429 076	429 077	-
Spigot	FKM	DIN 8063	-	-	-	423 944	423 945	423 946	423 947	423 948	423 949	-
Extern. thr.	FKM	G	-	552 560	444 025	-	-	-	-	-	-	-
True union	FKM		-	-	-	430 734	430 735	430 736	430 737	430 738	430 739	-
without spigot	EPDM		-	-	-	430 740	430 741	430 742	430 743	430 744	430 745	-
PP - with PVDF paddle-wheel - Temperature max. 80°C, PN10												
True union	FKM	DIN 16962	-	-	-	423 956	423 957	423 958	423 959	423 960	423 961	-
Spigot	FKM	DIN 16962	-	-	-	423 962	423 963	423 964	423 965	423 966	423 967	-
PVDF -with PVDF paddle-wheel - Temperature max. 100°C, PN10												
True union	FKM	ISO 10931	-	-	-	423 968	423 969	423 970	423 971	423 972	423 973	-
Spigot	FKM	ISO 10931	-	-	-	423 974	423 975	423 976	423 977	423 978	423 979	-
Extern. thr.	FKM	ISO 10931	-	-	444 028	-	-	-	-	-	-	-

* internal surface finish Ra = 0.8 µm

** external thread

1) EPDM seal

2) DN 20 only available in ASME BPE

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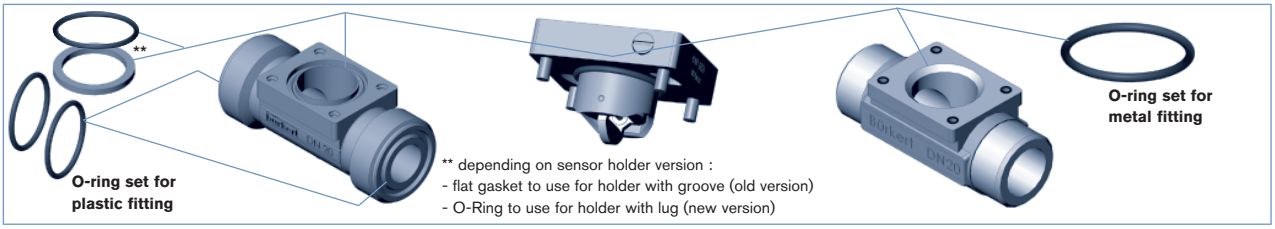
Ordering chart accessories / spare parts (other versions on request)

Description	Item no.
O-ring set	
FKM - for metal fitting, DN 06 to 65	426 340
EPDM - for metal fitting, DN 06 to 65	426 341
FKM - for plastic fitting, DN 08	448 679
FKM - for plastic fitting, DN 15	431 555
FKM - for plastic fitting, DN 20	431 556
FKM - for plastic fitting, DN 25	431 557
FKM - for plastic fitting, DN 32	431 558
FKM - for plastic fitting, DN 40	431 559
FKM - for plastic fitting, DN 50	431 560
EPDM - for plastic fitting, DN 08	448 680
EPDM - for plastic fitting, DN 15	431 561
EPDM - for plastic fitting, DN 20	431 562
EPDM - for plastic fitting, DN 25	431 563
EPDM - for plastic fitting, DN 32	431 564
EPDM - for plastic fitting, DN 40	431 565
EPDM - for plastic fitting, DN 50	431 566
Sensor holder	
Stainless steel with paddle-wheel (PVDF), gasket (FKM), screws and certificate for DN 06 and DN 08	448 678
Stainless steel with paddle-wheel (PVDF), gasket (FKM), screws and certificate for DN 15 up to DN 65	432 306
Stainless steel with paddle-wheel (PVDF), gasket (EPDM), screws and certificate for DN 15 up to DN 65	432 305
Stainless steel with paddle-wheel (PVDF), gasket (EPDM), screws and certificate, Ra int.= 0.8 µm for DN 15 up to DN 65	434 149
Stainless steel with paddle-wheel (PP), gasket (EPDM), screws and certificate for DN 06 and DN 08	554 896
Stainless steel with paddle-wheel (PP), gasket (EPDM), screws and certificate for DN 15 up to DN 65	449 425
Brass with paddle-wheel (PVDF), gasket (FKM), screws and certificate for DN 06 and DN 08	448 677
Brass with paddle-wheel (PVDF), gasket (FKM), screws and certificate for DN 15 up to DN 65	432 304
Brass with paddle-wheel (PVDF), gasket (EPDM), screws and certificate for DN 15 up to DN 65	432 303
Brass with paddle-wheel (PP), gasket (EPDM), screws and certificate for DN 15 up to DN 65	449 866
PVC with paddle-wheel (PVDF), gasket (FKM), screws and certificate for DN 06 and DN 08	448 674
PVC with paddle-wheel (PVDF), gasket (FKM), screws and certificate for DN 15 up to DN 65	432 298
PVC with paddle-wheel (PVDF), gasket (EPDM), screws and certificate for DN 15 up to DN 65	432 297
PVC with paddle-wheel (PP), gasket (EPDM), screws and certificate for DN 15 up to DN 65	443 982
PP with paddle-wheel (PVDF), gasket (FKM), screws and certificate for DN 15 up to DN 65	432 300
PP with paddle-wheel (PVDF), gasket (EPDM), screws and certificate for DN 15 up to DN 65	432 299
PP with paddle-wheel (PP), gasket (FKM), screws and certificate for DN 15 up to DN 65	552 881
PP with paddle-wheel (PP), gasket (EPDM), screws and certificate for DN 15 up to DN 65	443 983
PVDF with paddle-wheel (PVDF), gasket (FKM), screws and certificate for DN 06 and DN 08	448 676
PVDF with paddle-wheel (PVDF), gasket (FKM), screws and certificate for DN 15 up to DN 65	432 302
PVDF with paddle-wheel (PVDF), gasket (EPDM), screws and certificate for DN 15 up to DN 65	432 301
Approval / Certificate	
3.1 certificate	440 790
2.2 certificate	440 789
Rugosity certificate	444 898
Calibration certificate	550 676
FDA approval	449 788



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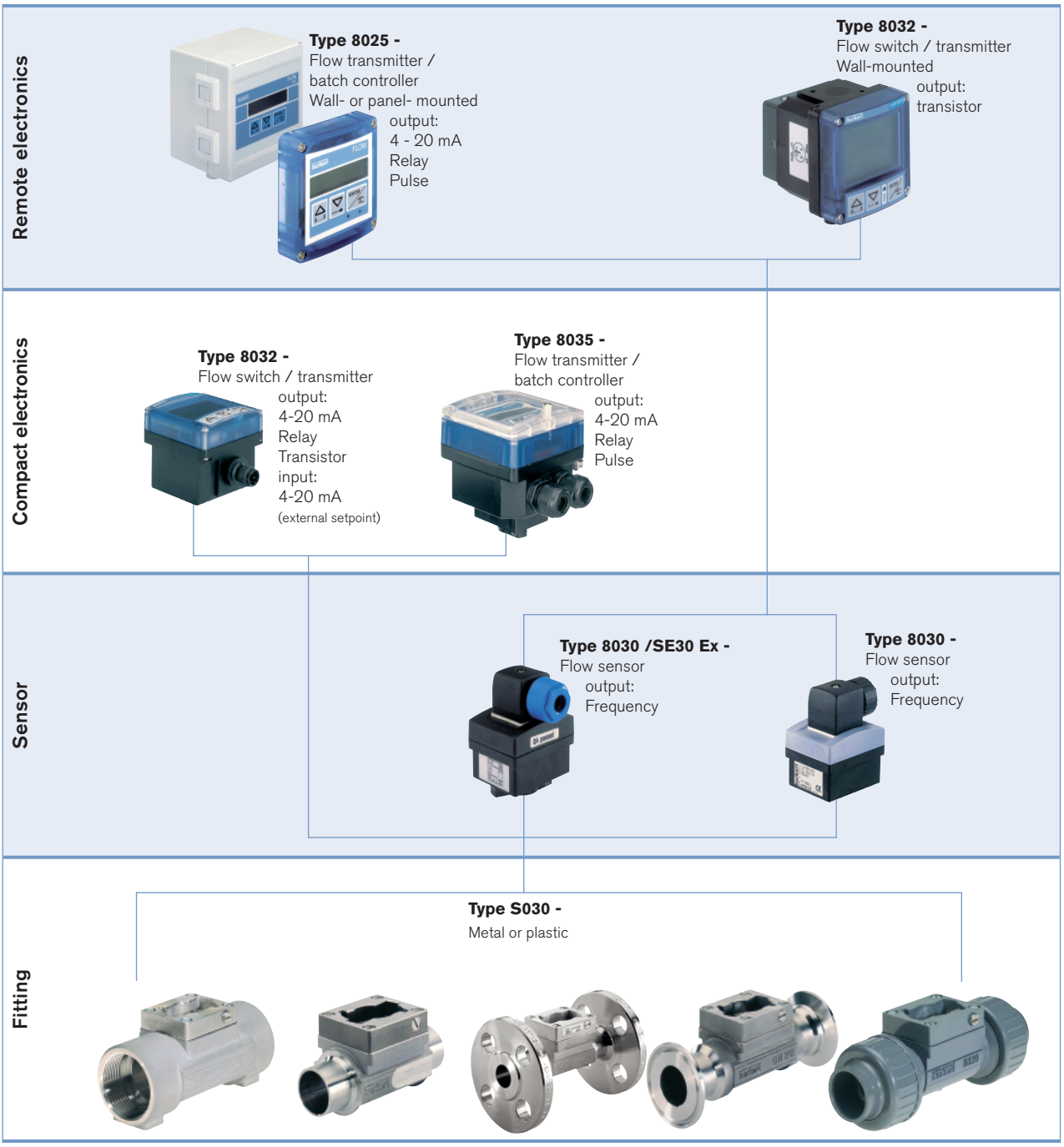
Interconnection possibilities with the S030



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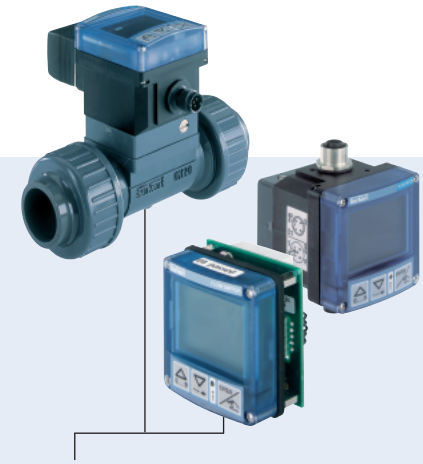
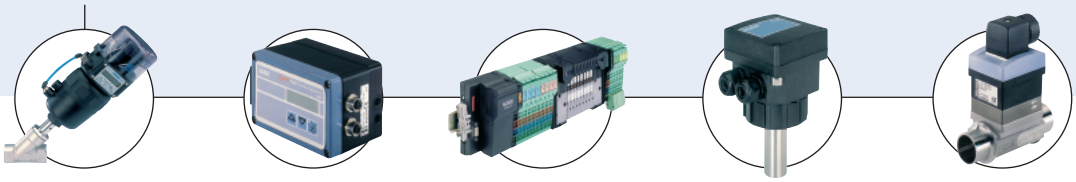
burkert
FLUID CONTROL SYSTEMS

Paddle-wheel flow controller for On/Off control



- Indication, monitoring, transmitting and On/Off control in one device
- Programmable outputs (transistor or relay)
- Automatic-calibration: Teach-In
- Communication - external setpoints and process value (4-20 mA)

Type 8032 can be combined with...



Type 2702 (8630)
Control valve with TopControl

Type 1067
Continuous SideControl

Type 8644-P AirLINE
Valve island with electronic I/O

Type 8041
Flow sensor only with 8032 remote

Type 8030
Flow sensor only with 8032 remote

This intelligent controller with display is designed for use in clear, neutral or aggressive liquids and specially to switch a valve and to establish a monitoring system or an On/Off control loop. The switching points can be programmed with the 3-key keypad under the display or optionally, for the compact 8032 only, from an external source over a 4-20 mA loop. The compact 8032 is proposed with On/Off output, or with external setpoints and process value outputs. The remote 8032 has a transistor output. The connection to the process in the piping is done with standard INLINE fittings.

General data	
Compatibility	With fittings S030 (see corresp. data sheet)
Materials	
Housing, cover	PC, +20% glass fibre
Front panel folio / Screws	Polyester / Stainless steel
Cable plug, gland	PA
Materials wetted parts	
Fitting, sensor armature / Seal	Brass, stainless steel, PVC, PP or PVDF / FKM (EPDM option)
Paddle-wheel / Axis, bearings	PVDF / Ceramics
Wall-mounted holder	PVC
Display	8-digit LCD
Electrical connections	Cable plug acc. to EN 175301-803 Multipin: swivel M12, 5-pin or M12, 8-pin
Voltage supply cable	0.5 mm² max. cross section; max. 100 m length, shielded
Remote sensor connection	0.5 mm² max. cross section; max. 50 m length, shielded
Complete device data (fitting + electronic module)	
Pipe diameter	DN 06 to 65
Measuring range	0.3 to 10 m/s
Medium temperature	0 up to 50°C *(32 to 122°F)* (with PVC fitting) / 0 up to 80°C *(32 to 176°F)* (with PP fitting) / -15 up to 100°C *(5 to 212°F)* (with St. st., brass or PVDF fitting)
Fluid pressure max.	PN10 *(145.1 PSI)* (with plastic fitting) PN16 *(232.16 PSI)* (with metal fitting)
Viscosity	300 cSt. max.
Accuracy[1]	
Teach-In	≤ ± 1% of F.S.* (at 10 m/s)
Standard K-factor	≤ ± (1% of F.S.* + 3% o. Reading)
Programming mode	Threshold, window or hysteresis
Linearity[1]	≤ ± 0.5% of F.S.* (at 10 m/s)
Repeatability[1]	≤ 0.4% of Reading

* F.S. = Full scale (10 m/s)
1) Under reference conditions i.e. measuring fluid = water, ambient and water temperature = 20°C, applying the minimum inlet and outlet pipe straights, matched inside pipe dimensions.

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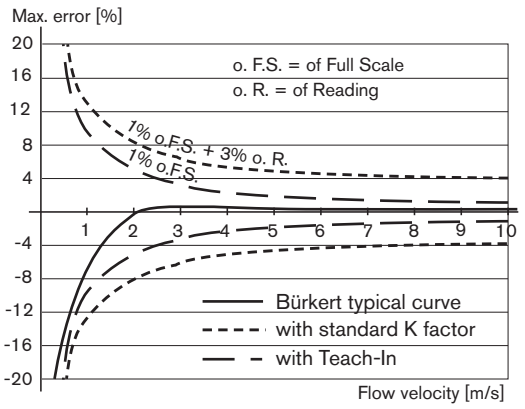
Electrical data	
Power supply	Filtered and regulated
Compact version	12-30 V DC
Remote version	Depends on the remote sensor: 8041: 18-30 V DC 8020, 8030: 12-30 V DC other: min. 12 V DC, max. 30 V DC
Current consumption	
Compact version	≤ 80 mA (without load)
Remote version	≤ 50 mA (without load) + consumption of remote sensor
Input	
External setpoint	4-20 mA, galvanic insulation max. input impedance: 250 Ω
Frequency (remote version)	Pulse signal: 2 to 400 Hz input impedance: 10 kΩ
Outputs	
Transistor (programmable)	NPN and PNP, open collector, 5-30 V DC, max. 700 mA, 0 to 300 Hz protect against short circuit.
Relay (programmable) (compact version)	3A/250 V AC or 3A/30 V DC. 3A/48 V AC or 3A/30 V DC[2].
Process value (option) (compact version)	4-20 mA, galvanic insulation Loop resistance: 1000 Ω at 30 V DC, 800 Ω at 24 V DC, 500 Ω at 18 V DC
Reversed polarity of DC	Protected
Environment	
Ambient temperature	0 up to + 60°C *(32 to 140°F)* (operating and storage)
Relative humidity	≤ 80%, without condensation
Standards, directives and approvals	
Protection class	IP65
Standard, directives	
EMC	EN 610006-2, 610006-3
Security	EN 61010-1
Pressure	Complying with article 3 of §3 from 97/23/CE directive.*
Vibration	EN 60068-2-6
Shock	EN 60068-2-27

2) Valid for: external setpoint input, process value output

* For the 97/23/CE pressure directive, the device can only be used under following conditions (depend on max. pressure, pipe diameter and fluid).

Type of fluid	Conditions
Fluid group 1, §1.3.a	DN ≤ 25 only
Fluid group 2, §1.3.a	DN ≤ 32 or DN > 32 and PN*DN ≤1000
Fluid group 1, §1.3.b	PN*DN ≤2000
Fluid group 2, §1.3.b	DN≤200

Accuracy diagram



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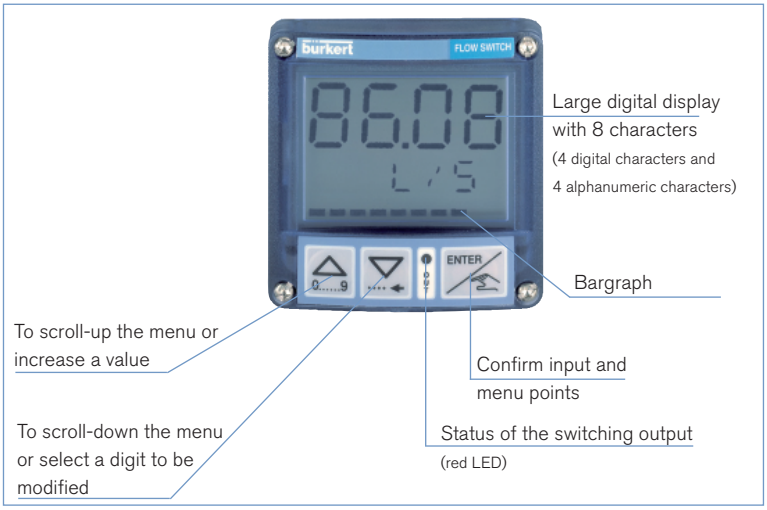
Operation and display

The device can be calibrated by means of the K-factor, or via the Teach-In function.
Customized adjustments, such as engineering units, output, filter, bargraph are carried out on site.

Indication in operating mode / Display
- measured flow
- high threshold value
- low threshold value

Parameter definition
- engineering units (International measuring units)
- K-factor / Teach-In function
- selection of switching mode (window, hysteresis) (see main features)
- selection of threshold value (see main features)
- delay
- filter
- 10-segment bargraph (select min. and max. value)

Test
- switching threshold test with flow simulation (dry-run test operation)

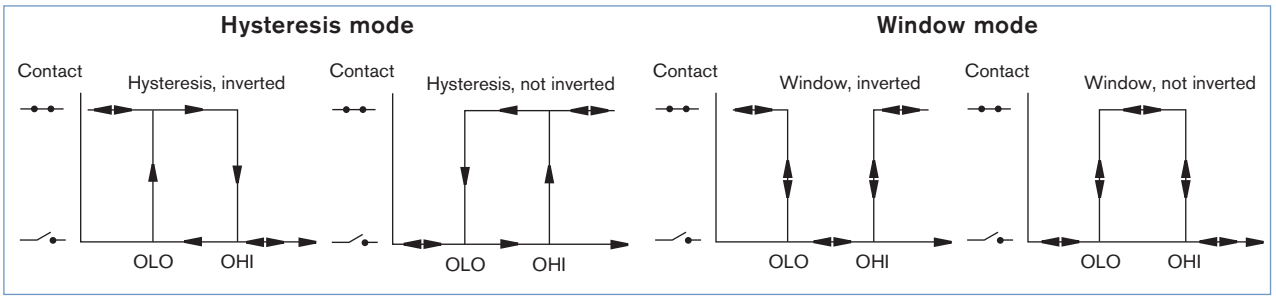


Main features

8032 with external setpoint option.

The switching points are automatically adjusted by the 4-20 mA input signal originating from a PLC.
- Power supplied by the PLC
- On/Off relay output

8032 with standard On/Off output
- 2 switching modes for the output, either hysteresis or window, inverted or not



- Programmable delay before switching
- Possible outputs depending on the version: relay, transistor NPN, transistor PNP, frequency

8032 with process value option.
This version delivers an electric signal whose value is the image of the measured quantity.
- On/Off relay output
- 4-20 mA output
- external setpoint (4-20 mA input)

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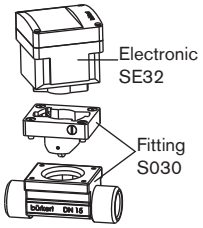
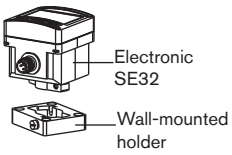
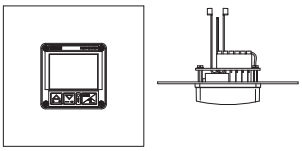
Design and principle of operation



The compact flow controller 8032 is built up with an electronic module SE32 associated to a fitting S030 with integrated measurement paddle-wheel. The output signal is provided via cable plug according to EN 175301-803 and/or a M12 multipin connector.



The wall-mounted flow controller 8032 is built up with an electronic module SE32 associated to a wall-mounted holder. The output signal is provided via two M12 multipin connector.



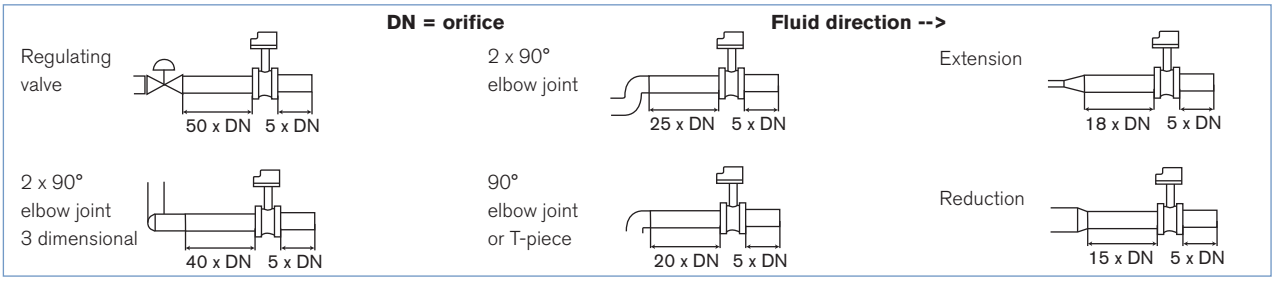
The panel-mounted flow controller 8032 is made up of an electronic module SE32 and a protection plate. The output signal is provided via a terminal strip located on the protection plate.

When liquid flows through the pipe, the 4 magnets, inserted in the paddle-wheel set in rotation, produce a measuring signal in the transducer. The frequency is proportional to the flow velocity of the fluid. A conversion coefficient (K factor, available in the instruction manual of the fitting), specific to each pipe (size and material) enables the conversion of this frequency into flow rate.

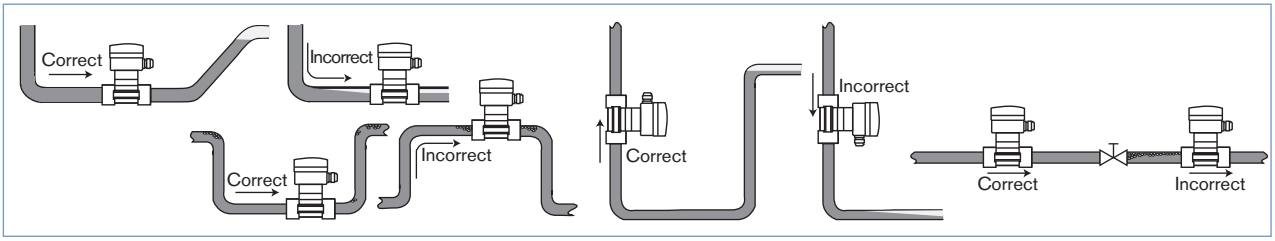
Installation

The 8032 flow controller can easily be installed into any Bürkert INLINE fitting system Type S030 by means of a Quarter-Turn. Minimum straight upstream and downstream distances must be observed. According to the pipe's design, necessary distances can be bigger or use a flow conditioner to obtain the best accuracy. For more information, please refer to EN ISO 5167-1.

EN ISO 5167-1 prescribes the straight inlet and outlet distances that must be complied with when installing fittings in pipe lines in order to achieve calm flow conditions. The most important layouts that could lead to turbulence in the flow are shown below, together with the associated prescribed minimum inlet and outlet distances. These ensure calm, problem-free measurement conditions at the measurement point.



The flow controller can be installed into either horizontal or vertical pipes.



Pressure and temperature ratings must be respected according to the selected fitting material.
The suitable pipe size is selected using the diagram Flow / Velocity / DN.

The controller is not designed for gas flow control.

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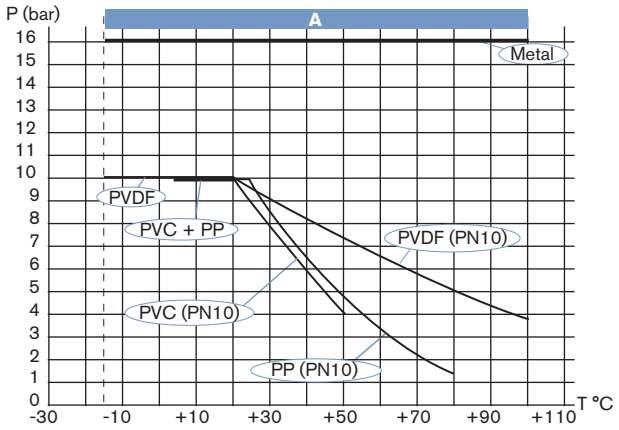
Pressure / temperature chart



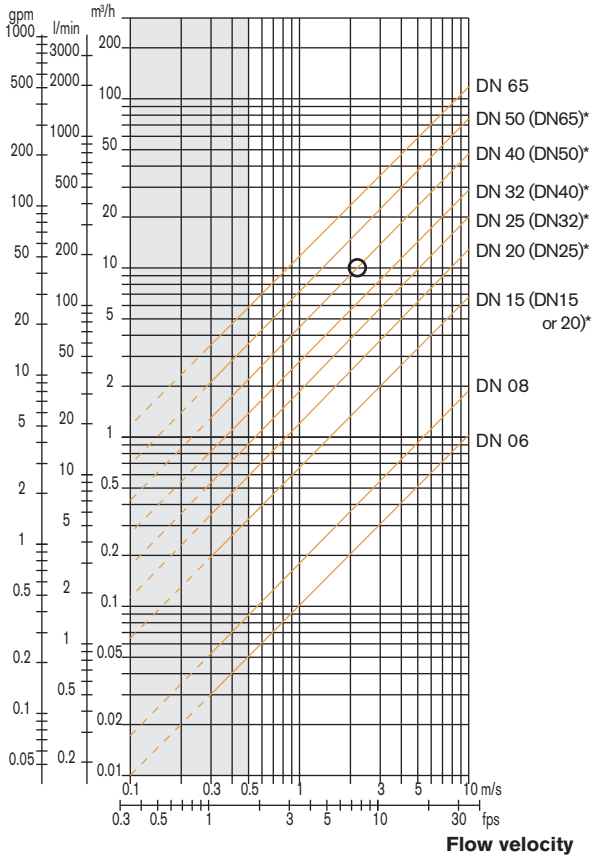
A: Application range for complete device (fitting + controller)

Selection of fitting / pipe size

Example:

- Specification of nominal flow: 10 m^3/h
- Ideal flow velocity: 2...3 m/s
- For these specifications, the diagram indicates a pipe size of DN40 [or DN50 for (*) mentioned fittings]

Flow rate



Flow velocity

*** for following fittings:**
- with external threads acc. to SMS 1145
- with weld-ends acc. to SMS 3008, BS 4825 / ASME BPE or DIN 11850 Series 2
- Clamp acc. to SMS 3017 / ISO 2852, BS 4825 / ASME BPE or DIN 32676

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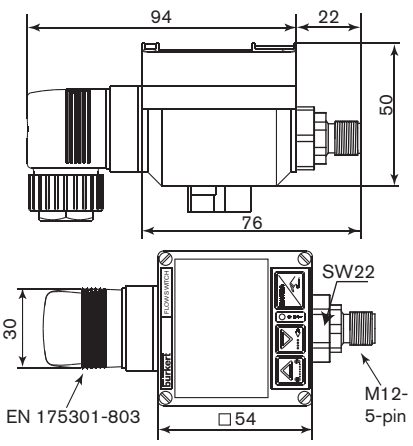
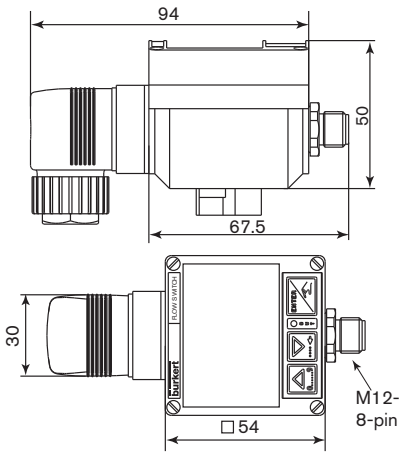
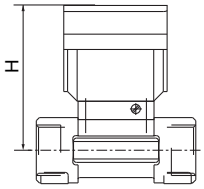
Dimensions

8032 compact

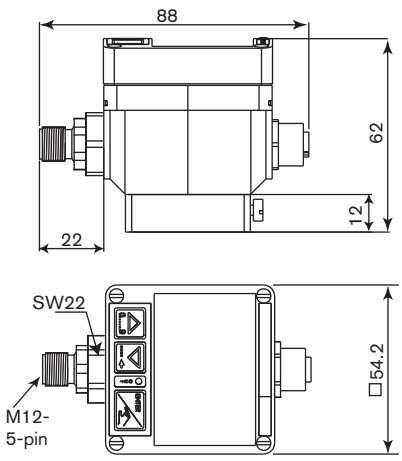




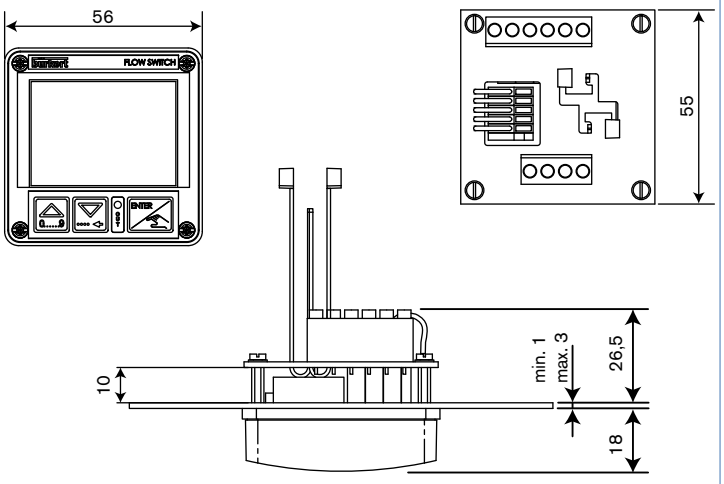


DN [mm]	H [mm]
06	79.5
08	79.5
15	84.5
20	82.0
25	82.2
32	85.8
40	89.6
50	95.7
65	95.7

8032 wall-mounted



8032 panel-mounted



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Ordering chart for Controller Type 8032

A compact flow controller Type 8032 consists of:

- a compact electronic module SE32
- an INLINE fitting S030 (DN 06 - DN 65) (Refer to corresponding data sheet - has to be ordered separately)

Voltage supply	Input	Output	Electrical connection	Item no.
12-30 V DC	---	NPN	Cable plug EN 175301-803*	436 474
		PNP	Cable plug EN 175301-803*	434 871
		NPN and PNP	Swivel 5-pin M12 plug	436 473
		Relay	Swivel 5-pin M12 plug and cable plug EN 175301-803*	436 475
	4-20 mA[1)]	4-20 mA[2)] +Relay	8-pin M12 plug and cable plug EN 175301-803*	444 699

1) External setpoint 2) Process value

* Europe / Asia (G / Rc): M16 x 1.5 mm cable plug
USA / CDN (NPT): NPT 1/2 cable plug

A wall- or panel- mounted a flow controller Type 8032 consists of:

- a wall- or a panel- mounted electronic module SE32
- a flow sensor Type 8020, 8030, 8030-HT, 8041 or 8070 - frequency output with pulse signal (Refer to corresponding data sheet - has to be ordered separately)

Description	Voltage supply	Input	Output	Electrical connection	Item no.
Wall-mounted	12-30 V DC	Frequency	NPN and PNP	Swivel 5-pin M12 male and 4-pin M12 female	448 861
Panel-mounted	12-30 V DC	Frequency	NPN and PNP	Terminal strips	558 181

Ordering chart for accessories (to be ordered separately)

Description	Item no.
4-pin M12 male cable connector with plastic threaded locking ring, for remote version	448 856
4-pin M12 male connector moulded on cable (2 m, shielded), for remote version	448 857
5-pin M12 female cable connector with plastic threaded locking ring	917 116
5-pin M12 female connector moulded on cable (2 m, shielded)	438 680
8-pin M12 female cable connector with plastic threaded locking ring	444 799
8-pin M12 female connector moulded on cable (2 m, shielded)	444 800
Cable plug EN 175301-803 with cable gland (Type 2508)	438 811
Cable plug EN 175301-803 with NPT1/2 " reduction without cable gland (Type 2509)	162 673

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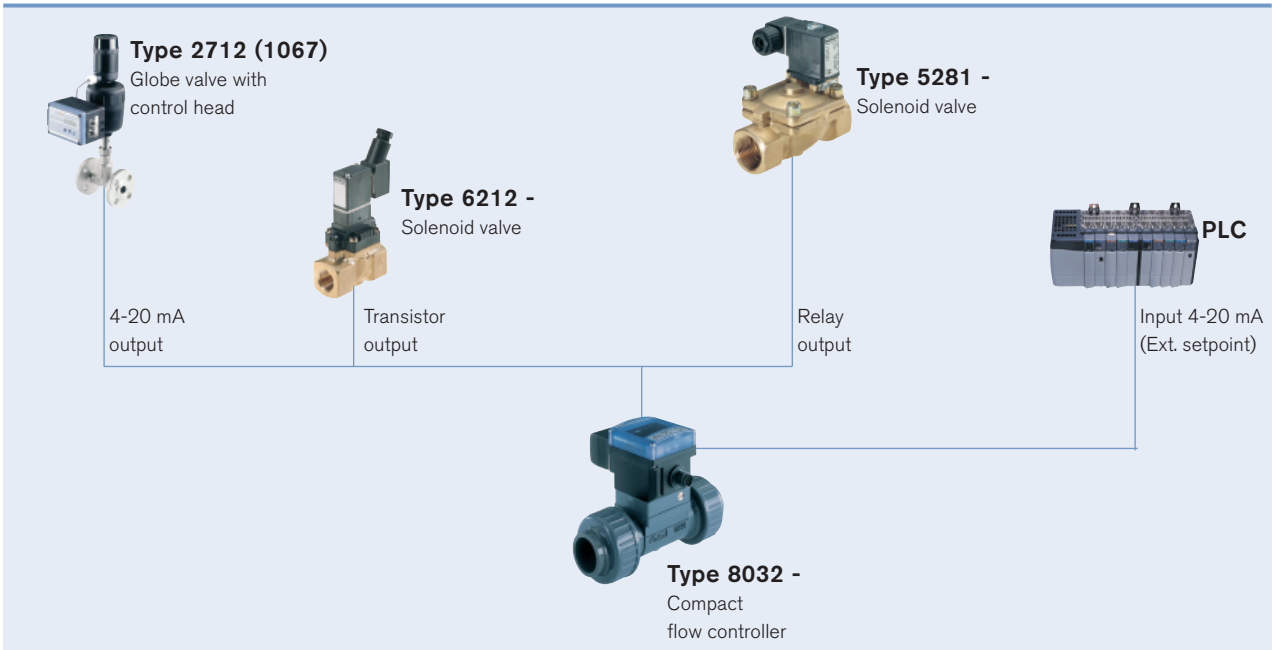
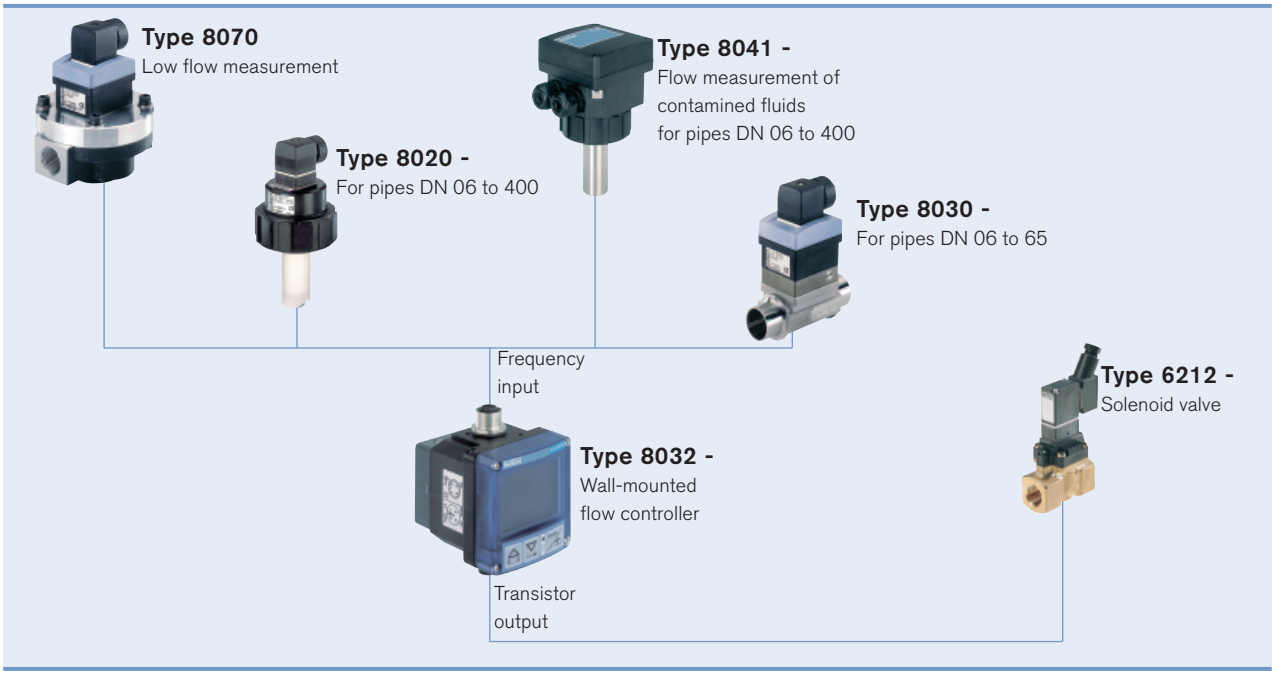
Interconnection possibilities with other Bürkert products

Compact flow controller



Wall-mounted flow controller



To find your nearest Bürkert facility, click on the orange box → www.burkert.com

In case of special application conditions,
please consult for advice.

Subject to alteration.
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0906/8_EU-en_00891781

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Type 1008S Stainless Case Gauge with Stainless Steel System

FEATURES

- *Patented PowerFlex™ movement*
- *All stainless steel welded construction*
- *1.6% full scale accuracy*
- *True Zero™ pointer indication*
- *NEW ventable plug*
- *NEW MSL helium leak tested to 1X10^{-6} ATM$^{-cc/sec}$*
- *Meets ASME B40.100 and EN837-1 standards*
- *RoHS compliant*
- *CRN approved*
- *1 year limited warranty*

Ashcroft is pleased to reintroduce the 1008S pressure gauge. This gauge has been upgraded with many new features outlined above while maintaining the tried and true performance and quality you have come to expect.

1008S gauges provide significant features and benefits. New features include a ventable plug that can be sealed or vented depending on your environment.

The combination of features including the patented Power*Flex™* movement and optional *PLUS!™* Performance dampening system in the Ashcroft 1008S gauge is the finest gauge technology for vibration, shock and pulsation applications. Available in pressure ranges from vacuum to 15,000 psi, including compound and metric ranges.

PRODUCT SPECIFICATIONS

Ashcroft Type No.:	1008S
Sizes:	63mm, 100mm
Case:	304SS
Ring:	304SS crimped
Window:	Polycarbonate
Dial:	Black figures on white background, aluminum
Pointer:	Friction adjust, black, aluminum
Bourdon Tube:	316L stainless steel C-Shaped (vacuum-600 psi and compound) Helical (1000 psi-15000 psi)
Socket:	316L stainless steel
Movement:	300 series stainless steel, Power*Flex*, polyester segment, overload/underload stops
Connections:	⅛ and ¼ NPT, lower or lower back ½ NPT lower (100mm) only
Ranges:	Vac-15000 psi and compound
Accuracy:	1.6% full scale
Fill Plug:	Ventable
Protection:	Nema 4X / IP65 plug sealed Nema 3 / IP54 plug vented
Ambient Temperature Limitations:	–40°F to 200°F dry +20°F to 150°F glycerin filled –40°F to 150°F silicone filled

(based on standard polycarbonate window)

OPTIONAL FEATURES

Liquid fill:	Glycerin, silicone, halocarbon (includes throttle plug)
Dampening:	*PLUS!™* Performance (LL) (includes throttle plug)
Connections:	Metric and SAE
Mounting:	U-clamp (UC), Front flange (FF),
Dials:	Receiver ranges, refrigerant ranges; custom dials

HOW TO ORDER (Typical example)

63 1008 S (L) 02L XXX 100#

Dial Size: 63mm (63), 100mm (10)
Case Type: 1008
Tube and Socket Material: 316L SS
Liquid Filled: (glycerin) leave blank if dry
Connection Size: ⅛ (01), ¼ (02), ½ (04) 100mm lower only
Connection Location: Lower (L), Lower Back (B)
Options:
Range: 0/100 psi

ISO 9001
REGISTERED FIRM

BULLETIN GS-1

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All sales subject to standard terms and conditions.
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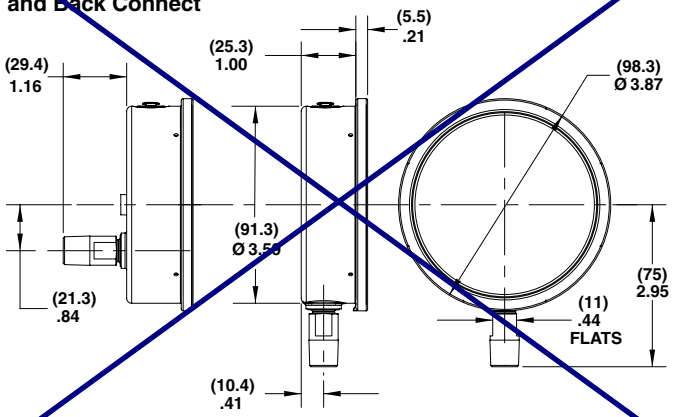
Ashcroft Inc., 250 East Main Street, Stratford, CT 06614 USA
Tel: 203-378-8281 • Fax: 203-385-0408
email: info@ashcroft.com • www.ashcroft.com

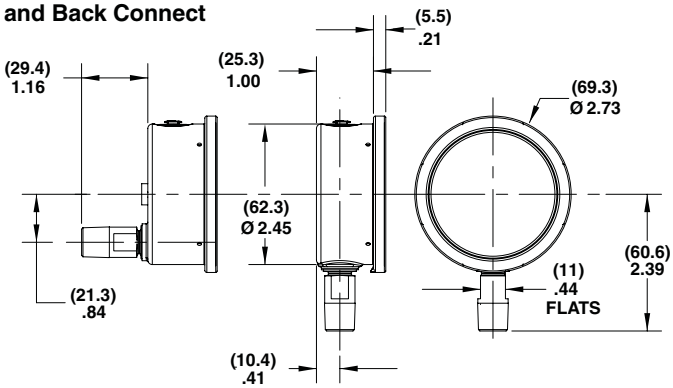
Type 1008S Stainless Case Gauge with Stainless Steel System

DIMENSIONS

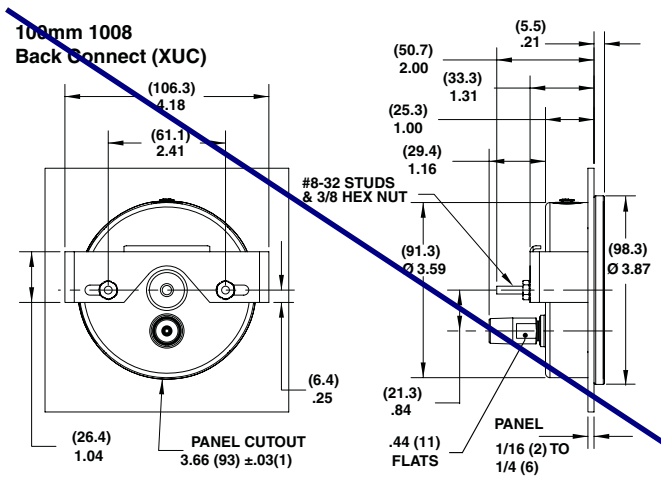
100mm 1008 Lower and Back Connect



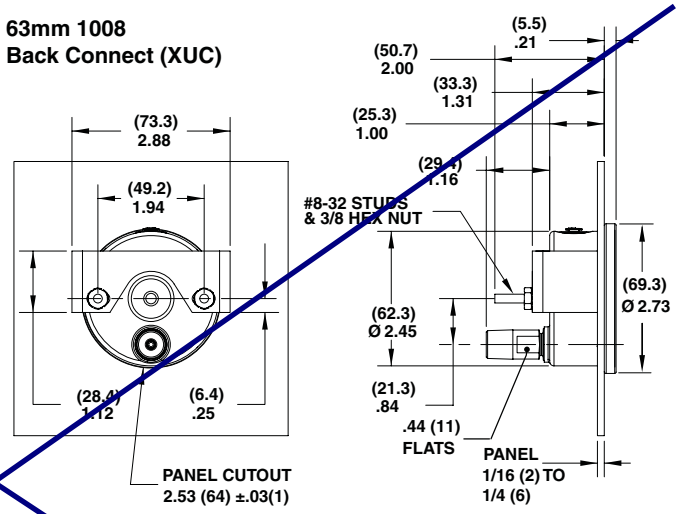
63mm 1008 Lower and Back Connect



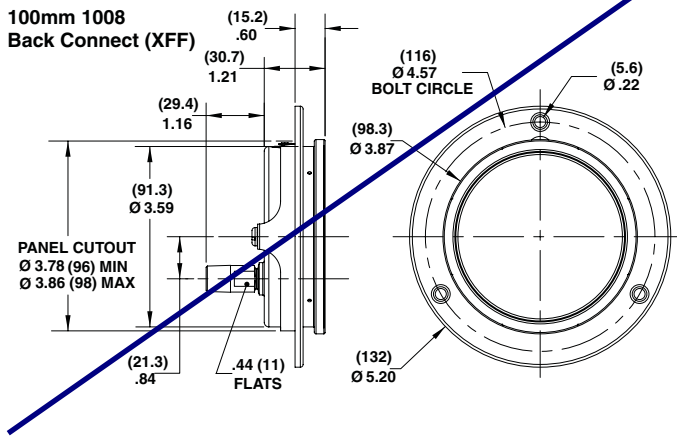
100mm 1008 Back Connect (XUC)



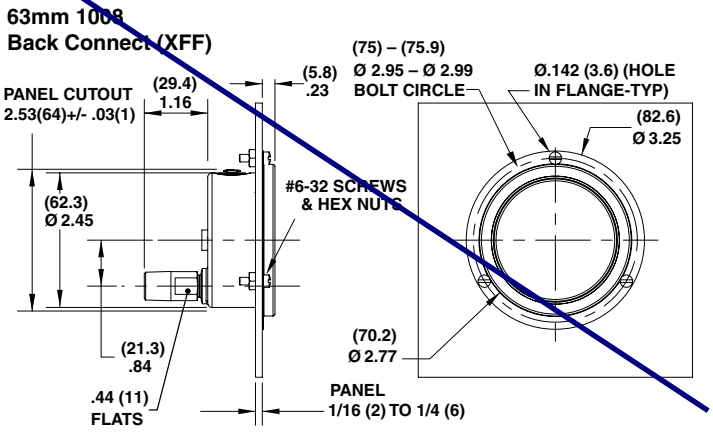
63mm 1008 Back Connect (XUC)



100mm 1008 Back Connect (XFF)



63mm 1008 Back Connect (XFF)



ISO 9001
REGISTERED FIRM

BULLETIN GS-1

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All sales subject to standard terms and conditions.
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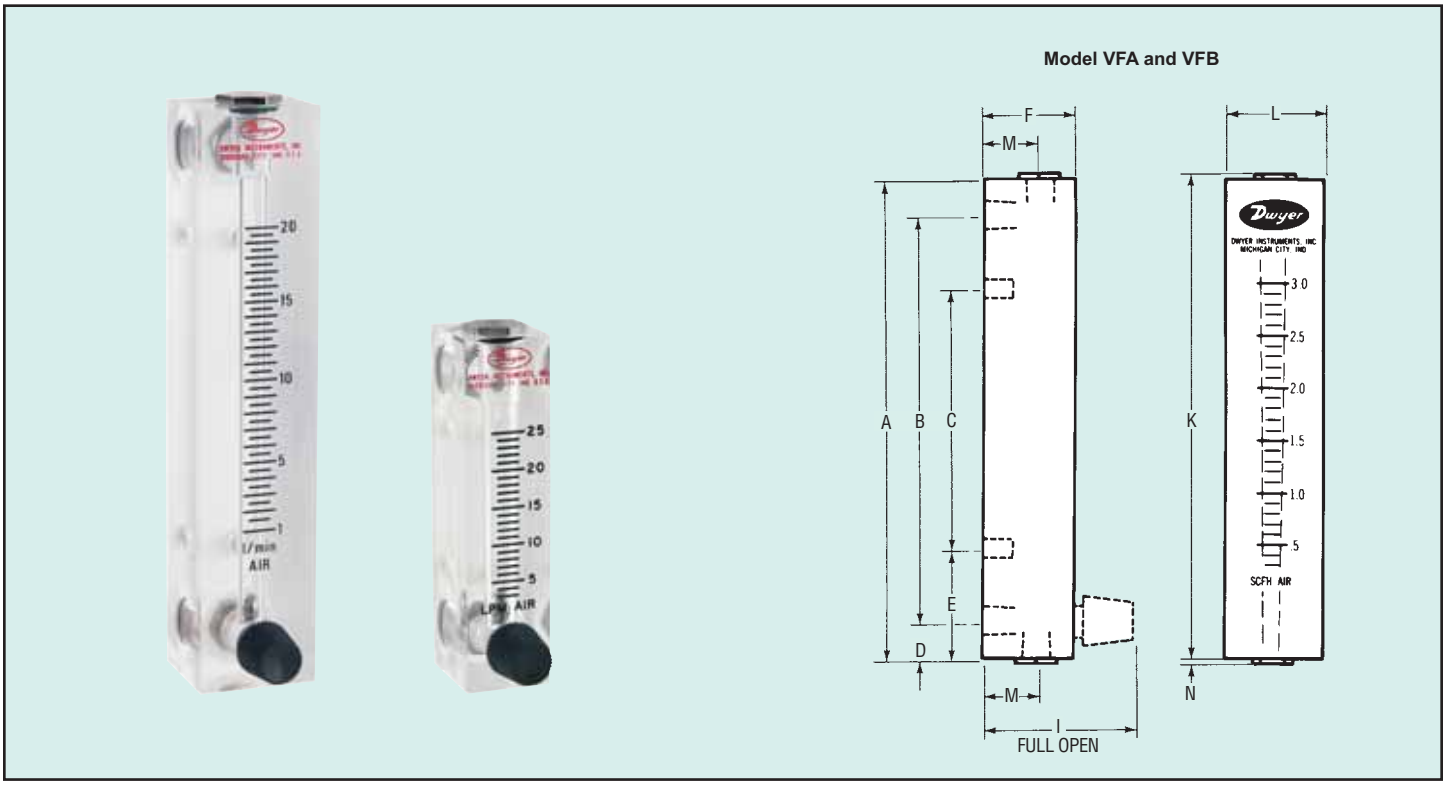
Ashcroft Inc., 250 East Main Street, Stratford, CT 06614 USA
Tel: 203-378-8281 • Fax: 203-385-0408
email: info@ashcroft.com • www.ashcroft.com

Series VFA & VFB

Visi-Float® Flowmeters

Used to Indicate or Manually Control Air or Water Flow



The Visi–Float® flowmeter bodies are cut and precision machined from solid, clear acrylic plastic blocks. This construction not only produces a handsome finished product, but permits complete visual inspection. As a result, the Visi-Float® flowmeters are especially popular for medical and laboratory equipment applications.

Scales are easy to read – The front scale location and white background provides excellent visibility. The direct reading scales are hot stamped into the plastic and will not wear off. Mid-range calibration is established with a master flowmeter. Accuracy is ±5% of full scale for VFA models, ±3% for VFB. Scales average 2" long on the VFA models, 4" long on VFB.

Durable and attractive construction – The machined acrylic bodies of the Visi-Float® flowmeters are practically unbreakable. Fabrication is backed by over 60 years of experience in acrylic instrument machining. The tapered bore is precision machined to a smooth surface that provides perfect visibility of the indicating float. The VFA and VFB models are available with either brass or stainless steel inlet and outlet connections and are tapped for 1/8˝ NPT thread. VFB models 85 and 86 have either 1/4˝ back or 3/8˝ end connections. All standard models employ Buna-N "O" rings for leak proof operation and are available with either back or end connections for horizontal or vertical piping. Precision metering valves in brass or stainless steel are available for most VFA and VFB models.

Easy installation – All Visi-Float® flowmeters have metal mounting inserts on rear for panel mounting. They can also be supported directly by system piping.

Dimension-In-Inches		
	Model VFA	**Model VFB**
A	4	6-1/2
B	3 (1/8 female NPT)	5-1/2 (1/8 female NPT)
C	1-5/8 (10-32 Thread)	3-1/2 (10-32 thread)
D	1/2	1/2
E	1-3/16	1-1/2
F	1-1/4	1-1/4
I	2-1/16 (BV or SSV)	2-1/16 (BV or SSV)
K	4-3/32	6-19/32
L	1	1-3/8
M	3/4 (EC)	3/4(EC)
N	3/32 (EC)	3/32 (EC)

Special Multi-Column Visi-Float® Flowmeters
Perfect for OEM applications, Visi-Float® flowmeters can be custom made with up to 10 columns in a single block of acrylic plastic.
Available with or without valves. Consult factory for more information.

OEM Specials – Special flowmeter designs can be supplied to meet a wide range of requirements and specific applications. These include: on-off plunger and push-to-test valves, special gas or fluid calibration, special ranges, scales, name brand or other identification. Pointer flags can be furnished for instant visual reference. For specific information, please supply an outline of your requirements.

SPECIFICATIONS

Service: Compatible gases & liquids.
Wetted Materials:
Body: Acrylic plastic.
O-ring: Buna-N (Fluoroelastomer available).
Metal Parts: Brass standard, stainless steel optional.
Float: Stainless steel, black glass, aluminum, K Monel depending on range.
Temperature & Pressure Limits:
Without Valve: 100 psig (6.9 bar) @ 150°F (65°C);
150 psig (10 bar) @ 100°F (38°C).
With Valve: 100 psig (6.9 bar) @ 120°F (48°C).
Accuracy: VFA = 5% of full scale; VFB = 3% of full scale.
Process Connection: 1/8″ female NPT. VFB ranges 85 and 86 have 1/4″ NPT back connections or 3/8″ NPT end connections. These ranges not available with brass valves.
Scale Length: VFA 2″ typical length; VFB 4″ typical length.
Mounting Orientation: Mount in vertical position.
Weight: VFA: 4.0-4.8 oz (.11-.14 kg). VFB: 7.2-8.8 oz (.20-.25 kg).

How To Order
Series—Range No.—Valve—Option
Example: VFA-9-BV
Series VFA with 20-200 SCFH Air Range & Brass Valve

VFA Series

Model	Description
VFA-X	Standard VFA
VFA-X-SS	VFA with Stainless Metal Wetted Parts
VFA-X-BV	VFA with Brass Valve
VFA-X-SSV	VFA with Stainless Steel Valve
VFA-X-EC	VFA with End Connections
VFA-X-EC-SS	VFA with End Connections and Stainless Steel Metal Wetted Parts

OPTIONS & ACCESSORIES
-PF, Red ABS Plastic Pointer Flag
-VIT, Fluoroelatomer O-rings
RKA, Pressure Regulator

VFB Series

Model	Description
VFB-X	Standard VFB
VFB-X-SS	VFB with Stainless Metal Wetted Parts
VFB-X-BV	VFB with Brass Valve
VFB-X-SSV	VFB with Stainless Steel Valve
VFB-X-EC	VFB with End Connections
VFB-X-EC-SS	VFB with End Connections and Stainless Steel Metal Wetted Parts

OPTIONS & ACCESSORIES
-PF, Red ABS Plastic Pointer Flag
-VIT, Fluoroelastomer O-rings
RK-VFB, Pressure Regulator

Popular Ranges

Model VFA — 2" Scale			
Range No.	**Range SCFH Air**	**Range No.**	**Range LPM Air**
1	.1-1	21	.06-0.5
2	.2-2	22	.15-1
3	.6-5	23	.6-5
4	1-10	24	1-10
5	2-20	25	3-25
6	4-30	26	6-50
7	5-50	27	10-100
8	10-100		
9	20-200		
	CC Water per min.		**Gal. Water per hour**
32	6-50	41	.6-5
33	10-100	42	2-10
34	20-200	43	3-20
		44	8-40

Popular Ranges

Model VFB — 4" Scale			
Range No.	**Range SCFH Air**	**Range No.**	**LPM Air**
50	.3-3	65	.2-4
91+	1-10	66	1-10
51+	2-20	67	1-20
52	4-40	68	3-30
53+	10-100	69	4-40
54+	10-150		**CC/Min. Water**
55+	20-200	82	2-30
	SCFM Air		**GPH Water**
90	.3-3	80+	.5-12
	CC/Min. Air	83+	1-20
60	100-1000	84	6-40
		81	6-60
			GPM Water
		85*	.2-2
		86*	.6-5

+ For dual range models in English and Metric add “D” to end of Range No.
* Ranges 85 and 86 consult factory. Not available with brass valve.

Schnell, Kristi

From: Robert Nickerson [RNickerson@therma-flite.com]
Sent: Tuesday, July 13, 2010 7:31 PM
To: Dale Wilson; Hargett, Kim
Cc: Schnell, Kristi; Burgett, Michael; 'Paul Lawrence'
Subject: RE: BGMU Dryer Building Thermal Flite Shop Drawing Section C Review

Drawing TFL 5412-00000 1 of 2 (note assume all drawing numbers referred to herein start with TFL5412

1) Are Drives & Gear Reducers, shown on left end of units, shipped pre-assembled on the dryer modules? The drives and gear reducers are shipped pre-assembled – no field labor required.
2) Tail End View ….is all of the piping shown pre-piped as an assembly and skid mounted? Are the valves shown EMO operated, and pre wired? The piping associated with the rack will be pre-piped and shipped as an assembly up to and including the valves. The flex lines and piping to the rotary unions and under the equipment will be shipped loose for field erecting. The valves are manually operated valves.
3) At the 16"Cooling Screw, what connects to this custom flange? Duct work? The outlet of the cooling screw is the final flange in our scope of work. I believe this will transition into the pneumatic conveying system.
4) At the End of Cooling Screw, there is a 2" sample port; does TF provide a valve or cock to open and close port for sampling? This sample port is an FNPT coupling with a plug that can be used as a sample port.
5) We assume the "structural supports" are shipped assembled; please confirm The structural supports qty(4) will be shipped as fabricated steel structures (painted) to be field erected – bolted to the dryer frame and anchored to slab.

Drawing 00000, 2 of 2

1) Cooling Screw….at what point is the connection made under the Dehydration Chamber, i.e., is it at the large flange between the devices shown as BSDLS 5412-1 & BSDLS 5412-2? Correct. The gasket and hardware will be provided. Plenty of RTV gasket maker should be used to ensure a good seal.

Drawing 10000, 1 of 3

1) Lifting Pipes…advise the ID of the pipes The lifting pipes are 8" Sch80 (7 5/8" ID). We typically use a 6" sch120 slide thru and lift no more than 10" outboard of the tubular frame. (4) Point pick to ensure an even distribution of the load.

Drawing 10000, 3 of 3

1) Are the channel supports K-I and L-J shipped with cross braces such that they are an assembly? Yes.
2) Are the anchor bolts included in the TF scope of supply? If so, are they the epoxy chemical type (they need to be) The epoxy anchors are not in TFL scope but we typically use HY150 epoxy chemical type – specification is in our submittal package.
3) At the Thermal Expansion Table, are flexible couplings required for connections or are they rigid?

   Nozzle e: This is the scrubber drain – typically this is routed directly to a floor drain cut into the concrete with a grate. The pipe should stick down thru the grate with a radial clearance to take up thermal expansion.

   Nozzle f: Supply water to the scrubber should have flex hose to allow the thermal expansion.

   Nozzle b: Feed supply from the sludge pumps will require a flex connection to take up the thermal expansion.

   All other expansion points have been addressed by Therma-Flite supplied piping.

Robert D. Nickerson
Therma-Flite, Inc.
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rnickerson@therma-flite.com

Statement of Confidentiality

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From: Dale Wilson [mailto:dwilson@judyconstructionco.com]
Sent: Tuesday, July 13, 2010 11:09 AM
To: 'Hargett, Kim'
Cc: 'Schnell, Kristi'; 'Burgett, Michael'; 'Paul Lawrence'
Subject: RE: BGMU Dryer Building Thermal Flite Shop Drawing Section C Review

Everyone,
Following up on our conversation last Thursday and Kim's email copying us on the email below, we have reviewed the Therma-Flite (TF) shop drawing Section C, pages 26-35 and find no issues that would keep them from starting their fabrication of the main components. As I am sure we all know, this will be the longest lead time item and it would be great to turn them loose ASAP on this portion of their fabrication.

With that being said, we still have a few questions/clarifications we'd like addressed:

Drawing TFL 5412-00000 1 of 2 (note assume all drawing numbers referred to herein start with TFL5412

6) Are Drives & Gear Reducers, shown on left end of units, shipped pre-assembled on the dryer modules?
7) Tail End View ….is all of the piping shown pre-piped as an assembly and skid mounted? Are the valves shown EMO operated, and pre wired?
8) At the 16"Cooling Screw, what connects to this custom flange? Duct work?
9) At the End of Cooling Screw, there is a 2" sample port; does TF provide a valve or cock to open and close port for sampling?
10) We assume the "structural supports" are shipped assembled; please confirm

Drawing 00000, 2 of 2

2) Cooling Screw….at what point is the connection made under the Dehydration Chamber, i.e., is it at the large flange between the devices shown as BSDLS 5412-1 & BSDLS 5412-2?

Drawing 10000, 1 of 3

2) Lifting Pipes…advise the ID of the pipes

Drawing 10000, 3 of 3

4) Are the channel supports K-I and L-J shipped with cross braces such that they are an assembly?
5) Are the anchor bolts included in the TF scope of supply? If so, are they the epoxy chemical type (they need to be)
6) At the Thermal Expansion Table, are flexible couplings required for connections or are they rigid?

That is all for now.
Dale Wilson
Judy Construction Company
2:05pm

From: Schnell, Kristi
Sent: Thursday, July 08, 2010 3:22 PM
To: Hargett, Kim
Subject: RE: BGMU Contractor Question

1. Marked-up page 5 to say NEMA 4X.
2. See Below.

3.4 MANUFACTURER'S FIELD SERVICES

A. The wet cake hopper supplier shall furnish the services of a factory-trained representative for a period of three days in a minimum of two trips to the jobsite, exclusive of travel time. Service shall be provided as necessary after the Contractor has installed the equipment.

B. These services shall be furnished for the purposes of the equipment manufacturer's inspection of the equipment following installation, and to certify that the equipment has been properly installed and is ready to operate, to train the Owner's personnel in operation, maintenance of the equipment, and to observe and supervise the initial operation of the equipment. Training shall comply with Division 01 Section "Demonstration and Training".

C. The Contractor shall coordinate the Manufacturer's technical services in a timely professional manner. At a minimum, two weeks notice must be given to the Manufacturer for travel planning purposes unless previously agreed by Manufacturer. To avoid project delays, every effort should be made to coordinate inspection, training, and start-up of the equipment.

D. After inspection of the installed equipment the Manufacturer shall furnish a written report certifying that the equipment has been properly installed and lubricated, is in accurate alignment, is free from any undue stress imposed by connecting piping or anchorage, has been operated under full load conditions and that it operates satisfactorily.

3. Section C pages C-1 thru C-6 (or page 26 thru 36 of 635). However, Richard wanted the note added to page 34 of 635 about referencing his structural drawing. So I would say it would be an "Exceptions Noted" approval.

Kristi Schnell, P.E.

GRESHAM, SMITH AND PARTNERS
[P] 615.770.8529

From: Hargett, Kim
Sent: Thursday, July 08, 2010 3:06 PM
To: Schnell, Kristi
Subject: BGMU Contractor Question

I have three questions from a conference call I just had with BGMU and Judy.

1. Can you check the spec for the bridge crane on Contract 3 for a conflict? Section 41-2213.13 apparently has a NEMA 4X panel spec'd on page 3 and a NEMA 12 spec'd on page 5.

2. Also, tell me what the wet cake hopper training specified was.

3. What pages of Section C, Volume 1 of Therma-Flite submittal do we need to have released?

Kim K. Hargett, P.E.
Senior Project Manager

GRESHAM, SMITH AND PARTNERS
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Schnell, Kristi

From: Robert Nickerson [RNickerson@therma-flite.com]
Sent: Friday, July 16, 2010 1:07 PM
To: Dale Wilson
Cc: 'Paul Lawrence'; Schnell, Kristi
Subject: RE: BGMU Dryer Equipmetn Questions, Clarifications
Attachments: Room Layout T99-1530.pdf

- In the Thermal Fluid Piping section, Page 244 for 635, there are two options; we are assuming option Case #1 is the one that applies to this project…can you confirm? Case #2 applies to this application. The Thermal Fluid Heater is located away from the dryer in a separate room. We are providing the dryer with the piping header system you see in our GA Drawing TFL5412-00000. We are also providing the Thermal Fluid Heater as shown in T99DR-1530 from Fulton. All interconnecting piping from the dryer header (supply/return) to the Fulton Heater (supply/return) plus insulation and support is outside our scope.
- In the same section above, there is a "Catch Tank"; you indicate you are not providing this; our plans somewhat indicate it is in your scope (see MP7.2.0, labeled BSD-7442); we're trying to get an idea what this tank is made of, a manufacturer, etc. if we have to price adding it. The catch tank and the piping/valves associated between the Thermal Fluid Heater and the catch tank is outside our scope. The tank is typically a thin wall fabricated tank or an existing onsite containment with a volume of at least 200gal for a system this size. We typically do not include this tank and pipe/valves in our bid package but make it aware to the Engineering and GC that it is required during field installation. A 200 gal steel tank (hot oil may discharge into it during an upset or overpressure) with the ability to drain and vent with connection ports in the top for each pipe-run from the thermal Fluid Heater.
- Also, on the Catch Tank, where does it drain to and is there any thermal conditions to be concerned with? What is the normal material used for the Catch Tank?....FRP, Concrete, Steel? Typically Steel w/ a drain connection near the bottom to connect a hand or electric pump if it ever needs to be drained. Thermal concerns are warranted. In an upset condition 500F oil could discharge into the tank.
- Page 244, you all is going with Case 1 correct? We don't see a good drawing of this equipment….the page that we printed was not completed; can you email us a PDF drawing of page 246? Will this all be pre-piped, pre-wired, all on a skid with expansion tank all together? Case #2 applies to this application. Therma-Flite is to provide all equipment depicted in T99-1530. This equipment will be pre-piped as shown with 2-point (supply/return) connection points from the dryer to the heater (E and F of T991530 connect to A and B of TFL5412-00000). The Thermal Heater will also require the Catch Tank and all associated piping and valves.
- Speaking of drawings, can you also send us one of page 444, BGMU Room Layout? Attached.
- On page 447, there is a description of the Condenser Scrubber; there is no drawing afterward; would there be a page 447A as a drawing of this? Is this available and where does it go? Maybe it is integral with other equipment and we're missing it; The Condenser Scrubber is integral to the dryer and attached to it. Please refer to TFL5412-00000 (A-A View).
- On page 442, there is a "3" gas train"…….is an integral part of the Thermal Heater/Boiler, aka Thermal Fluid Heater, included in the pre-piped skid? Yes. This is integral with the Heater and pre-piped for field connection.

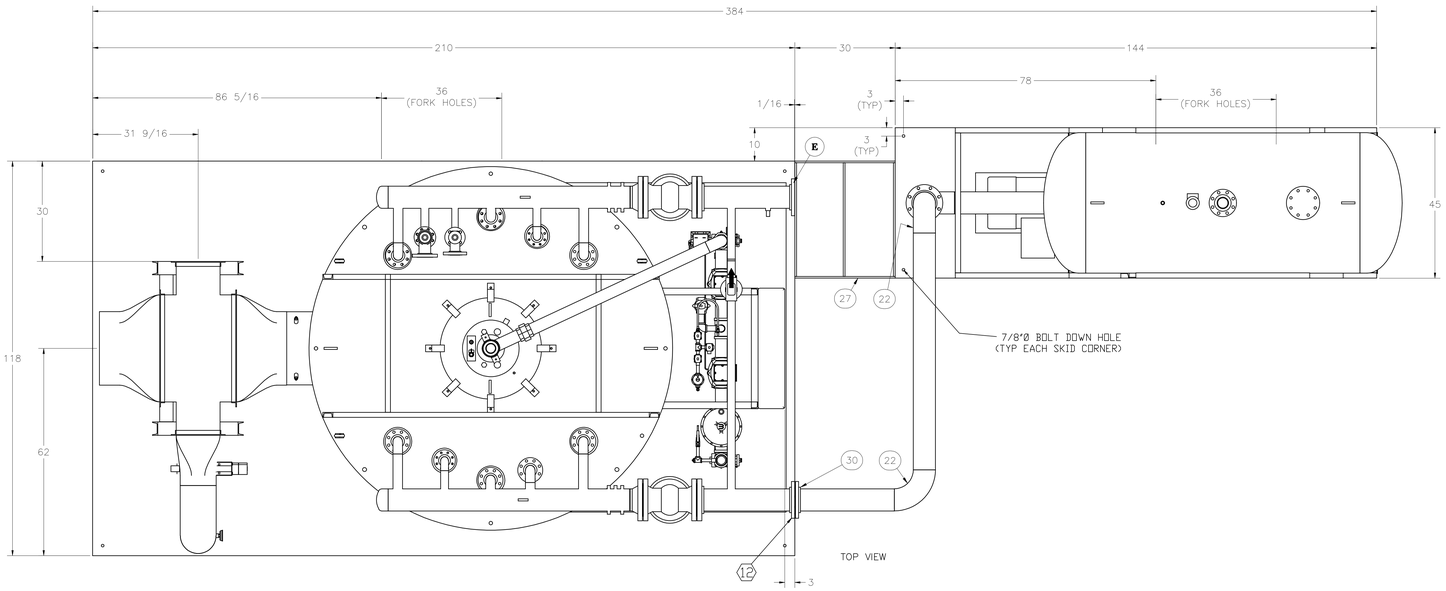
- In looking on your P& ID drawing with our piping subcontractor, you/TF have the piping from the Thermal Fluid Heater (TFH) to the Dehydration Chamber (confirm and advise type of pipe and joints) The piping (supply/return) from the (TFH) to the Dehydration Chamber is outside our scope. This is field piping that must be routed from the Boiler Room to the location of the dryer. This piping must be supported, insulated with consideration for thermal expansion.
- Again on the P&ID drawing, you have several valves (looks like 3) that go on three lines coming off of the TFH to the Catch Tank….what are these valves and type of joints? Can you tell us too the expected type of pipe used in conjunction with these valves? These valves are 1" and 2- ½"; we see in the same area on this drawing drawn above the expansion tank what look like valves (labeled BSDPRV 5412-1 & 2); are these pressure relief valves and they apprear to be 2 1/2" and 3"; what type of joint are these and what is the normal type of pipe used in conjunction with these? Please refer to the legend at the lower left portion of the PID drawing for size and type of connection. (BSDPRV 5412-1&2) will be provided by Therma-Flite and can be referenced on T99-1530. These pressure relief valves will need to be piped to the catch tank. A106 or A53 Carbon Steel pipe is typical. Typical valve used in this application are VELAN – cast carbon gate valves or equivalent.
- Again on the P&ID drawing, related to the Supply and Return of the Thermal Fluid, there is shown "insulation on these lines; the insulation is shown only on the piping we are responsible for; should we expect to insulate the piping and valves which you/TF is providing? Are there other lines (that we will be providing) that are normally

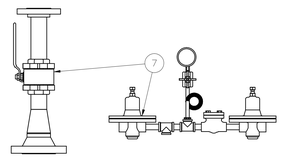
insulated? Therma-Flite will provide insulation on all “long runs” and headers as shown in TFL5412-00000. Flanges, valves and flex lines will not be provided insulated. Personnel protection will be provided by the piping rack guard at the inlet end of the machine. The TFH will not be provided with piping insulation. Expanded metal guards will be provided around the motor and pump for personnel safety. Field erected and interconnecting piping will not be insulated.

Robert, if you want to give me a call to discuss the above in lieu of having to type answers that is fine with me; I actually would prefer both….answers and a call this afternoon (our afternoon any way); we have a bid today at 2:00pm (your time 11am); if you could call me around 12:30-1:00pm PST, that would be good.
(I will give you a call at 1pm PST).

Thanks
Dale Wilson
Judy Construction Company

Parts List				
ITEM	PART NUMBER	DESCRIPTION	QTY	U.O.M.
1		1/4" HR PLATE	45	S.F.
2	2-10-000216	4" x 6" TUBE STEEL	30	FT.
3	T91DR-0565	FT-1200-C HEATER SKID	1	EA.
4	9-FT-2000-L	FT-2000-L COMBINATION 528 GAL. COLD SEAL EXPANSION & DEAERATOR TANKS	1	EA.
5	T40DR-0491	FT-2000-L D.A. TANK STANDARD SUPPORT FRAME	1	EA.
6	7-30-002022	4 x 6 x 8 1/2 DEAN PUMP W/ 60 HP MOTOR	1	EA.
7	4-30-000210	2-WAY NITROGEN BLANKET KIT	1	EA.
8	2-30-000639	1 1/2" N.P.T. INLET 2 1/2" N.P.T. OUTLET SAFETY RELIEF VALVE	1	EA.
9	2-30-000891	VELAN 6" 150# GATE VALVE	1	EA.
10	2-30-001070	6" X 24" 150# FLANGED FLEX CONNECTION SA105	2	EA.
11	2-30-000733	6" 150# VELAN GLOBE VALVE	1	EA.
12	2-30-000869	3/4" S.W. GATE VALVE	2	EA.
13	2-30-004054	6" 150# STRAINER SURE FLOW	1	EA.
14	2-12-000804	6" STRAINER GASKET SURE FLOW	1	EA.
15	5-10-004703	TANK FRAME MOUNTING PLATE	4	EA.
16	5-10-004702	9" x 9" x 1/4" STEEL GUSSET PLATE	8	EA.
17	2-30-000453	1/4" N.P.T. CARBON STEEL NEEDLE VALVE 60-101-01	1	EA.
18	2-35-000390	1/4" N.P.T. SMLS STEEL SIPHON XH 350# SA-106B	1	EA.
19	2-35-000883	WINTERS .25 NPT PRESSURE INDICATOR 30-0-60	1	EA.
20	2-35-000178	1/4" F.S. N.P.T. COUPLING	1	EA.
21	2-35-000189	3/4" x 3" N.P.T. SCHED 80 T.O.E.	2	EA.
22	2-35-000551	6" WELD ELBOW SCH 40	5	EA.
23	2-35-001094	3/4" SOCKET WELD ELBOW	1	EA.
24	2-35-000285	3/4" THREADED CAP	2	EA.
25	2-35-000471	6" x 4" WELD REDUCER	1	EA.
26	2-35-000461	1 1/2 " x 3/4" WELD REDUCER	1	EA.
27	1-10-000101	2" x 1/2" FLATSTOCK	14	FT.
28	2-10-000100	4" x 5.4# CHANNEL	78	FT.
29	2-10-000147	6" PIPE	21	FT.
30	2-35-000553	6" 150# R.F. S.O. FLANGE	5	EA.
31	2-35-000580	6" 150# R.F. W.N. FLANGE	4	EA.
32	2-35-000458	4 300# R.F. W.N. FLANGE	1	EA.
33	2-35-000557	6 300# R.F. W.N. FLANGE	1	EA.
34	2-35-000555	6" 300# R.F. S.O. FLANGE	1	EA.
35	2-12-000417	4" 300# GASKET	1	EA.
36	2-12-000421	6" 300# GASKET	2	EA.
37	2-12-000420	6" 150# GASKET	10	EA.
38	2-35-000343	3/4" x 4 1/2" BOLT	24	EA.
39	2-22-000068	3/4" LOCK WASHER	120	EA.
40	2-35-000346	3/4" HEX NUT	120	EA.
41	2-35-000352	3/4" x 4" BOLT	8	EA.
42	2-35-000342	3/4" x 3 1/2" BOLT	80	EA.





DETAIL VIEW OF NITROGEN KIT (SHIPPED LOOSE)

NOTES:
1. PORTIONS OF THE PIPING AND COMPONENTS WILL BE DISASSEMBLED FOR SHIPPING.
2. D.A. TANK IS SHIPPED SEPARATELY.
3. THE SUPPORT STRUCTURE MAY BE CROSS BRACED OR OTHERWISE ENHANCED BEYOND WHAT IS SHOWN, AS REQUIRED.
4. FORK HOLES ARE LOCATED ON RIGHT SIDE OF SKIDS. HEATER SKID CONSTRUCTION FOR FT-0600-C THRU FT-1200-C, PLACE ONE RUNNER ON HEATER CENTERLINE & ONE ON OUTSIDE EDGE OF EACH FORK HOLE. PLACE ALL OTHER RUNNERS MAX. 24" ON CENTER
5. ADDITIONAL FIELD SUPPORTS MAY BE REQUIRED.
6. PLEASE REFER TO THE O&M MANUAL FOR ADDITIONAL INFORMATION REGARDING CLEARANCES AND INSTALLATION INSTRUCTIONS.

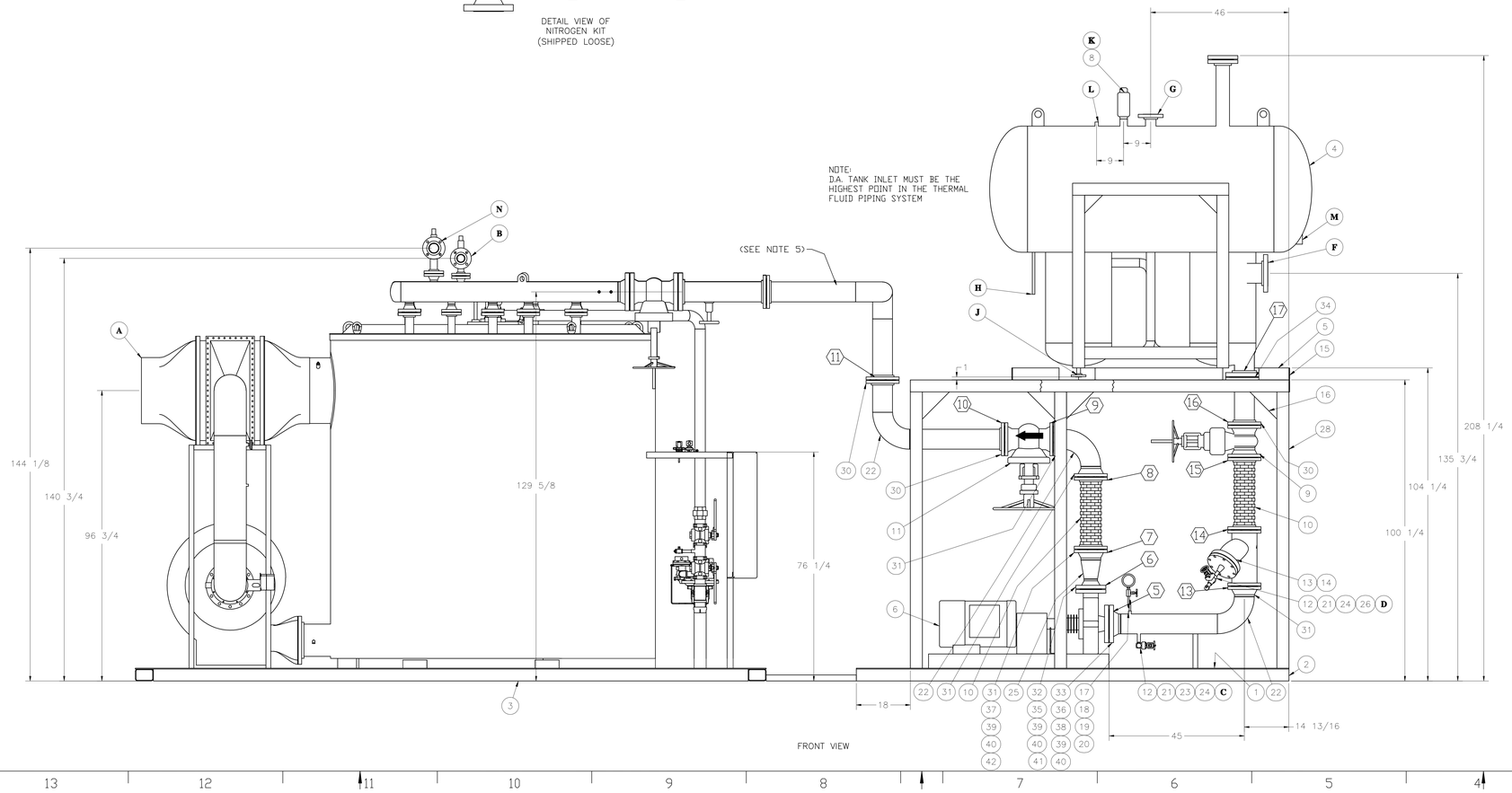
(X) — DENOTES FLANGE CONNECTION NUMBER- USE NUMBERS STAMPED ON MATCHING FLANGES TO AID REASSEMBLY.

ESTIMATED DRY WEIGHT 48,941 LBS

ESTIMATED FLUID VOLUME 752 GAL.

THE FOLLOWING ARE MAJOR CUSTOMER CONNECTIONS:
- **A** - 22"Ø FLUE CONNECTION 26"Ø RECOMMENDED VERTICAL STACK DIAMETER
- **B** - 2 1/2" 150# FLANGED SAFETY RELIEF VALVE OUTLET
- **C** - 3/4" N.P.T. DRAIN AND FILL CONNECTION (CAPPED)
- **D** - 3/4" N.P.T. STRAINER DRAIN (CAPPED)
- **E** - 6" 150# SUPPLY
- **F** - 6" 300# RETURN
- **G** - 3" 300# VENT
- **H** - 1/2" N.P.T. MANUAL HIGH/LOW LEVEL CHECK PIPES
- **J** - 1" 300# DRAIN
- **K** - 2 1/2" N.P.T. SAFETY RELIEF VALVE OUTLET
- **L** - 1/2" N.P.T. NITROGEN CONN.
- **M** - 2 1/2" N.P.T. LIQUID LEVEL SWITCH
- **N** - 3" 150# FLANGED SAFETY RELIEF VALVE OUTLET

NOTE:
D.A. TANK INLET MUST BE THE HIGHEST POINT IN THE THERMAL FLUID PIPING SYSTEM



REV.	DESCRIPTION	CHECKED	MECH. ENG.	ELEC. ENG.	APPROVAL
-	INITIAL RELEASE	A.C. 04/20/2010	M.R. 04/20/2010	L.N.L. 04/20/2010	G.W. 04/20/2010

REVISIONS

The item shown in this drawing may be covered by one or more patents of The Fulton Companies.

This design and drawing are proprietary and are the exclusive property of The Fulton Companies. The corporation does not permit their use except with prior written consent.

DWG BY: T. CORSON DATE: 16 APR 2010
SCALE: 1 / 16 SHEET NO: 1 / 1
UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN INCHES
TOLERANCE ON
FRACTIONS ± 1/4
TWO PLACE DECIMALS ± .01
THREE PLACE DECIMALS ± .005
ANGLES ± 2 DEG.
SURFACE FINISH 250 MICROINCHES

Fulton Thermal Corp.
972 Centerville Road
Pulaski, New York, USA 13142

FT-1200-C THERMAL FLUID HEATER WITH FT-2000-L D.A. TANK, DEAN'S 4 x 6 x 8 1/2" PUMP 60 H.P. MOTOR AND SPACER BRACING

SHEET SIZE E | DWG NO. T99DR-1530 | REV. -

Schnell, Kristi

From: Schnell, Kristi
Sent: Monday, August 09, 2010 11:24 AM
To: Wiesner, Gina
Subject: FW: BGMU submittal - part 1 clarification

Add as supplement to Part 1 of Dryer submittal.

Kristi Schnell, P.E.

GRESHAM, SMITH AND PARTNERS
[P] 615.770.8529

From: Robert Nickerson [mailto:RNickerson@therma-flite.com]
Sent: Monday, August 09, 2010 11:18 AM
To: Schnell, Kristi; Mike McCawley
Cc: Hargett, Kim; Burgett, Michael; Dale Wilson; 'Paul Lawrence'
Subject: RE: BGMU submittal - part 1 clarification

The drawing of the cooling screw, sent in supplement 3 on 7/8/2010 lists a processing rate of 2,250 lb/hr. However page 216 of 635 in the submittal says the rate is 2,500 lb/hr. Which is correct? The required processing rate is 2,250 lb/hr. We use this Cooling Screw arrangement up to 2,500 lb/hr design capacity.

Reference supplement 4 sent on 7/12/2010 about the odor control unit:

1. It lists on page 6 under "SK-450 BTF/BF Odor Control Module" that the media is proprietary. Do you know if BGMU would have to continue to use the proprietary media or if there is another option for media replacement? BioRem offers a 10 year warranty on their media designed to operate with their system. But if you would like to use another media – feel free but it will limit BioRem on their obligation to this equipment.
2. Same section – the last sentence refers to field installation, can you provide a list of all the field installation items? Also can you update the P&ID and electrical drawings to show what is to be field installed versus what is factory installed. All the piping on the skid is provided by BIOREM. The contractor needs to provide Power and Communication, Effluent Water Supply, Drain with P-trap, Ducting to Fan, Level Concrete Pad, Installation Labor.
3. On page 7 under "Installation" it talks about what Biorem provides versus what the Contractor would need to provide. Please confirm that all the Contractor needs to do is hook up the external water, drain, and electrical supply as mentioned? (Sheets 1-7 of the general arrangement drawings seem to indicate all piping on skid is being provided by Biorem.) Above.
4. Can you provide a detail for the drainage trap required by Biorem but provided by the Contractor? Is it a standard P-trap, or does it need to be something special? Standard P-Trap
5. In the P&ID drawings, sheet 1 references a line type labeled "boundary" and this boundary line appears on a few sheets. Is this line type similar to Therma-Flite's tie in points? Please update P&ID drawings so that what is to be provided by the Contractor and what Biorem/Therma-Flite is providing is clearly defined. I believe the P&ID drawings are clear. BIOREM/Therma-Flite are providing everything required except Power and Communication, Effluent Supply, Drain with P-trap, Ducting to Fan, Level Concrete Pad, Installation Labor.
6. Can you confirm the amount of water required – on page 5 it lists 0.16 gpm continuous but on the P&ID drawings sheet 3 it has different water usage quantities (11.1 gpm and 1.73 gph/each). Sheet 4, lists water requirements for irrigation, make-up, and blowdown. Please verify individual water requirements along with the total water required. (In the submittal page 465, it also references the 11.1 gpm and 0.7 gpm requirements.) Continuous Water consumption is approx. 0.16 GPM. The 11.1 GPM is recirculated and any other small usage is intermittent and accounted for in the 0.16 GPM continuous.
7. On the P&ID drawings, sheet 2 it shows a 1" drain off the exhaust fan. Is this pre-piped on the skid or is this piping the Contractor will need to provide? BioRem has indicated that this drain is not necessary and will be removed from the final documentation.
8. On P&ID sheet 4, the nutrient solution lines have the words "optional" listed. Are these included or not? Drawings should show what Biorem/Therma-Flite are supplying BGMU. The Nutrient System is not included in this package.

The Nutrient Tank System is only required if you are using Potable Water. This installation will be using Effluent Water which has the nutrients required.

9. Sheet 5 of the P&ID drawings lists that potable water is required for the nutrient tank. GS&P plans show only plant water feeding the unit, is potable water required? If so at what rate and pressure? Can plant water be used? Is nutrient tank being provided? Plan and section views of unit don't show a nutrient tank; however, electrical drawings seem to indicate the nutrient pump is included. Please confirm scope of supply. Nutrient Tank is not required and is not provided.

In supplement #5, questions from JCC sent on July 13, 2010 – item number 2 referencing that the thermal fluid piping under the dryer will be shipped loose and is to be field erected. Can you confirm that this should be done by Therma-Flite personnel or the Contractor? The loose-ship piping shall be field erected by the Contractor.

Page 41 of 635, spare parts – are all listed being provided? Please verify which spare parts are being provided by Therma-Flite. Also pages 428-635 lists recommended spare parts for the thermal fluid heater, which spare parts are being provided by Therma-Flite? Page 41 is recommended spare parts in reference to duration. Therma-Flite will provide price and delivery of spare parts based upon what BGMU wants to keep as a stock item. Therma-Flite will be providing the required Thermal Fluid during startup and any required consumables related to the startup. None of the other components will be provided unless determined defective during startup in which they will be converted to a warranty item in which we will revert to our standard warranty. Spare bearings, rotary joints, motors drives etc. are at the determination of the buyer. These are considered long-lead items and will not be available on a fast turn-around. The buyer will have to determine an acceptable down-time if any of these components fail.

Page 572 of 635, there is a reference to conveyors ("No conveyor will start…"). What conveyors? Is this a reference to a Holo-Scru rotor or cooling screw, or what? Terminology – We are referring to the Dryer and Cooling Conveyor.

Page 573 of 635, item 6 reference cooling conveyors (plural), please confirm there is only one cooling screw and this is a typo. Also item 8 references the dehydration conveyor, is this referencing the holo-screw rotors? Same item, it references water spray is open, is this referring to the saturation cycle? Reading thru these items it sounds like at startup you purge with nitrogen and then go thru a saturation cycle, is this correct? Page 575, item 13 and 14 reference that at shutdown a saturation cycle occurs, please confirm. Please confirm what occurs at both startup and shutdown with quantities of nitrogen, water, etc. specified. We are providing a single Cooling Conveyor. The Dehydration Conveyor is referring to the Holo-Scru Dryer. We will clarify the startup/shutdown sequence in a supplementary submittal and final operating manual.

Supplement #2 referencing the instrumentation index (Page 584 of 635 in submittal) – Please confirm BSDF1-5412-1, the nitrogen rotometer, is provided by Therma-Flite for the nitrogen purge for the dryer. Also please confirm that a rotometer is provided by Fulton in nitrogen kit for thermal fluid heater expansion tank, but is not listed in the instrumentation list. The nitrogen rotometer for the dryer is provided by TFL. The Fulton expansion tank does not require a rotometer.

Page 596 of 635, lists the cooling screw as 3 HP; however page 582 of 635 lists 2 HP. Please confirm correct horsepower for cooling screw. The correct HP for the Cooling Screw is 3 HP.

Kristi Schnell, P.E.
Associate

GRESHAM, SMITH AND PARTNERS
Architecture, Engineering, Interiors, Planning

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immediately notify me by phone or by return E-mail and permanently delete the original and any copy of any E-mail and any printout thereof. Mail delivered by Gresham, Smith and Partners mail system.

Schnell, Kristi

From: Robert Nickerson [RNickerson@therma-flite.com]
Sent: Tuesday, August 24, 2010 7:41 PM
To: Schnell, Kristi
Cc: Mike McCawley; Burgett, Michael; Hargett, Kim; Richards, Kenneth; Mosley, Dale
Subject: RE: TFL5412_Fulton Thermal Fluid Heater

Kristi,

We agree with your assessment. Therma-Flite will redesign the Thermal Fluid Piping "cage piping" at the dryer to match the 135.75" elevation of the Fulton System and re-submit a General Arrangement to reflect this change.

Robert D. Nickerson
Therma-Flite, Inc.
P: 707-747-5949
F: 707-747-5951
rnickerson@therma-flite.com

Statement of Confidentiality

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From: Schnell, Kristi [mailto:kristi_schnell@gspnet.com]
Sent: Tuesday, August 24, 2010 4:05 PM
To: Robert Nickerson
Cc: Mike McCawley; Burgett, Michael; Hargett, Kim; Richards, Kenneth; Mosley, Dale
Subject: RE: TFL5412_Fulton Thermal Fluid Heater

Robert,

Thanks for the response, we attempted to call you this afternoon to discuss but we were told that you were in a meeting. We have reviewed the thermal fluid piping and have a few comments.

From the beginning, we were told that the expansion/de-aerator tank needed to be the highest point in the system. And the thermal fluid piping centerline elevation in the thermal fluid "cage" at the inlet to the dryer was set by Therma-Flite. GS&P matched this centerline elevation (465.25) for the thermal fluid piping running between the dryer and thermal fluid system and then adjusted the expansion/de-aerator tank to make it the highest point in the thermal fluid system.

Is there a reason the supply and return piping were set at elevation 465.25 and were not matched with the height of the expansion /de-aerator tank on the Fulton drawings? Is there a way to lower the "cage" piping connections in lieu of lowering the piping at the expansion tank? We can adjust to a lower elevation but that will still require us to revise drawings issued for construction.

We understand that Fulton has confirmed that with the nitrogen purge system in place the de-aerator tank does not have to be the highest point in the system; however there would be additions to the contract in order to accommodate this change. There would need to be an air release valve in the high point of the piping system. In our opinion, it does not seem like a good idea to have an air release on thermal fluid piping that will be 575 degrees F. We believe the best design would be that Therma-Flite/Fulton either raise the expansion tank/de-aerator tank to accommodate the centerline elevation of 465.25; or Therma-Flite lower the centerline elevation for the inlet connection in the "cage" to 459.98 (135.75" off FF). If the piping is lowered we will adjust our contract drawings to show the changes.

Please give me a call when you get a second to discuss this.
Thanks

Kristi Schnell, P.E.

GRESHAM, SMITH AND PARTNERS
[P] 615.770.8529

From: Robert Nickerson [mailto:RNickerson@therma-flite.com]
Sent: Wednesday, August 18, 2010 6:06 PM
To: Schnell, Kristi
Cc: Mike McCawley; Burgett, Michael; Hargett, Kim; Richards, Kenneth; Mosley, Dale
Subject: RE: TFL5412_Fulton Thermal Fluid Heater

Kristi,

I apologize – Fulton has informed us that in order to raise the Expansion Tank to the 16.3 ft, they would need to make the skid structure and support structure significantly larger foot print at a sizable cost increase. They recommend holding the elevation at the original 135.75" and the supply and return piping run at the higher elevation to and from the dryer and drop down at the boiler room. The expansion tank does not need to be the highest point in the system when operating with a Nitrogen Purge.

> "Fulton have confirmed that the elevation change is not required for this installation due to the Nitrogen Pressure blanket on the Expansion tank. The Nitrogen Blanket needs to be a high enough pressure to overcome the weight of the fluid above it. Roughly 1 psi for every 2.5 feet above the low liquid level switch. In this case we will need an additional high point vent in the lines running back to the dryer to allow air to escape during the initial fill. The supply and return pipes would run back at the 16+ ft elevation then drop to the 135.75" elevation in the boiler room or at any point convenient."

Let me know if this solution will work for you.

Robert D. Nickerson
Therma-Flite, Inc.
P: 707-747-5949
F: 707-747-5951
rnickerson@therma-flite.com

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From: Schnell, Kristi [mailto:kristi_schnell@gspnet.com]
Sent: Wednesday, August 18, 2010 3:02 PM
To: Robert Nickerson
Cc: Mike McCawley; Burgett, Michael; Hargett, Kim; Richards, Kenneth; Mosley, Dale
Subject: RE: TFL5412_Fulton Thermal Fluid Heater

On the thermal fluid heater, I don't recall getting a response on if the way we have it shown on our drawings will work or not. I had previously attached our drawings for your reference in discussing with Fulton. We need that confirmation prior to making a decision.

On the odor control, we are still reviewing this piece of equipment. We will try to let you know soon if it is acceptable.

Kristi Schnell

From: Robert Nickerson [mailto:RNickerson@therma-flite.com]
Sent: Wednesday, August 18, 2010 4:43 PM
To: Schnell, Kristi
Cc: Mike McCawley
Subject: TFL5412_Fulton Thermal Fluid Heater

Kristi,

Please confirm that we will be using the Fulton Heater System at its original elevation and not changing the expansion tank return line to 464.97ft elevation. We need to provide Fulton with a final approval very soon to stay on schedule.

Also, please confirm that the BioRem Odor Control Equipment is acceptable – I also need to give them the final approval very soon.

Best regards,

Robert D. Nickerson
Therma-Flite, Inc.
P: 707-747-5949
F: 707-747-5951
rnickerson@therma-flite.com

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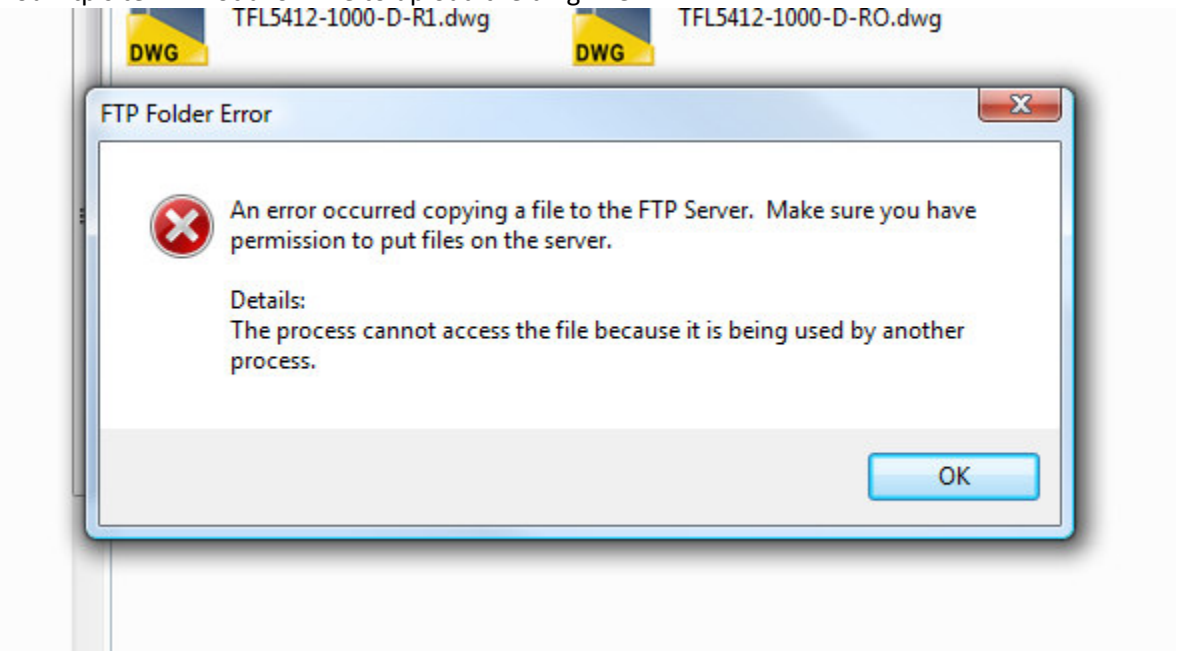
Schnell, Kristi

From: Robert Nickerson [RNickerson@therma-flite.com]
Sent: Friday, August 27, 2010 10:30 AM
To: Schnell, Kristi
Cc: Mike McCawley
Subject: TFL5412_Document Submittal 8-26-10
Attachments: TFL5412-11_Document Transmittal_8-26-10.pdf; TFL5412-00000-D-R3 SHEET 1.pdf; TFL5412-00000-D-R3 SHEET 2.pdf

Kristi,

We have changed the flange elevations on the Thermal Fluid Piping to accommodate the lower piping run from the dryer to the boiler room. Please review and approve or comment this change.

Your ftp site will not allow me to upload the dwg. file.



Robert D. Nickerson
Therma-Flite, Inc.
P: 707-747-5949
F: 707-747-5951
rnickerson@therma-flite.com

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Therma-Flite
The Screw Heat Exchanger Company

P.O. Box 847
849 Jackson St.
Benicia, CA 94510
P (707) 747-5949
F (707) 747-5951
www.therma-flite.com

DOCUMENT TRANSMITTAL

Number: TFL5412-11

Date: August 26, 2010

Company: Bowling Green / BGMU

Attention: **Kristi Schnell, P.E.**

Project: TFL5412 IC10,000 "Bio-Scru"

Description	File Name	Sheet	Date	Rev.	Issued For
Revised System General Arrangement Modified Piping Elevation	TFL5412-00000-D-R3	1 & 2	8-26-10	3	FA

Legend:

FA **For Approval**
FI **For Information**
FC **Certified for Construction**
AB **As Built**

Submitted By: *Robert D. Nickerson*

Robert D. Nickerson
Therma-Flite, Inc.

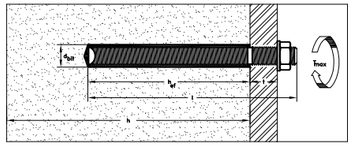
HY 150 MAX Installation Specification Table for HAS Rods

Details	Rod Size		3/4 (19.1)	1-1/4 (31.8)
d_{bit} bit diameter			13/16	1-3/8
$h_{ef} = h_{min}$ standard embedment			6-3/4 (172)	11-1/4 (286)
t_{inst} max. tightening torque	All HIT-Threaded Rods	$h_{ef} \geq h_{min}$	150 (203)	400 (540)
		$h_{ef} < h_{min}$	105 (142)	288 (375)
h minimum base material thickness		$h_{ef} = h_{min}$	8-3/4 (222)	14-1/4 (362)
		$h_{ef} > h_{min}$	1.0 h_{ef} 2 (51)	1.0 h_{ef} 3 (76)

Final Cure Time Table (Approximate)

Approx. Curing Time	Base Material Temperature
20 Minutes	104°F/40°C
25 Minutes	86°F/30°C
30 Minutes	68°F/20°C
1 Hour	50°F/10°C
2 Hours	32°F/0°C
4 Hours	23°F/-5°C
12 Hours	14°F/-10°C

HILTI HIT HY-150 MAX Injection Adhesive Anchor

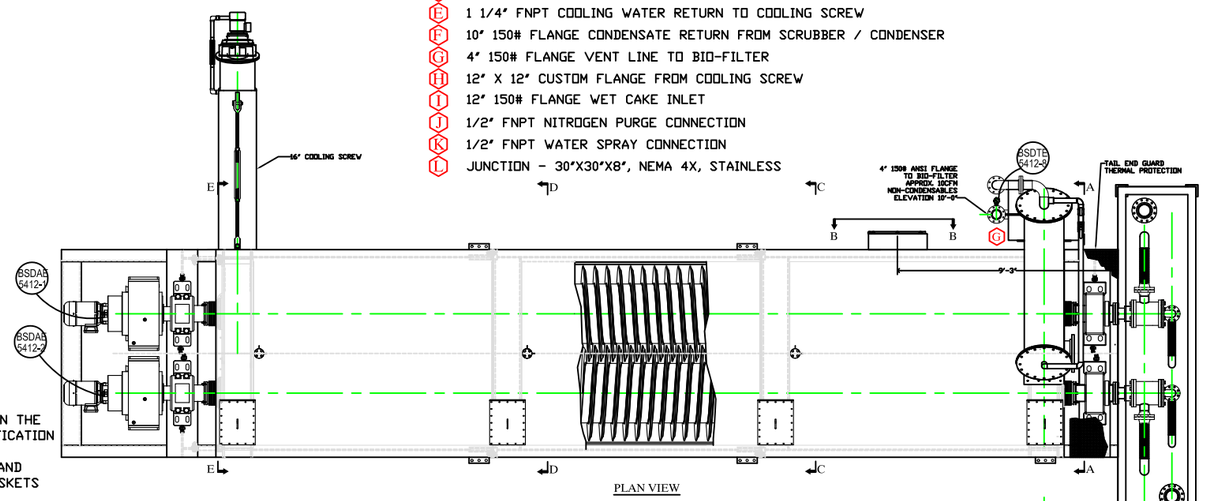


UTILITY AND AUXILIARY CONNECTIONS POINTS:

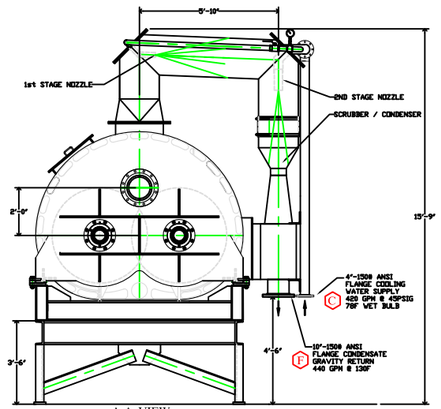
- (A) 6" 300# FLANGE THERMAL FLUID SUPPLY
- (B) 6" 300# FLANGE THERMAL FLUID RETURN
- (C) 4" 150# FLANGE COOLING WATER SUPPLY TO SCRUBBER / CONDENSER
- (D) 1 1/4" FNPT COOLING WATER SUPPLY TO COOLING SCREW
- (E) 1 1/4" FNPT COOLING WATER RETURN TO COOLING SCREW
- (F) 10" 150# FLANGE CONDENSATE RETURN FROM SCRUBBER / CONDENSER
- (G) 4" 150# FLANGE VENT LINE TO BIO-FILTER
- (H) 12" X 12" CUSTOM FLANGE FROM COOLING SCREW
- (I) 12" 150# FLANGE WET CAKE INLET
- (J) 1/2" FNPT NITROGEN PURGE CONNECTION
- (K) 1/2" FNPT WATER SPRAY CONNECTION
- (L) JUNCTION - 30"X30"X8", NEMA 4X, STAINLESS

INSTALLATION NOTES:

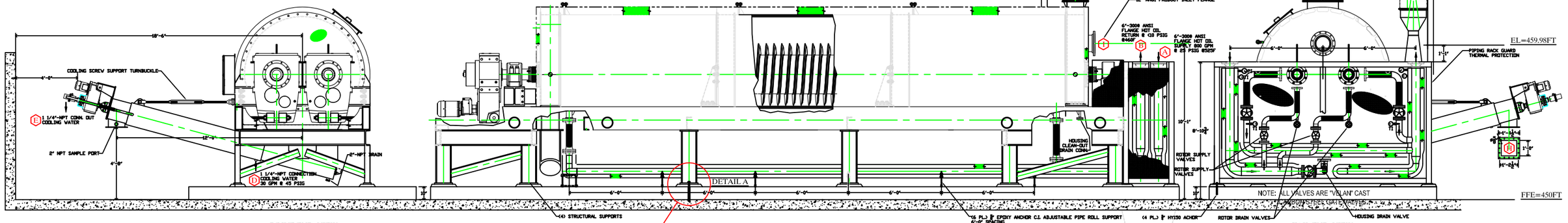
1. THE IC10000 SYSTEM SHALL BE SHIPPED IN SEPARATE COMPONENTS:
   - DEHYDRATION CHAMBER
   - COOLING SCREW
   - STRUCTURAL SUPPORTS
   - SCRUBBER / CONDENSER
   - PIPING RACK / LOOSE SHIP PIPING COMPONENTS
   - ALL REQUIRED GASKETS AND HARDWARE FOR FIELD ASSEMBLY
2. THE DEHYDRATION CHAMBER AND SUPPORT STRUCTURES SHALL BE ERECTED FIRST ON THE 10" CONCRETE PAD PER BGMU DWG# XXX AND ANCHORED PER TFL5412 GUIDE SPECIFICATION THE MACHINE SHALL BE LEVELED (2 PLANE) 1/16" IN 20'-0" BEFORE GROUTING.
3. THE REMAINNG COMPONENTS SHALL BE ERECTED FOLLOWING THE FINAL PLACEMENT AND ANCHORING OF THE DEHYDRATION CHAMBER. EACH COMPONENT IS PROVIDED WITH GASKETS AND HARDWARE REQUIRED FOR PLACEMENT AND BOLTING.
4. GASKETS: ALL GASKET SHALL BE INSTALLED WITH >500F SILICON GASKET FORMING COMPOUND TO BOTH SIDES OF THE GASKET TO ENSURE PROPER SEALING BETWEEN EACH COMPONENT.
5. TORQUE: ALL HARDWARE SHALL BE TORQUED BASED UPON INDUSTRY STANDARD FOR BOLT DIA.



PLAN VIEW



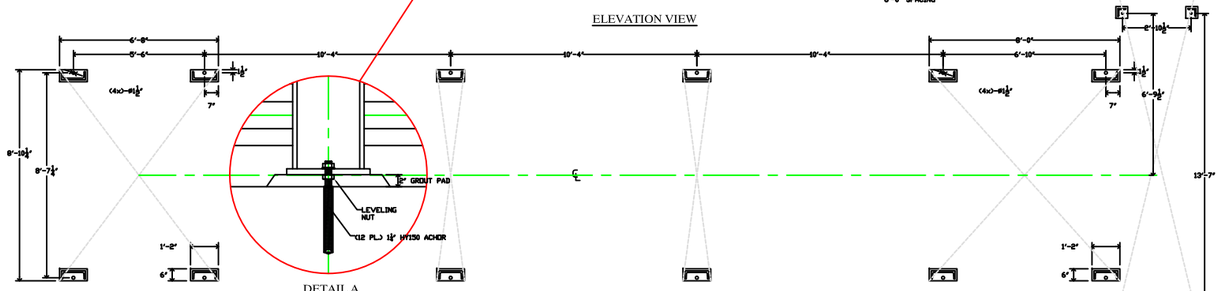
A-A VIEW



DRIVE END VIEW

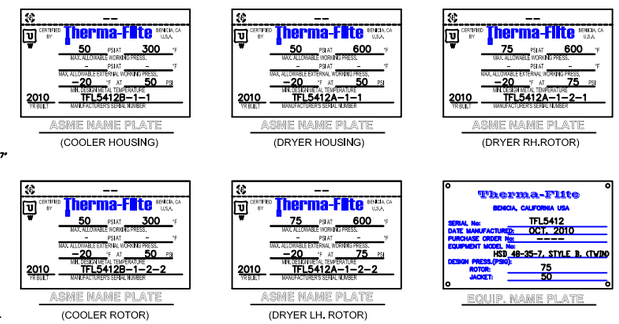
ELEVATION VIEW

TAIL END VIEW



DETAIL A

MOUNTING VIEW



(COOLER HOUSING) (DRYER HOUSING) (DRYER RH.ROTOR)

(COOLER ROTOR) (DRYER LH. ROTOR) EQUIP. NAME PLATE

DESIGN AND CONSTRUCTION NOTES:

1. DESIGN AND CONSTRUCTION PER ASME CODE, SECTION VIII, DIVISION I, 2007, JULY 09 ADDENDA. 'NB' & 'U' STAMP REQUIRED.
2. WELDING PROCEDURE PER ASME CODE SECTION IX, 2007, JULY 09 ADDENDA.
3. MILL CERTIFICATES REQUIRED FOR ALL MATERIALS.
4. NDE PER TFL QUALITY CONTROL MANUAL.
5. IMPACT TEST EXEMPT PER UG-20.
6. DESIGN PRESSURE:
   - SCREW ROTOR: 75 PSI.
   - JACKETED HOUSING: 50 PSI.
7. HYDRO-TEST PRESSURE:
   - SCREW ROTOR: 114 PSI
   - JACKETED HOUSING: 76 PSI

IC10,000 DESIGN DATA:

PROCESSING RATE:	24 DRY TON/DAY (24HOUR OPERATION)
BULK DENSITY:	115 LB/CU.FT (WET)
SOLIDS INLET CONTENT:	18%
H20 INLET CONTENT:	82%
H20 OUTLET CONTENT:	10%
PRODUCT HEATED TEMP:	212 F
THERMAL FLUID TEMP:	525 F
THERMAL FLUID VOLUME:	SCREW---185 GAL./EACH HOUSING---300 GAL.

IC10,000 PERFORMANCE DATA:

WATER REMOVAL CAPACITY: 10000 LB/HR

HOURLY FEED RATE DRYING TO 90%	11,538 LB/HR	12,000 LB/HR	12,500 LB/HR	13,043 LB/HR	13,846 LB/HR
HOURLY FEED RATE DRYING TO 75%	13,968 LB/HR	14,167 LB/HR	14,386 LB/HR	14,630 LB/HR	15,00 LB/HR
% SOLIDS INFEED (MINIMUM 14%)	12%	15%	18%	21%	25%

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REVISIONS No.	MADE BY	CHECKED BY	DATE	DESCRIPTION
1	RDN		2/1/10	RELEASED FOR INFORMATION ONLY
2	RDN		2/8/10	COOLING SCREW MODIFICATION
3	RDN		3/8/10	RELEASED FOR APPROVAL
4	RDN		3/8/10	THERMAL FLUID PIPING MODIFICATION

JOB No:	TFL5412
DRAWN BY:	CJ 12/03/09
CHECKED BY:	RDN 12/03/09
APPROVED BY:	BRB 12/03/09

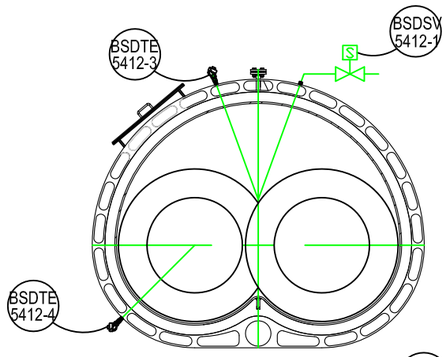
GENERAL ARRANGEMENT DRAWING OF "IC10,000" DRYER MODULE FOR BOWLING GREEN MUNICIPAL UTILITIES

CUSTOMER: BGMU

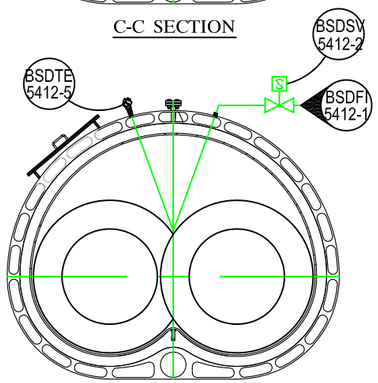
PROJECT No: S07-653

Therma-Flite
The Screw Heat Exchange Company
P.O.Box 847
849 Jackson Street,
Benicia, CA 94510
Telephone: (707) 747-5949
Fax: (707) 747-5951

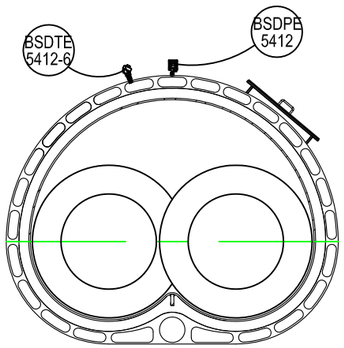
SHEET: 1 OF 2 DWG No: TFL5412-00000 R3



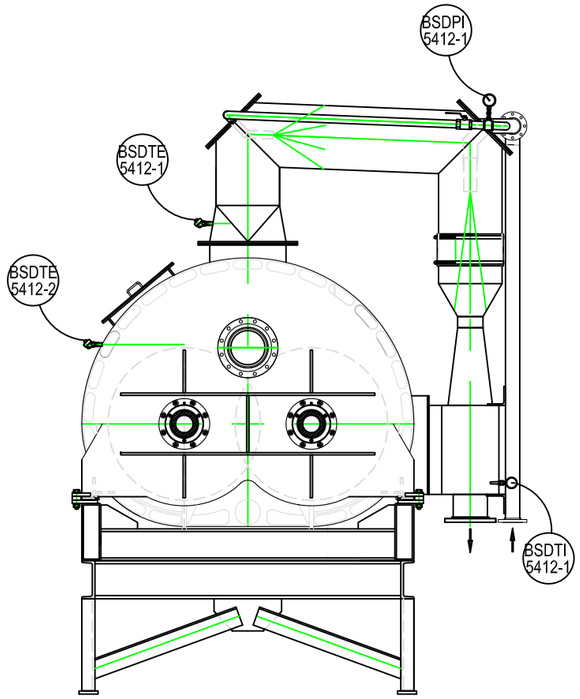
C-C SECTION

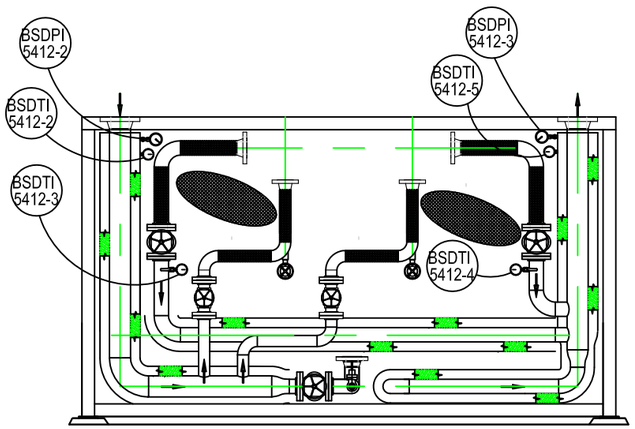


D-D SECTION

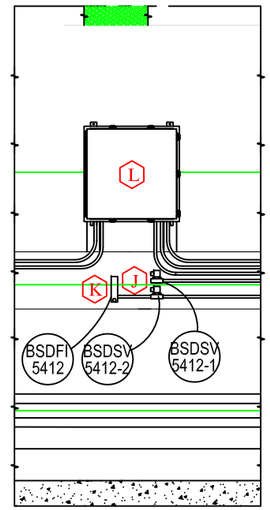


E-E SECTION
COOLING SCRU NOT SHOWN



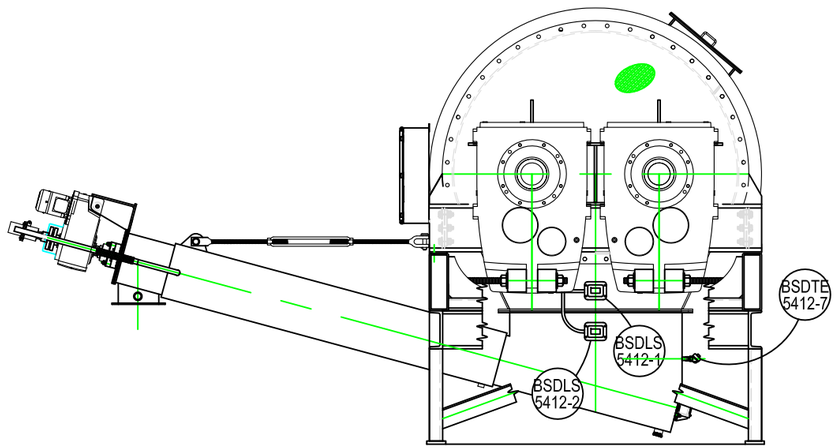


NOTE: ALL VALVES ARE "VELAN" CAST
CARBON STEEL GATE VALVES.



B-B VIEW

NOTE: ALL INSTRUMENTATION SHALL BE FACTORY PREWIRED TO THE JUNCTION ENCLOSURE L. REFERENCE JUNCTION ENCLOSURE DRAWING #XXX.



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REVISIONS	No.	MADE BY	CHECKED BY	DATE	DESCRIPTION
	1	RDN		2/1/10	RELEASED FOR INFORMATION ONLY
	2	RDN		2/18/10	COOLING SCREW MODIFICATION
	3	RDN		3/8/10	RELEASED FOR APPROVAL
	4	RDN		8/26/10	THERMAL FLUID PIPING MODIFICATION

		DATE
JOB No:	TFL5412	
DRAWN BY:	CJ	12/03/09
CHECKED BY:	RDN	12/03/09
APPROVED BY:	BRB	12/03/09

GENERAL ARRANGEMENT DRAWING
OF
"IC10,000" DRYER MODULE
FOR
BOWLING GREEN MUNICIPAL UTILITIES

CUSTOMER: BGMU

PROJECT No: S07-653

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The Screw Heat Exchange Company
P.O.Box 847
849 Jackson Street,
Benicia, CA 94510
Telephone: (707) 747-5949
Fax: (707) 747-5951

SHEET: 2 OF 2 | DWG. No: TFL5412-00000 | R3

Supplement #10

Therma-Flite
The Screw Heat Exchanger Company

P.O. Box 847
849 Jackson St.
Benicia, CA 94510
P (707) 747-5949
F (707) 747-5951
www.therma-flite.com

DOCUMENT TRANSMITTAL

Number: TFL5412-13

Date: September 8, 2010

Company: Bowling Green / BGMU

Attention: **Kristi Schnell, P.E.**

Project: TFL5412 IC10,000 “Bio-Scru”

Description	File Name	Sheet	Date	Rev.	Issued For
Revised System General Arrangement Modified Piping Elevation, **AutoCAD File** Uploaded to GS&P FTP site	TFL5412-00000-D-R3.dwg	1 & 2	9-8-10	3	FA

Legend:

FA **For Approval**
FI **For Information**
FC **Certified for Construction**
AB **As Built**

Submitted By: *Robert D. Nickerson*

Robert D. Nickerson
Therma-Flite, Inc.

Schnell, Kristi

From: Mike McCawley [MMcCawley@therma-flite.com]
Sent: Wednesday, September 08, 2010 11:07 AM
To: Schnell, Kristi
Cc: Robert Nickerson
Subject: RE: FTP site

Kristi,

Sorry about that.

The AutoCAD file: TFL5412-00000-D-R3 has been uploaded to:
/To_GSP/ThermaFlite/TFL Submittal 9-8-10/

Please let me know if there is anything else I can do to help,

Thanks,

Mike McCawley
Sales Engineer
Therma-Flite, Inc.
P: 707-747-5949
F: 707-747-5951

From: Schnell, Kristi [mailto:kristi_schnell@gspnet.com]
Sent: Wednesday, September 08, 2010 7:04 AM
To: Mike McCawley
Cc: Robert Nickerson
Subject: RE: FTP site

Got the files. They're the same pdfs Robert sent on August 27th. I thought he was trying to upload the CAD file? That's what the error message he sent said.

Kristi Schnell, P.E.

GRESHAM, SMITH AND PARTNERS
[P] 615.770.8529

> **From:** Mike McCawley [mailto:MMcCawley@therma-flite.com]
> **Sent:** Tuesday, September 07, 2010 5:16 PM
> **To:** Schnell, Kristi
> **Cc:** Robert Nickerson
> **Subject:** RE: FTP site
>
> Kristi,
>
> Thanks for setting me up with the GS&P FTP site.
>
> The files have been uploaded to the directory:
>
> /To_GSP/ThermaFlite/TFL Submittal 8-26-10/
>
> Please let me know if there is anything else I can do to help.

Mike McCawley
Sales Engineer
Therma-Flite, Inc.
P: 707-747-5949
F: 707-747-5951

From: Schnell, Kristi [mailto:kristi_schnell@gspnet.com]
Sent: Tuesday, September 07, 2010 2:51 PM
To: Mike McCawley
Subject: RE: FTP site

You should have received a message like this:

To: MMcCawley@therma-flite.com <MMcCawley@therma-flite.com>

Subject: Invitation from Kristi Schnell

Kristi Schnell from Gresham Smith & Partners would like to invite you to join the BGMU WWTP Expansion And Renovation Project Web Site.

To enroll with projects.gspnet.com just cut and paste the entire URL below into your web browser:

---Start URL---
https://projects.gspnet.com/index.php?request=account&pcode=1925914&referby=3414
---Finish URL---

Try going to the URL listed above and see if it will let you register.

Kristi Schnell, P.E.

GRESHAM, SMITH AND PARTNERS
[P] 615.770.8529

From: Mike McCawley [mailto:MMcCawley@therma-flite.com]
Sent: Tuesday, September 07, 2010 4:47 PM
To: Schnell, Kristi
Subject: RE: FTP site

Kristi,

I did not receive an invite.

Mike McCawley
Sales Engineer
Therma-Flite, Inc.
P: 707-747-5949
F: 707-747-5951

From: Schnell, Kristi [mailto:kristi_schnell@gspnet.com]
Sent: Tuesday, September 07, 2010 2:21 PM
To: Mike McCawley
Subject: FTP site

Did you get the invite? I never got an email that said you've set up your profile. Please let me know. Thanks.

Kristi Schnell, P.E.
Associate

GRESHAM, SMITH AND PARTNERS
Architecture, Engineering, Interiors, Planning

1400 Nashville City Center, 511 Union Street
Nashville, TN 37219-1733
[P] 615.770.8529

www.gspnet.com

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Schnell, Kristi

From: Robert Nickerson [RNickerson@therma-flite.com]
Sent: Wednesday, September 08, 2010 4:19 PM
To: Schnell, Kristi; Mike McCawley
Cc: Hargett, Kim; Burgett, Michael
Subject: Re: Therma-Flite Submittal - Part 1, Supplement #4

Kristi,

FRP will be fine.

Robert

Sent from my HTC on the Now Network from Sprint!

----- Reply message -----
From: "Schnell, Kristi" <kristi_schnell@gspnet.com>
Date: Wed, Sep 8, 2010 3:55 pm
Subject: Therma-Flite Submittal - Part 1, Supplement #4
To: "Robert Nickerson" <RNickerson@therma-flite.com>, "Mike McCawley" <MMcCawley@therma-flite.com>
Cc: "Hargett, Kim" <kim_hargett@gspnet.com>, "Burgett, Michael" <michael_burgett@gspnet.com>

Robert and/or Mike,

What material are the platforms next to the dryer? Will FRP be ok with the heat? Please let us know, thanks.

Kristi Schnell, P.E.

GRESHAM, SMITH AND PARTNERS
[P] 615.770.8529

> **From:** Dale Wilson [mailto:dwilson@judyconstructionco.com]
> **Sent:** Wednesday, September 08, 2010 8:57 AM
> **To:** Schnell, Kristi
> **Cc:** 'John L. Walker'; 'Paul Lawrence'; Hargett, Kim; Burgett, Michael
> **Subject:** RE: Therma-Flite Submittal - Part 1, Supplement #4
>
> Thanks Kristi,
> We'll look over.
>
> On a side note, it came to me that after talking to Robert some weeks ago, the Dryer Modules will experience some major heat, such that the mounting of the dry units to the structural steel support frames are pretty special….
> With this in mind, we got to thinking about the FRP grating on the adjacent walk way….will it be subject to warping or "melting"? Just wondering.
> Dale

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Therma-Flite
The Screw Heat Exchanger Company
P.O. Box 847
849 Jackson St.
Benicia, CA 94510
P (707) 747-5949
F (707) 747-5951
www.therma-flite.com

Therma-Flite IC-10,000 Biosolids Drying System

Submittal Package
Part 2 of 2
Control Panel Components

For

Bowling Green Municipal Utilities
Wastewater Treatment Plant Expansion and Renovation

BGMU Project No.: S07-653
GS&P Project No.: 26064.00
TFL Project No.: 5412

TFL 5412
Control Panel Components
Submittal Contents

(PDF: To go directly to a Section or Component from this table of contents, click on it.)

Hoffman Enclosure, 72" x 34 ¼" x 18", Flange Disconnect, NEMA Type 4X ..... A
Hoffman Inner Panel, 60" x 27 ¾" ..... B
Main Circuit Breaker, Allen Bradley 140U-J2D3-D12 C

Variable Frequency Drive 480VAC 3-Phase, 7.5HP 12A, 5.5kW, Allen-Bradley, 22B-D012N104 ..... E
Variable Frequency Drive 480VAC 3-Phase, 3HP 6A, 2.2kW, Allen-Bradley, 22B-D6P0N104 ..... F
HMI, Allen Bradley Panelview 12" 2711P-T12C4A2 ..... G
PLC, Allen Bradley ..... H
- I/O Chassis, 7 Slot, 1756-A7 I
- Power Supply, 1756-PA72 ..... J
- Control Logic Processor, 1756-L61 ..... K
- Ethernet Module, 1756-ENBT L
- Analog Input Module, 1756-IF8 ..... M
- Analog Output Module, 1756-OFC6I ..... N
- AC Input Module, 1756-IA16 ..... O
- Relay Output Module, 16-PT, 1756-OW161 ..... P

Motor Circuit Protector, 140M-D8E-C20 ..... Q
Motor Circuit Protector, 140M-C2E-C10 ..... R
Circuit Breaker, 1-Pole, 10A, 1489-A1C100 ..... S
Fused Terminal w/ Neon Indicator (120VAC), 1492-H4 ..... T
Fused Terminal w/ Neon Indicator (120VAC), 1492-H5 ..... U
RFI Filter, Corcom, 20V56 V
Ethernet Switch, BB Electronics, EIR308 ..... W
Power Supply, PULS, CS5-241 X
Power Distribution Block Safety Cover, Ferraz Shawmut, 08570 ..... Y
Control Transformer, Hammond PH1500MQMJ ..... Z
Fluorescent Light, Hoffman ALF16D24R ..... AA
Fuse Holder, Ferraz Shawmut, USCC21 ..... BB
Fuse, Ferraz Shawmut, ATDR2 CC

Hoffman Enclosure, 72” x 34 ¼” x 18”, Flange Disconnect, NEMA Type 4X

Stainless Steel Heavy Duty Disconnect Enclosures

Stainless Steel Heavy-Duty Free-Stand Enclosures for Flange-Mount Disconnects, Type 4X

Specifications

- Manufactured from 12 gauge Type 304 stainless steel
- Seams continuously welded and ground smooth
- Body stiffeners in larger enclosures for extra rigidity
- Body flange trough collar excludes liquids and contaminants
- Heavy-duty lifting eyes anchor into reinforced top
- Removable centerposts permit easy panel installation
- Heavy-gauge continuous hinges
- Heavy-duty 3-point latching mechanism operated by Type 316L stainless steel POWERGLIDE® padlocking handle on all doors
- Ends of latch rods have rollers for easier door closing
- Panel supports
- Data pocket is high-impact thermoplastic
- Seamless foam-in-place gasket provides oil-tight and dust-tight seal against contaminants
- Removable 10 gauge steel panels mount on collar studs
- Master door is far right-hand door on all enclosures
- Type 316 stainless steel handle with defeater on master door
- Type 316 stainless steel handle (non-defeater) on slave door
- Mechanical interlock activated by master door prevents slave doors from being opened first. Doors can be closed in any order.
- Preferred cutout on right flange provides mounting for most disconnect operators
- Bonding provision on doors; grounding studs on body
- Accessory mounting channel provided in enclosure top

Finish

Stainless steel enclosures are unpainted. Sides and body have smooth #4 brushed finish. White mild steel panels are furnished with enclosure. Optional conductive panels are available.

Accessories

See also Accessories.
Electric Heater
Compact Cooling Fans
Floor Stand Kit
Fluorescent Light Package
Operator Adapters for Preferred Cutouts
An operator adapter for a preferred cutout must be ordered separately.

Modification and Customization

Hoffman excels at modifying and customizing products to your specifications. Contact your local Hoffman sales office or distributor for complete information.

Bulletin: A28S4

Industry Standards

UL 508A Listed 508; Type 3R, 4, 4X, 12; File No. E61997
cUL Listed per CSA C22.2 No. 94; Type 3R, 4, 4X, 12; File No. E61997

NEMA/EEMAC Type 3R, Type 4, 4X, 12
CSA File No. 42186: Type 4, 4X, 12
IEC 60529, IP66
Meets NEMA Type 3RX requirements

Subject to change without notice
PH (763) 422-2211 • FX (763) 422-2600 • hoffmanonline.com
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Stainless Steel Heavy Duty Disconnect Enclosures

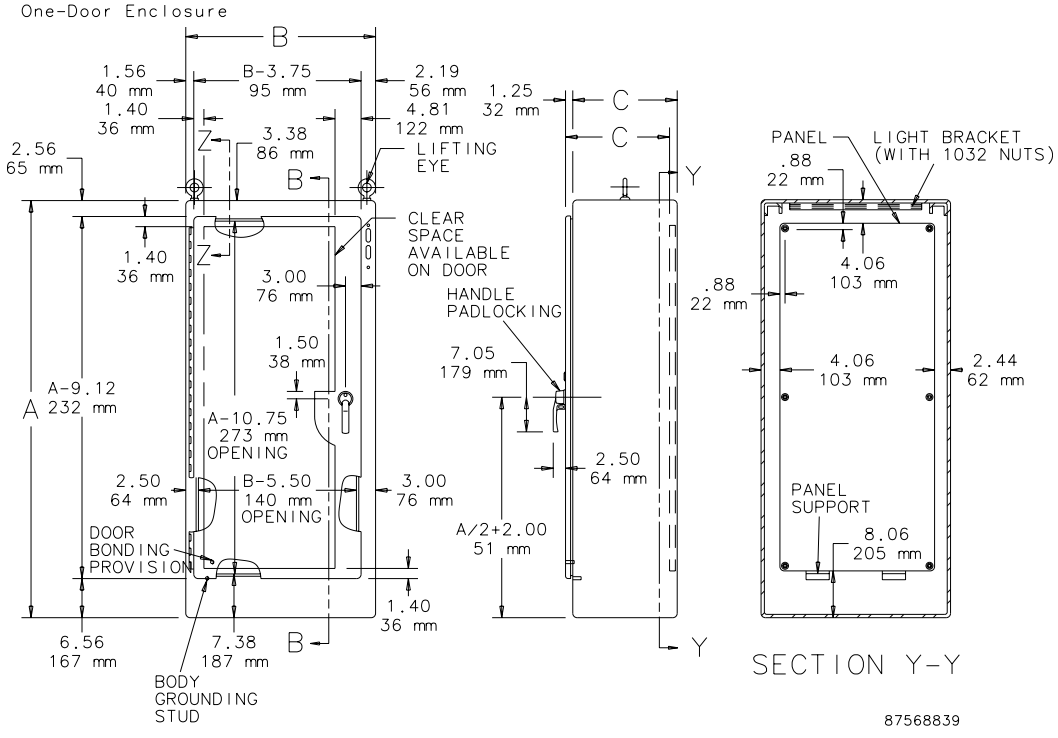
Standard Product **One-Door Enclosures**

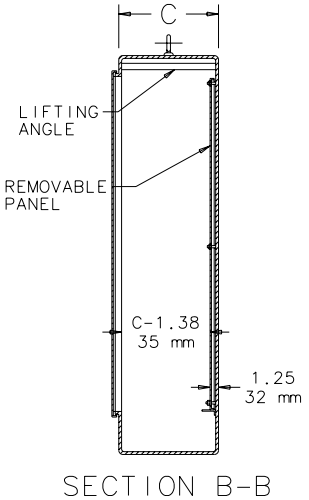
Catalog Number	AxBxC in.	AxBxC mm	Panel	Conductive Panel	Panel Size (in.)	Panel Size (mm)
A72XM2818SSN4	72.12 x 28.25 x 18.12	1832 x 718 x 460	A72PM28	A72PM28G	60.00 x 21.75	1524 x 552
A72XM3418SSN4	72.12 x 34.25 x 18.12	1832 x 870 x 460	A72PM34	A72PM34G	60.00 x 27.75	1524 x 705
A72XM4018SSN4	72.12 x 40.25 x 18.12	1832 x 1022 x 460	A72PM40	A72PM40G	60.00 x 33.75	1524 x 857
A84XM4018SSN4	84.12 x 40.25 x 18.12	2137 x 1022 x 460	A84PM40	A84PM40G	72.00 x 33.75	1829 x 857
A90XM4018SSN4	90.12 x 40.25 x 18.12	2289 x 1022 x 460	A90PM40	A90PM40G	78.00 x 33.75	1981 x 857
A90XM4020SSN4	90.12 x 40.25 x 20.12	2289 x 1022 x 511	A90PM40	A90PM40G	78.00 x 33.75	1981 x 857
A84XM4024SSN4	84.12 x 40.25 x 24.12	2137 x 1022 x 613	A84PM40	A84PM40G	72.00 x 33.75	1829 x 857
A90XM4024SSN4	90.12 x 40.25 x 24.12	2289 x 1022 x 613	A90PM40	A90PM40G	78.00 x 33.75	1981 x 857

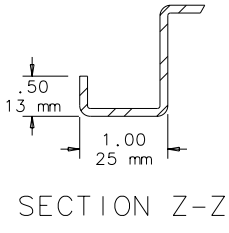
White mild steel panels are furnished with enclosure. Purchase conductive panels separately.

All 24.12-in. (613-mm) and deeper enclosures using short connecting rods in the following models require a Hoffman platform assembly, catalog number ADSCPA, purchased separately. • ABB Controls flange-operated devices • Cutler-Hammer C361 devices • Cutler-Hammer C371 mechanisms which use C371E, F, G, K operating mechanism • General Electric Type TDA devices (see next paragraph for option) • Square D Class 9422 devices (see next paragraph for option)

The platform assembly can be omitted if long connecting rods are ordered in place of short connecting rods. • For Cutler-Hammer operating mechanisms C371E and C371F order catalog number C371CS1 connecting rod. For C371G and C371K order catalog number C371CS2 connecting rod. • For General Electric devices, order catalog number TDSR extended length drive rod • For Square D devices, order catalog number 9422-R2 extra long operating rod(s). Some devices require two rods. Consult factory for space occupied on panel when platform is used.







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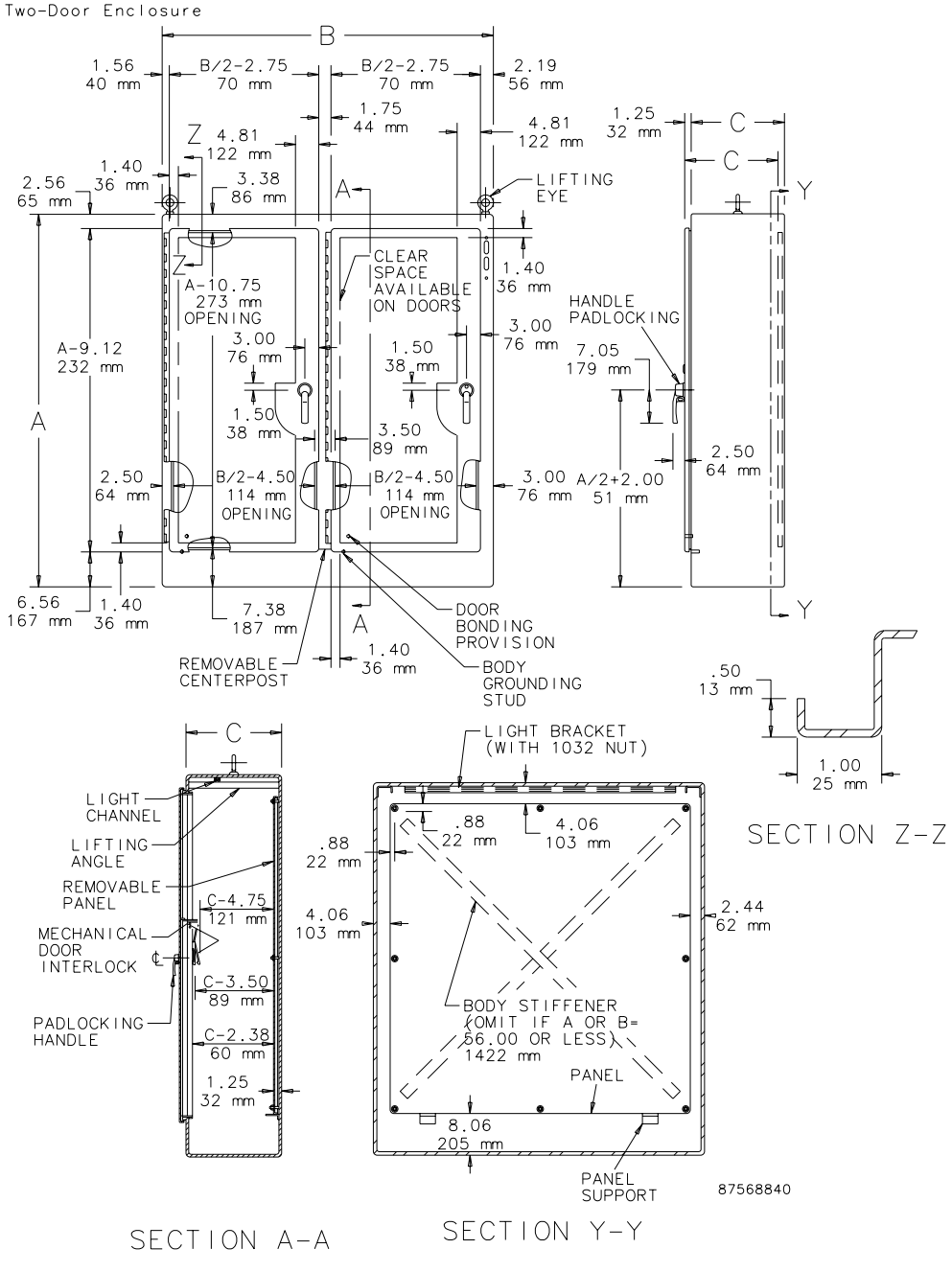
Stainless Steel Heavy Duty Disconnect Enclosures

Standard Product **Two-Door Enclosures**

Catalog Number	AxBxC in.	AxBxC mm	Panel	Conductive Panel	Panel Size (in.)	Panel Size (mm)
A72XM5418SSN4	72.12 x 54.50 x 18.12	1832 x 1384 x 460	A72PM54	A72PM54G	60.00 x 48.00	1524 x 1219
A72XM6618SSN4	72.12 x 66.50 x 18.12	1832 x 1689 x 460	A72PM66	A72PM66G	60.00 x 60.00	1524 x 1524
A72XM7818SSN4	72.12 x 78.50 x 18.12	1832 x 1994 x 460	A72PM78	A72PM78G	60.00 x 72.00	1524 x 1829
A84XM7818SSN4	84.12 x 78.50 x 18.12	2137 x 1994 x 460	A84PM78	A84PM78G	72.00 x 72.00	1829 x 1829
A90XM7818SSN4	90.12 x 78.50 x 18.12	2289 x 1994 x 460	A90PM78	A90PM78G	78.00 x 72.00	1981 x 1829
A90XM7820SSN4	90.12 x 78.50 x 20.12	2289 x 1994 x 511	A90PM78	A90PM78G	78.00 x 72.00	1981 x 1829
A72XM7824SSN4	72.12 x 78.50 x 24.12	1832 x 1994 x 613	A72PM78	A72PM78G	60.00 x 72.00	1524 x 1829
A84XM7824SSN4	84.12 x 78.50 x 24.12	2137 x 1994 x 613	A84PM78	A84PM78G	72.00 x 72.00	1829 x 1829
A90XM7824SSN4	90.12 x 78.50 x 24.12	2289 x 1994 x 613	A90PM78	A90PM78G	78.00 x 72.00	1981 x 1829

White mild steel panels are furnished with enclosure. Purchase conductive panels separately.



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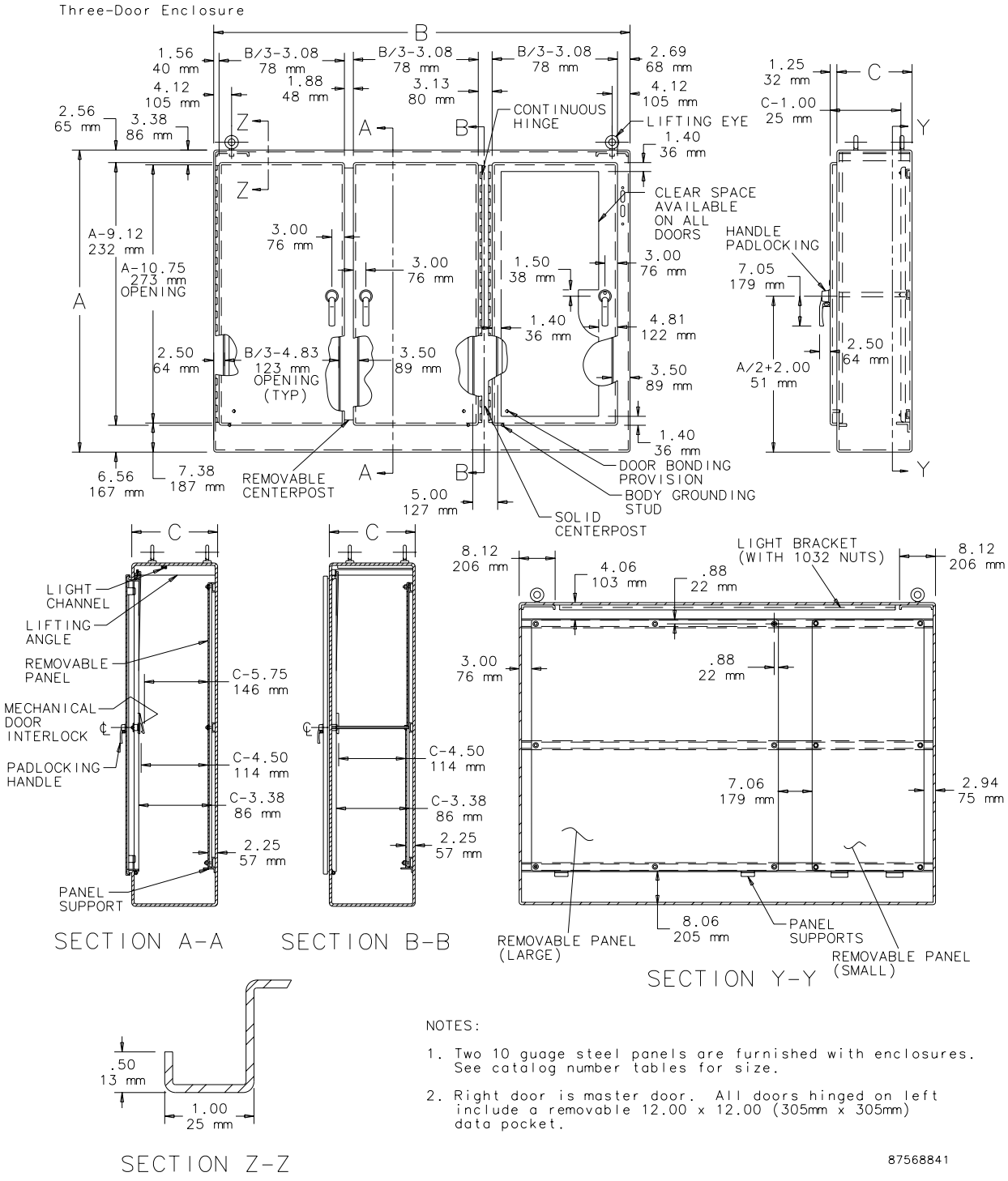
Stainless Steel Heavy Duty Disconnect Enclosures

Standard Product **Three-Door Enclosures**

Catalog Number	AxBxC in.	AxBxC mm	Large Panel	Conductive Large Panel	Number of Large Panels	Size of Large Panels (in.)	Size of Large Panels (mm)	Small Panel	Small Conductive Panel	Number of Small Panels	Size of Small Panels (in.)	Size of Small Panels (mm)
A72XM3EQ18SSN4	72.12 x 100.75 x 18.12	1832 x 2559 x 460	A72PM66	A72PM66G	1	60.00 x 60.00	1524 x 1524	A72PM34	A72PM34G	1	60.00 x 27.75	1524 x 705
A72XM3EW18SSN4	72.12 x 118.75 x 18.12	1832 x 3016 x 460	A72PM78	A72PM78G	1	60.00 x 72.00	1524 x 1829	A72PM40	A72PM40G	1	60.00 x 33.75	1524 x 857
A84XM3EW18SSN4	84.12 x 118.75 x 18.12	2137 x 3016 x 460	A84PM78	A84PM78G	1	72.00 x 72.00	1829 x 1829	A84PM40	A84PM40G	1	72.00 x 33.75	1829 x 857
A84XM3EW24SSN4	84.12 x 118.75 x 24.12	2137 x 3016 x 613	A84PM78	A84PM78G	1	72.00 x 72.00	1829 x 1829	A84PM40	A84PM40G	1	72.00 x 33.75	1829 x 857
A90XM3EW24SSN4	90.12 x 118.75 x 24.12	2289 x 3016 x 613	A90PM78	A90PM78G	1	78.00 x 72.00	1981 x 1829	A90PM40	A90PM40G	1	78.00 x 33.75	1981 x 857

White mild steel panels are furnished with enclosure. Purchase conductive panels separately.



NOTES:

1. Two 10 guage steel panels are furnished with enclosures. See catalog number tables for size.
2. Right door is master door. All doors hinged on left include a removable 12.00 x 12.00 (305mm x 305mm) data pocket.

87568841

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Stainless Steel Heavy Duty Disconnect Enclosures

Standard Product **Four- and Five-Door Enclosures**

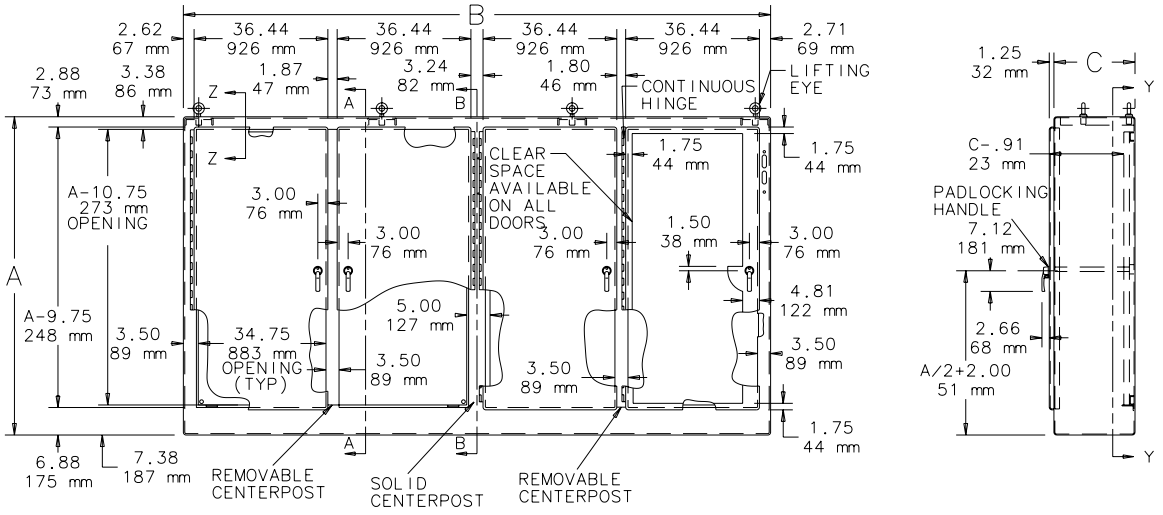
Catalog Number	AxBxC in.	AxBxC mm	Number of Doors	Panel	Number of Panels	Size of Panels (in.)	Sizes of Panels (mm)
A72XM4EW18SSN4	72.12 x 158.00 x 18.12	1832 x 4013 x 460	4	A72PM78	2	60.00 x 72.00	1524 x 1829
A84XM4EW18SSN4	84.12 x 158.00 x 18.12	2137 x 4013 x 460	4	A84PM78	2	72.00 x 72.00	1829 x 1829
A84XM5EW24SSN4	84.12 x 197.75 x 24.12	2137 x 5023 x 613	5	A84PM78 and A84PM40	2 and 1	72.00 x 72.00 and 72.00 x 33.75	1829 x 1829 and 1329 x 857

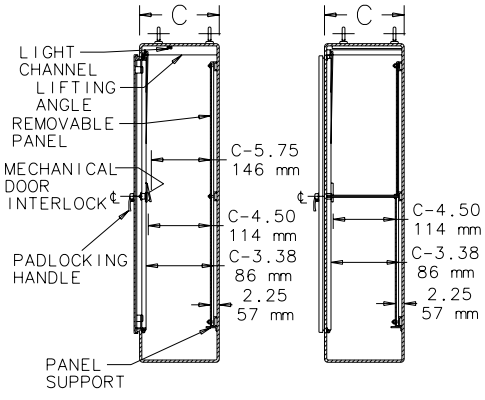
White mild steel panels are furnished with enclosure. Optional conductive panels are available.

All 24.12-in. (613-mm) and deeper enclosures using short connecting rods in the following models require a Hoffman platform assembly, catalog number ADSCPA, purchased separately. • ABB Controls flange-operated devices • Eaton Cutler-Hammer C361 devices • Eaton Cutler-Hammer C371 mechanisms which use C371E, F, G, K operating mechanism • General Electric Type TDA devices (see next paragraph for option) • Schneider Square D Class 9422 devices (see next paragraph for option)

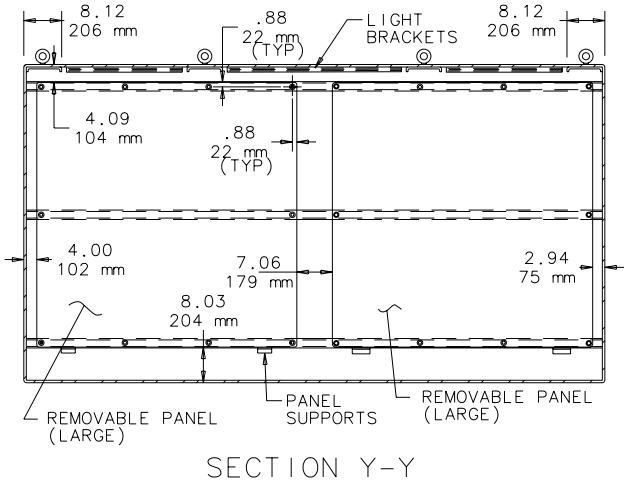
The platform assembly can be omitted if long connecting rods are ordered in place of short connecting rods. • For Eaton Cutler-Hammer operating mechanisms C371E and C371F order catalog number C371CS1 connecting rod. For C371G and C371K order catalog number C371CS2 connecting rod. • For General Electric devices, order catalog number TDSR extended length drive rod • For Schneider Square D devices, order catalog number 9422-R2 extra long operating rod(s). Some devices require two rods. Consult factory for space occupied on panel when platform is used.

Four-Door Enclosure





SECTION A-A SECTION B-B



SECTION Y-Y

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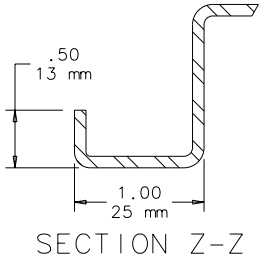

SECTION Z-Z

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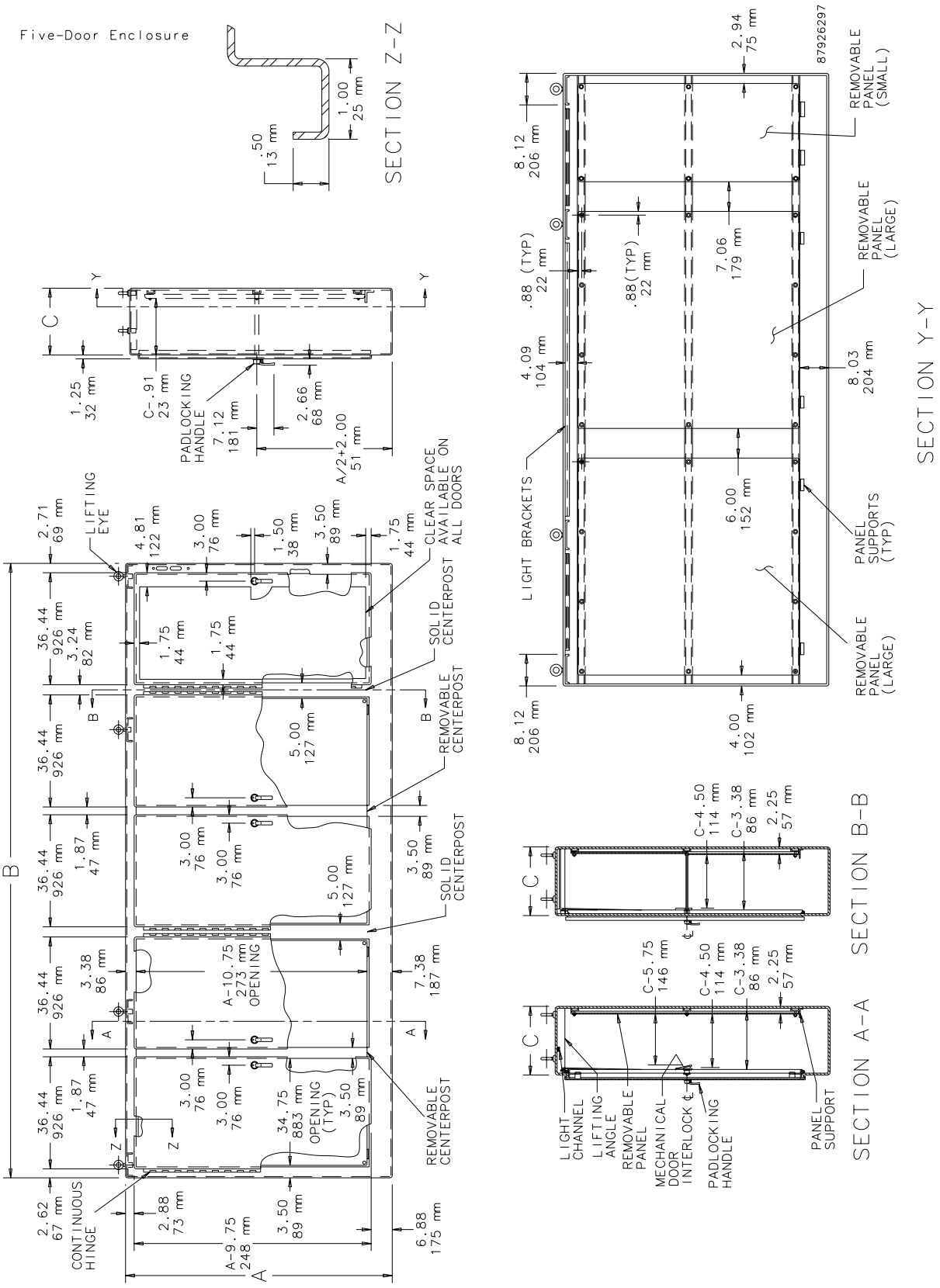
Stainless Steel Heavy Duty Disconnect Enclosures



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Stainless Steel Heavy Duty Disconnect Enclosures

Disconnect Mounting Space

Disconnects will occupy space on panel shown by dimensions E1, F1 and G1 in the diagram. Wiring space W1 is available when disconnect is installed in the enclosure.
See the Technical Information section for E1 Spacing by Enclosure Height for various disconnect switch manufacturers.
Refer to *National Electrical Code* , 2005 article 430-10(b) for wiring space required for line side conductors to be connected to disconnect.
Verify your application to determine if wiring space is adequate.

All 24.12-in. (613-mm) and deeper enclosures using short connecting rods by the following manufacturers require a Hoffman platform assembly, catalog number ADSCPA, purchased separately.

- ABB Controls flange-operated devices
- Eaton Cutler-Hammer C361 devices
- Eaton Cutler-Hammer C371 mechanisms which use C371E, F, G, K operating mechanism (see Disconnect Enclosure Accessories)
- General Electric Type TDA devices (see Disconnect Enclosure Accessories)
- Schneider Square D® Class 9422 devices (see Disconnect Enclosure Accessories)

The platform assembly can be omitted if long connecting rods are ordered in place of short connecting rods.

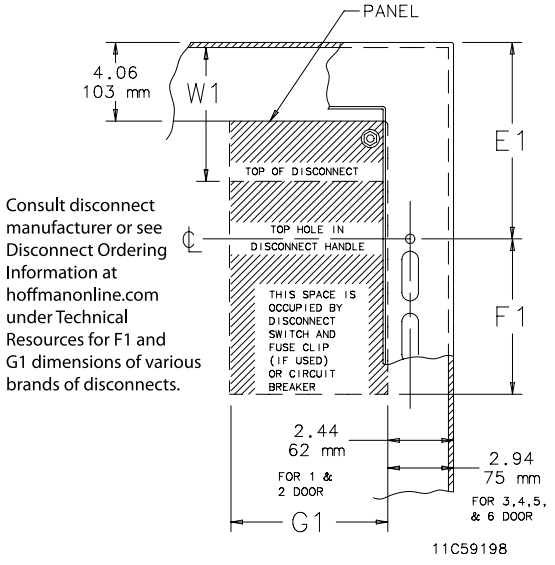
- For Eaton Cutler-Hammer operating mechanisms C371E and C371F order catalog number C371CS1 connecting rod. For C371G and C371K order catalog number C371CS2 connecting rod.
- For General Electric devices, order catalog number TDSR extended length drive rod
- For Schneider Square D devices, order catalog number 9422-R2 extra long operating rod(s). Some devices require two rods.

Consult factory for space occupied on panel when platform is used.

A Complete Assembly Consists of:

1. An enclosure
2. A panel
3. An operator adapter (see Disconnect Enclosure Accessories in this publication to select the proper operator adapter for the brand and type of disconnect being used). *Door hardware is furnished with enclosure.*
4. A disconnect device.

Consult disconnect manufacturer or see Disconnect Ordering Information at hoffmanonline.com under Technical Resources for F1 and G1 dimensions of various brands of disconnects.



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Free-Stand Preferred-Cutout Stainless Steel Disconnect Overview

Preferred-Cutout Overview

Application

Enclosures having the preferred cutout are sized for use with up to 200 A disconnect switches and up to 400A circuit breakers unless otherwise specified. The preferred cutout accepts the smaller operating handle whose mounting hole centers are 4.688 in. apart. Preferred cutouts are standard in mild steel wall-mount enclosures, modular enclosures and some select large mild steel enclosures. They are also present on all standard stainless steel offerings.
Operator adapters for preferred cutouts must be ordered separately to be used with A21S, A28S4, WS2D and A4S enclosures.

Preferred cutouts are designed to house the following:

Allen-Bradley
- Bulletin 1494V disconnect switches with flange-mount variable-depth operating mechanisms and Bulletin 1494V flange-mount variable-depth operating mechanisms for circuit breakers
- Bulletin 140U flexible cable operating mechanisms for 140U molded case circuit breakers
- Bulletin 1494C cable-operated disconnect switches with flange-mount handles
- Bulletin 194RC cable-operated flange-mount handles for use with the NFPA 79 compliant 194R IEC rotary disconnect switches

Allen-Bradley Bulletin 1494V-R1, -R2 and -W2 operating handles and Allen-Bradley Bulletin 1494F disconnect devices or Bulletin 1494D circuit breaker operators will NOT fit these enclosures.

ABB Controls flange-mount variable-depth operating mechanisms for disconnect switches and circuit breakers. Also the cable version for circuit breakers.

Eaton Cutler-Hammer Type C361 flange-mount variable-depth operating mechanisms with disconnect switches and Type C371 flange-mount variable-depth operating mechanisms for circuit breakers.

General Electric Type STDA flange handles and variable-depth operating mechanisms for disconnect switches and circuit breakers. Also SPECTRAFLEX™ cable operators for circuit breakers.

Siemens ITE MAX FLEX® flange-mount variable-depth operating handles for circuit breakers.

Schneider Square D Class 9422 disconnect switches with flange-mount variable-depth operating mechanisms or cable mechanisms and Class 9422 flange-mount variable-depth operating mechanisms or cable mechanisms for circuit breakers.
These enclosures will NOT accept Square D Class 9422 bracket-mounted disconnect devices, Class 9422TG1 or TG2 devices.

Ordering

Order the disconnect switch, operating handle and operating mechanism separately. See Technical Information in the Hoffman Specifier's Guide for wire bend space available when various manufacturers' disconnect switches are installed or Disconnect Ordering Information at hoffmanonline.com for disconnect ordering guidelines and wire bend space available. Check the enclosure dimension drawings to verify the chosen disconnect switch will fit in the enclosure.

All 24.12-in. (613-mm) and deeper enclosures using short connecting rods by the following manufacturers require a Hoffman platform assembly, catalog number ADSCPA, purchased separately.
- ABB Controls flange-operated devices
- Eaton Cutler-Hammer C361 devices
- Eaton Cutler-Hammer C371 mechanisms which use C371E, F, G, K operating mechanism (see Disconnect Enclosure Accessories)
- General Electric Type TDA devices (see Disconnect Enclosure Accessories)
- Schneider Square D® Class 9422 devices (see Disconnect Enclosure Accessories)

The platform assembly can be omitted if long connecting rods are ordered in place of short connecting rods.
- For Eaton Cutler-Hammer operating mechanisms C371E and C371F order catalog number C371CS1 connecting rod. For C371G and C371K order catalog number C371CS2 connecting rod.
- For General Electric devices, order catalog number TDSR extended length drive rod
- For Schneider Square D devices, order catalog number 9422-R2 extra long operating rod(s). Some devices require two rods.

Consult factory for space occupied on panel when platform is used.

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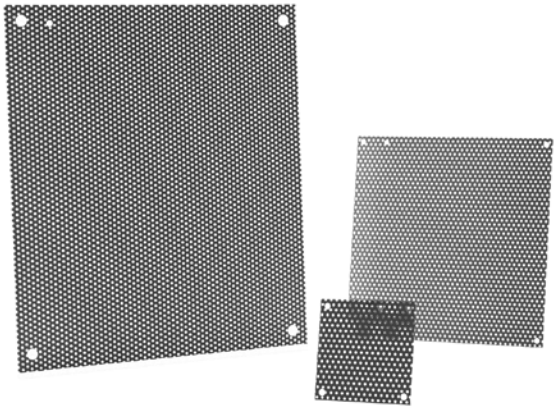
Hoffman Inner Panel, 60” x 27 ¾”

Panels for Enclosures

Perforated Panels



Perforated panels are 16 gauge steel and accept self-tapping screws and eliminate the need to measure, mark and drill when mounting components. Use for mounting lightweight control components.

Bulletin: PNLP

Catalog Number	Use in	Panel Size D x E (in.)	Panel Size D x E (mm)
A6N6PP	Small Type 1 Panel Enclosures and Small Type 3R Boxes	4.25 x 4.25	108 x 108
A8N6PP	Small Type 1 Panel Enclosures and Small Type 3R Boxes	6.25 x 4.25	159 x 108
A8N8PP	Small Type 1 Panel Enclosures and Small Type 3R Boxes	6.25 x 6.25	159 x 159
A10N8PP	Small Type 1 Panel Enclosures and Small Type 3R Boxes	8.25 x 6.25	210 x 159
A10N10PP	Small Type 1 Panel Enclosures and Small Type 3R Boxes	8.25 x 8.25	210 x 210
A12N10PP	Small Type 1 Panel Enclosures and Small Type 3R Boxes	10.25 x 8.25	260 x 210
A12N12PP	Small Type 1 Panel Enclosures and Small Type 3R Boxes	10.25 x 10.25	260 x 260
A14N12PP	Small Type 1 Panel Enclosures and Small Type 3R Boxes	12.25 x 10.25	311 x 260
A16N12PP	Small Type 1 Panel Enclosures and Small Type 3R Boxes	14.25 x 10.25	362 x 260
A20N12PP	Small Type 1 Panel Enclosures and Small Type 3R Boxes	18.25 x 10.25	464 x 260
A16N12MPP	Medium Type 1 Panel Enclosures	10.50 x 13.00	267 x 330
A16N16MPP	Medium Type 1 Panel Enclosures	14.50 x 13.00	368 x 330
A16N20MPP	Medium Type 1 Panel Enclosures	18.50 x 13.00	470 x 330
A18N18MPP	Medium Type 1 Panel Enclosures	16.50 x 15.00	419 x 381
A20N12MPP	Medium Type 1 Panel Enclosures	10.50 x 17.00	267 x 432
A20N16MPP	Medium Type 1 Panel Enclosures	14.50 x 17.00	368 x 432
A20N20MPP	Medium Type 1 Panel Enclosures	18.50 x 17.00	470 x 432
A24N16MPP	Medium Type 1 Panel Enclosures	14.50 x 21.00	368 x 533
A24N20MPP	Medium Type 1 Panel Enclosures	18.50 x 21.00	470 x 533
A24N24MPP	Medium Type 1 Panel Enclosures	22.50 x 21.00	572 x 533
A30N20MPP	Medium Type 1 Panel Enclosures	18.50 x 26.00	470 x 660
A30N24MPP	Medium Type 1 Panel Enclosures	22.50 x 26.00	572 x 660
A30N30MPP	Medium Type 1 Panel Enclosures	28.50 x 26.00	724 x 660
A36N24MPP	Medium Type 1 Panel Enclosures	22.50 x 32.00	572 x 813
A36N30MPP	Medium Type 1 Panel Enclosures	26.50 x 32.00	724 x 813
A16P12PP	Medium Type 3R Hinged-Cover Panel Enclosures	13.00 x 9.00	330 x 229
A16P16PP	Medium Type 3R Hinged-Cover Panel Enclosures	13.00 x 13.00	330 x 330
A20P16PP	Medium Type 3R Hinged-Cover Panel Enclosures	17.00 x 13.00	432 x 330
A18P18PP	Medium Type 3R Hinged-Cover Panel Enclosures	15.00 x 15.00	381 x 381
A20P20PP	Medium Type 3R Hinged-Cover Panel Enclosures	17.00 x 17.00	432 x 732
A24P20PP	Medium Type 3R Hinged-Cover Panel Enclosures	21.00 x 17.00	533 x 432
A24P24PP	Medium Type 3R Hinged-Cover Panel Enclosures	21.00 x 21.00	533 x 533
A30P24PP	Medium Type 3R Hinged-Cover Panel Enclosures	27.00 x 21.00	686 x 533
A36P24PP	Medium Type 3R Hinged-Cover Panel Enclosures	33.00 x 21.00	838 x 533
A30P30PP	Medium Type 3R Hinged-Cover Panel Enclosures	27.00 x 27.00	686 x 686
A36P30PP	Medium Type 3R Hinged-Cover Panel Enclosures	33.00 x 27.00	838 x 686
A36P36PP	Medium Type 3R Hinged-Cover Panel Enclosures	33.00 x 33.00	838 x 838

A24N24MPP, A30N20MPP, A30N24MPP, A36N24MPP, A30N30MPP and A36N30MPP are flanged on all four sides.
A24P24PP, A30P24PP, A30P30PP, A36P24PP, A36P30PP and A36P36PP are flanged on all four sides.

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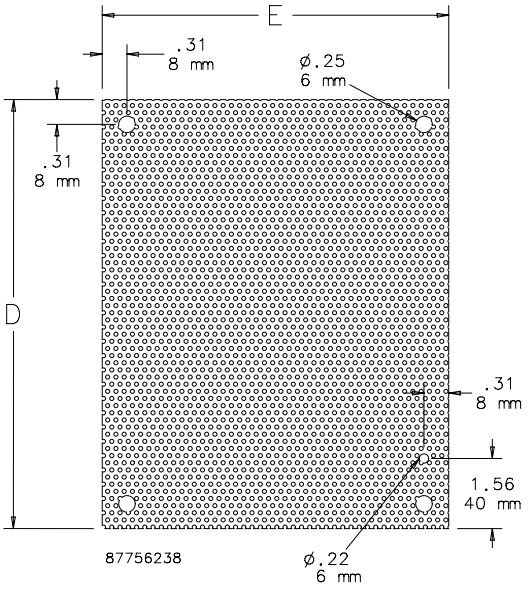
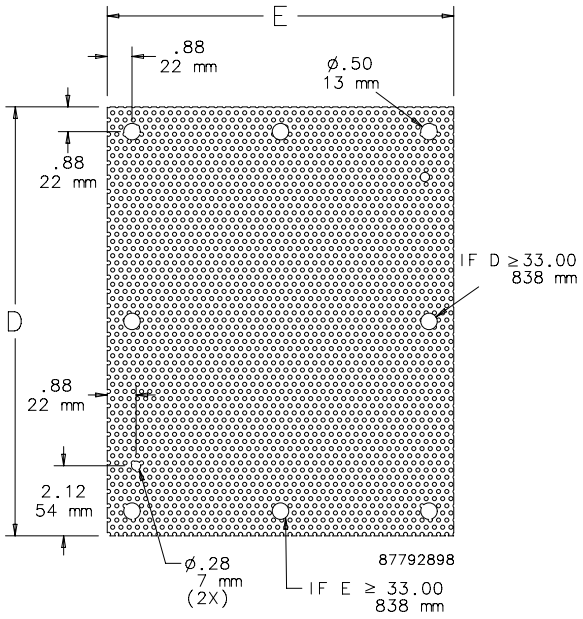
Panels for Enclosures

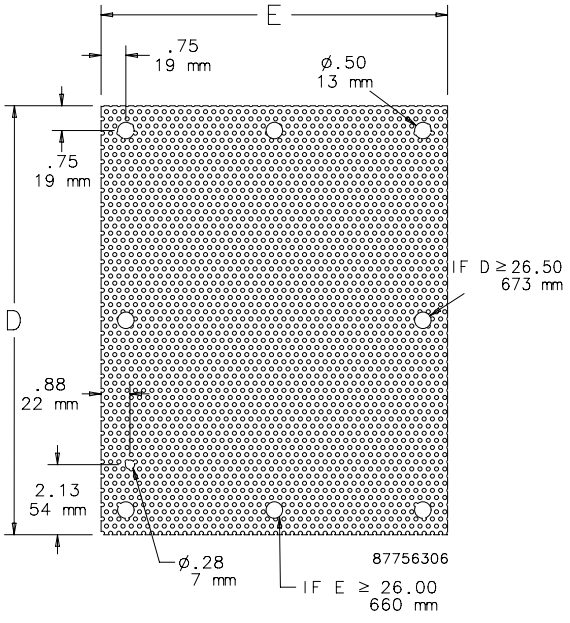
Small Perforated Panels



Medium Type 3R Hinged Cover Perforated Panels



Medium Type 1 Perforated Panels



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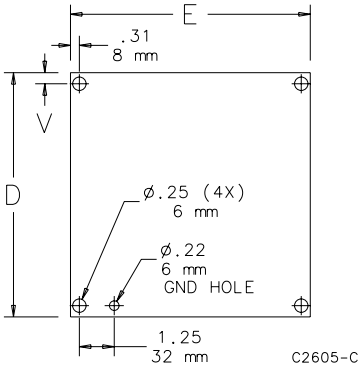
Panels for Enclosures

Panels for Junction Boxes



Steel panels are 14 gauge, finished with white polyester powder paint or with a conductive, corrosion-resistant coating. Stainless steel panels are 14 gauge Type 304 and have a commercial #2B finish which is protected on one side with a plastic film. Aluminum panels are 5052-H32 aluminum alloy 0.080-in. (2-mm) thick and protected on one side with a plastic film. Panel mounting hardware is furnished with all enclosures which accept these panels.

Bulletin: PNLJ, PNLWM

Catalog Number	Material	Panel Size D x E (in.)	Panel Size D x E (mm)	V (in.)	V (mm)
A6P4	Painted steel	4.88 x 2.88	124 x 73	0.31	8
A6P4G	Conductive steel	4.88 x 2.88	124 x 73	0.31	8
A6P4SS	Stainless Steel	4.88 x 2.88	124 x 73	0.31	8
A6P4AL	Aluminum	4.88 x 2.88	124 x 73	0.31	8
A6P6	Painted steel	4.88 x 4.88	124 x 124	0.31	8
A6P6G	Conductive steel	4.88 x 4.88	124 x 124	0.31	8
A6P6SS	Stainless Steel	4.88 x 4.88	124 x 124	0.31	8
A6P6AL	Aluminum	4.88 x 4.88	124 x 124	0.31	8
A8P6	Painted steel	6.75 x 4.88	171 x 124	0.25	6
A8P6G	Conductive steel	6.75 x 4.88	171 x 124	0.25	6
A8P6SS	Stainless Steel	6.75 x 4.88	171 x 124	0.25	6
A8P6AL	Aluminum	6.75 x 4.88	171 x 124	0.25	6
A8P8	Painted steel	6.75 x 6.88	171 x 175	0.25	6
A8P8AL	Aluminum	6.75 x 6.88	171 x 175	0.25	6
A10P8	Painted steel	8.75 x 6.88	222 x 175	0.25	6
A10P8G	Conductive steel	8.75 x 6.88	222 x 175	0.25	6
A10P8SS	Stainless Steel	8.75 x 6.88	222 x 175	0.25	6
A10P8AL	Aluminum	8.75 x 6.88	222 x 175	0.25	6
A10P10	Painted steel	8.75 x 8.88	222 x 226	0.25	6
A10P10G	Conductive steel	8.75 x 8.88	222 x 226	0.25	6
A10P10AL	Aluminum	8.75 x 8.88	222 x 226	0.25	6
A12P6	Painted steel	10.75 x 4.88	273 x 124	0.25	6
A12P6G	Conductive steel	10.75 x 4.88	273 x 124	0.25	6
A12P10	Painted steel	10.75 x 8.88	273 x 226	0.25	6
A12P10G	Conductive steel	10.75 x 8.88	273 x 226	0.25	6
A12P10SS	Stainless Steel	10.75 x 8.88	273 x 226	0.25	6
A12P10AL	Aluminum	10.75 x 8.88	273 x 226	0.25	6
A12P12	Painted steel	10.75 x 10.88	273 x 276	0.25	6
A12P12G	Conductive steel	10.75 x 10.88	273 x 276	0.25	6
A12P12SS	Stainless Steel	10.75 x 10.88	273 x 276	0.25	6
A14P8	Painted steel	12.75 x 6.88	324 x 175	0.25	6
A14P8G	Conductive steel	12.75 x 6.88	324 x 175	0.25	6
A14P12	Painted steel	12.75 x 10.88	324 x 276	0.25	6
A14P12G	Conductive steel	12.75 x 10.88	324 x 276	0.25	6
A14P12SS	Stainless Steel	12.75 x 10.88	324 x 276	0.25	6
A14P12AL	Aluminum	12.75 x 10.88	324 x 276	0.25	6
A16P10	Painted steel	14.75 x 8.88	375 x 226	0.25	6
A16P10G	Conductive steel	14.75 x 8.88	375 x 226	0.25	6
A16P14	Painted steel	14.75 x 12.88	375 x 327	0.25	6
A16P14G	Conductive steel	14.75 x 12.88	375 x 327	0.25	6
A16P14SS	Stainless Steel	14.75 x 12.88	375 x 327	0.25	6
A16P14AL	Aluminum	14.75 x 12.88	375 x 327	0.25	6
A18P16	Painted steel	16.75 x 14.88	425 x 378	0.25	6
A18P16G	Conductive steel	16.75 x 14.88	425 x 378	0.25	6
A18P16SS	Stainless Steel	16.75 x 14.88	425 x 378	0.25	6
A18P16AL	Aluminum	16.75 x 14.88	425 x 378	0.25	6

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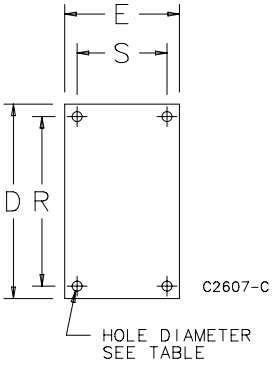
Composite Panels for Junction Boxes and UL/NEMA Wall-Mount Enclosures

Manufactured from light-brown, reinforced phenolic laminate sheet stock. This material has exceptional strength and chemical resistance, which makes it ideally suited for the most corrosive environments. Composite panels are intended for use in corrosion-resistant enclosures. Panel sizes are available for junction boxes and UL/NEMA size enclosures. Composite panels may be drilled and tapped but work equally as well with self-threading or thread-cutting screws. Refer to the table for recommended mounting specifications.

Bulletin: PNLC

Standard Product

Catalog Number	Panel Size D x E in./mm	R in./mm	S in./mm	Hole Dia. in./mm	Panel Thickness in./mm
A6P4C	4.88 x 2.88	4.25	2.25	0.25	0.12
	124 x 73	108	57	6	3
A6P6C	4.88 x 4.88	4.25	4.25	0.25	0.12
	124 x 124	108	108	6	3
A8P6C	6.75 x 4.88	6.25	4.25	0.25	0.12
	171 x 124	159	108	6	3
A10P8C	8.75 x 6.88	8.25	6.25	0.25	0.12
	222 x 175	210	159	6	3
A12P10C	10.75 x 8.88	10.25	8.25	0.25	0.19
	273 x 226	260	210	6	5
A14P12C	12.75 x 10.88	12.25	10.25	0.25	0.19
	324 x 276	311	260	6	5
A16P14C	14.75 x 12.88	14.25	12.25	0.25	0.19
	375 x 327	362	311	6	5
A18P16C	16.75 x 14.88	16.25	14.25	0.25	0.19
	425 x 379	413	362	6	5
A20P16C	17.00 x 13.00	15.25	11.25	0.50	0.19
	432 x 330	387	286	13	5
A20P20C	17.00 x 17.00	15.25	15.25	0.50	0.19
	432 x 432	387	387	13	5
A24P20C	21.00 x 17.00	19.25	15.25	0.50	0.19
	533 x 432	489	387	13	5
A24P24C	21.00 x 21.00	19.25	19.25	0.50	0.19
	533 x 533	489	489	13	5
A30P24C	27.00 x 21.00	25.25	19.25	0.50	0.19
	686 x 533	641	489	13	5



Composite Panel Mounting Recommendations

Screw Type	Screw Size	Hole Size in./mm	Max. Insertion Torque (lb.) in 0.12 in. Material	Max. Insertion Torque (lb.) in 0.19 in. Material	Max. Load (lb. per screw) in 0.12 in. Material	Max. Load (lb. per screw) in 0.19 in. Material
Machine (tapped hole)	8-32	.136 3	15	25	40	45
Machine (tapped hole)	10-32	.161 4	15	25	35	40
Machine (tapped hole)	1/4-20	.204 5	20	25	30	35
Thread Cutting Type T	8-32	.144 4	15	25	40	45
Thread Cutting Type T	10-32	.166 4	15	25	35	40
Thread Cutting Type T	1/4-20	.288 7	20	25	30	35
Sheet Metal A-B	8-32	.147 4	Not recommended	10	40	45
Sheet Metal A-B	10-32	.166 4	Not recommended	10	35	40
Sheet Metal A-B	1/4-20	.221 6	Not recommended	15	30	35

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Junction Box and Wall-Mount Enclosure Swing-Out Panel Kit

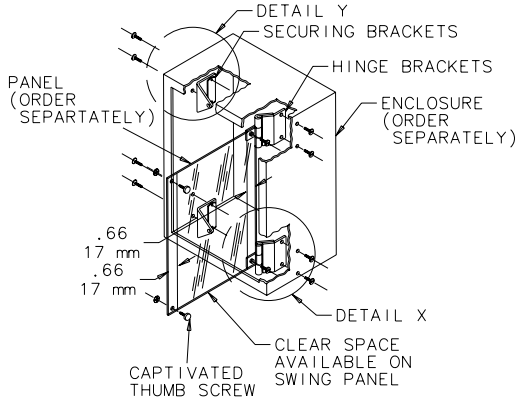
Kits allow mounting standard Hoffman junction box and NEMA style panels (purchase separately) near the front of the enclosure for easy access to or reading of gauges, switches, pilot lights and other components. Kits consist of heavy-gauge brackets and hinges which are easily installed by drilling small holes in the sides of the enclosure and bolting the brackets in place. External screws are stainless steel; internal components are plated steel. All mounting hardware and instructions are provided. Sealing washers ensure the enclosure will meet original JIC or NEMA standards after installation.
Swing-Out Panel Kits do not fit single-door disconnect enclosures.

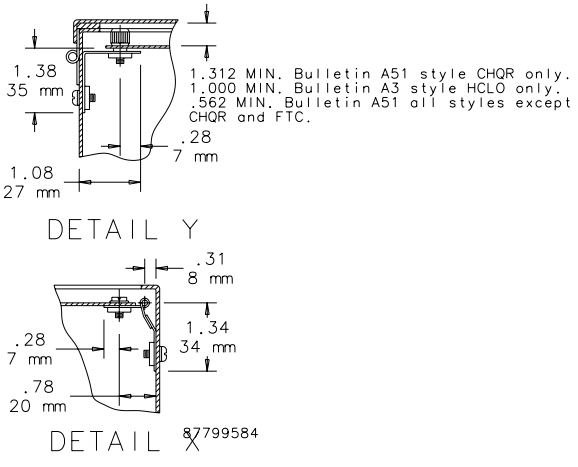
Bulletin: A80

Catalog Number	Description	Maximum Load (lb.)	Maximum Load (kg)	Use In
AJCDFK	Junction Box Kit	25	11.3	- Junction boxes where A x B is 8.00 x 6.00 in. (203 x 152 mm) or larger - HCLO Type 3R enclosures where A x B is 16.00 x 12.00 in. (406 x 305 mm) or smaller
ANADFK	Wall-Mount Enclosure Kit	100	45.4	- One-door Type 4, 12 and 13 enclosures where A x B is 12.00 x 12.00 in. (305 x 305 mm) or larger - HCLO Type 3R enclosures where A x B is 16.00 x 16.00 in. (406 x 406 mm) or larger - HCR Type 3R enclosures where A x B is 16.00 x 12.00 (406 x 305 mm) or larger - Type 1 enclosures where A x B is 42.00 x 30.00 in. (1067 x 762 mm) or larger

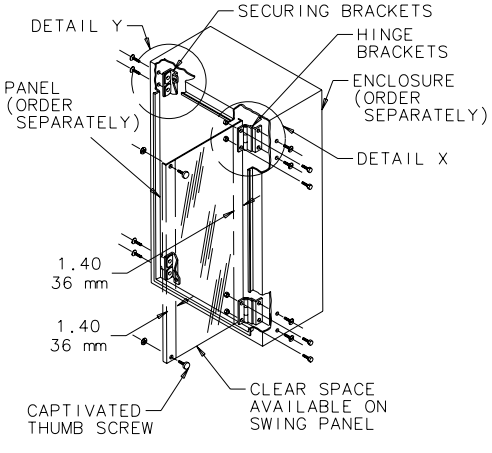
Both kits maintain UL Type 4 rating when properly installed in a Hoffman enclosure.
Maximum load includes the weight of the panel plus the weight of the components, with the weight of the components spread evenly over the panel.

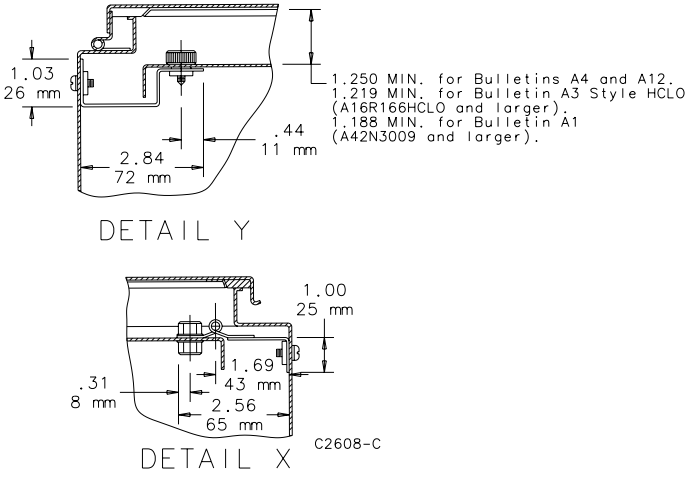
Junction Box Swing-Out Panel Kit





Wall-Mount Enclosure Swing-Out Panel Kit





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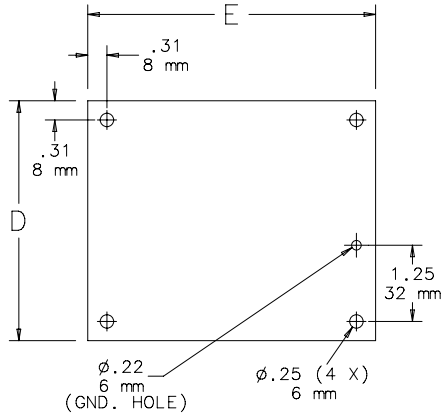
Panels for Enclosures

Panels for Type 1 Enclosures and Small Type 3R Enclosures

Steel panels are 14 gauge, finished with white polyester powder paint. Panel mounting hardware is furnished with enclosure.

Bulletin: PNLT1



C2646-C

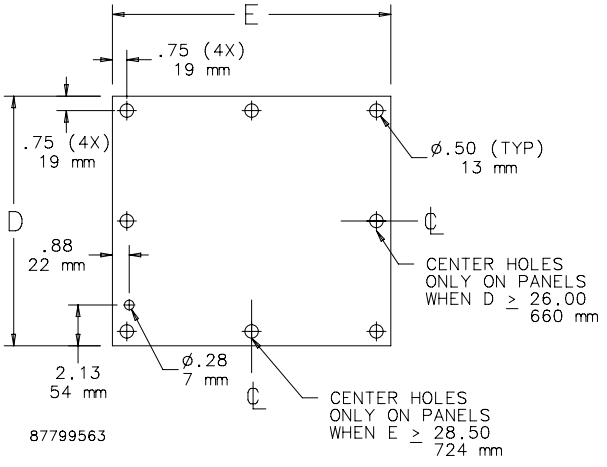
Catalog Number	Panel Size D x E (in.)	Panel Size D x E (mm)
A6N4P	4.25 x 2.25	108 x 57
A6N6P	4.25 x 4.25	108 x 108
A8N6P	6.25 x 4.25	159 x 108
A8N8P	6.25 x 6.25	159 x 159
A10N8P	8.25 x 6.25	210 x 159
A10N10P	8.25 x 8.25	210 x 210
A12N10P	10.25 x 8.25	260 x 210
A12N12P	10.25 x 10.25	260 x 260
A14N12P	12.25 x 10.25	311 x 260
A16N12P	14.25 x 10.25	362 x 260
A20N12P	18.25 x 10.25	464 x 260

Panels for Medium Type 1 Enclosures

Steel panels are 14 or 12 gauge with a white polyester powder paint finish. Panel mounting hardware is furnished with enclosure.

Bulletin: PNLT1

Catalog Number	Panel Thickness (ga.)	Panel Size D x E (in.)	Panel Size D x E (mm)
A16N12MP	14	13.00 x 10.50	330 x 267
A20N12MP	14	17.00 x 10.50	432 x 267
A16N16MP	14	13.00 x 14.50	330 x 368
A20N16MP	14	17.00 x 14.50	432 x 368
A24N16MP	14	21.00 x 14.50	533 x 368
A18N18MP	14	15.00 x 16.50	381 x 419
A16N20MP	14	13.00 x 18.50	330 x 470
A20N20MP	14	17.00 x 18.50	432 x 470
A24N20MP	14	21.00 x 18.50	533 x 470
A30N20MP	14	26.00 x 18.50	660 x 470
A24N24MP	12	21.00 x 22.50	533 x 571
A30N24MP	12	26.00 x 22.50	660 x 571
A36N24MP	12	32.00 x 22.50	813 x 571
A30N30MP	12	26.00 x 28.50	660 x 724
A36N30MP	12	32.00 x 28.50	813 x 724



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Panels for Enclosures

Panels for Type 3R, 4, 4X, 12 and 13 Enclosures

Steel panels are 12 gauge, finished with white polyester powder paint or a conductive, corrosion-resistant coating. Larger panels have flanges on two or four sides. Some larger steel panels are 10 gauge and include extra holes for panel lifting. Aluminum panels are 5052-H32 aluminum alloy. Larger panels have flanges on four sides. Aluminum panels are protected on one side with a plastic film. Stainless steel panels are Type 316 stainless steel. Panel mounting hardware is furnished with all enclosures which accept these panels.

Bulletin: PNLFS, PNLJ, PNLWM

Catalog Number	Material	Panel Size D x E (in.)	Panel Size D x E (mm)	Panel Gauge or Thickness	Edge Flanges	T (in.)	T (mm)	Number of Holes
A12P24	Painted steel	9.00 x 21.00	229 x 533	12 ga.	None	—	—	4
A12P24G	Conductive steel	9.00 x 21.00	229 x 533	12 ga.	None	—	—	4
A16P12	Painted steel	13.00 x 9.00	330 x 229	12 ga.	None	—	—	4
A16P12G	Conductive steel	13.00 x 9.00	330 x 229	12 ga.	None	—	—	4
A16P12SS6	Stainless Steel	13.00 x 9.00	330 x 229	12 ga.	None	—	—	4
A16P12AL	Aluminum	13.00 x 9.00	330 x 229	0.10 in./3 mm	None	—	—	4
A16P16	Painted steel	13.00 x 13.00	330 x 330	12 ga.	None	—	—	4
A16P16G	Conductive steel	13.00 x 13.00	330 x 330	12 ga.	None	—	—	4
A16P16SS6	Stainless Steel	13.00 x 13.00	330 x 330	12 ga.	None	—	—	4
A16P16AL	Aluminum	13.00 x 13.00	330 x 330	0.10 in./3 mm	None	—	—	4
A18P18	Painted steel	15.00 x 15.00	381 x 381	12 ga.	None	—	—	4
A18P18G	Conductive steel	15.00 x 15.00	381 x 381	12 ga.	None	—	—	4
A20P12	Painted steel	17.00 x 9.00	432 x 229	12 ga.	None	—	—	4
A20P12G	Conductive steel	17.00 x 9.00	432 x 229	12 ga.	None	—	—	4
A20P16	Painted steel	17.00 x 13.00	432 x 330	12 ga.	None	—	—	4
A20P16G	Conductive steel	17.00 x 13.00	432 x 330	12 ga.	None	—	—	4
A20P16SS6	Stainless Steel	17.00 x 13.00	432 x 330	12 ga.	None	—	—	4
A20P16AL	Aluminum	17.00 x 13.00	432 x 330	0.10 in./3 mm	None	—	—	4
A20P20	Painted steel	17.00 x 17.00	432 x 432	12 ga.	None	—	—	4
A20P20G	Conductive steel	17.00 x 17.00	432 x 432	12 ga.	None	—	—	4
A20P20SS6	Stainless steel	17.00 x 17.00	432 x 432	12 ga.	None	—	—	4
A20P20AL	Aluminum	17.00 x 17.00	432 x 432	0.10 in./3 mm	None	—	—	4
A24P16	Painted steel	21.00 x 13.00	533 x 330	12 ga.	None	—	—	4
A24P16G	Conductive steel	21.00 x 13.00	533 x 330	12 ga.	None	—	—	4
A24P16SS6	Stainless Steel	21.00 x 13.00	533 x 330	12 ga.	None	—	—	4
A24P20	Painted steel	21.00 x 17.00	533 x 432	12 ga.	2	0.75	19	4
A24P20G	Conductive steel	21.00 x 17.00	533 x 432	12 ga.	2	0.75	19	4
A24P20SS6	Stainless Steel	21.00 x 17.00	533 x 432	12 ga.	2	0.75	19	4
A24P20AL	Aluminum	21.00 x 17.00	533 x 432	0.10 in./3 mm	4	0.75	19	4
A24P24	Painted steel	21.00 x 21.00	533 x 533	12 ga.	2	0.75	19	4
A24P24G	Conductive steel	21.00 x 21.00	533 x 533	12 ga.	2	0.75	19	4
A24P24SS6	Stainless Steel	21.00 x 21.00	533 x 533	12 ga.	2	0.75	19	4
A24P24AL	Aluminum	21.00 x 21.00	533 x 533	0.10 in./3 mm	2	0.75	19	4
A30P16	Painted steel	27.00 x 13.00	686 x 330	12 ga.	2	0.75	19	4
A30P16G	Conductive steel	33.00 x 27.00	838 x 686	12 ga.	2	0.75	19	4
A30P20	Painted steel	27.00 x 17.00	686 x 432	12 ga.	2	0.75	19	4
A30P20G	Conductive steel	27.00 x 17.00	686 x 432	12 ga.	2	0.75	19	4
A30P20SS6	Stainless Steel	27.00 x 17.00	686 x 432	12 ga.	2	0.75	19	4
A30P24	Painted steel	27.00 x 21.00	686 x 533	12 ga.	2	0.75	19	4
A30P24G	Conductive steel	27.00 x 21.00	686 x 533	12 ga.	2	0.75	19	4
A30P24SS6	Stainless Steel	27.00 x 21.00	686 x 533	12 ga.	2	0.75	19	4
A30P24AL	Aluminum	27.00 x 21.00	686 x 533	0.10 in./3 mm	2	0.75	19	4
A30P30	Painted steel	27.00 x 27.00	686 x 686	12 ga.	4	0.75	19	4
A30P30G	Conductive steel	27.00 x 27.00	686 x 686	12 ga.	4	0.75	19	4
A30P30SS6	Stainless Steel	27.00 x 27.00	686 x 686	12 ga.	4	0.75	19	4
A36P16	Painted steel	33.00 X 13.00	838 X 330	12 ga.	2	0.75	19	4
A36P16G	Conductive steel	33.00 x 13.00	838 x 330	12 ga.	2	0.75	19	4
A36P24	Painted steel	33.00 x 21.00	838 x 533	12 ga.	2	0.75	19	6
A36P24G	Conductive steel	33.00 x 21.00	838 x 533	12 ga.	2	0.75	19	6
A36P24SS6	Stainless Steel	33.00 x 21.00	838 x 533	12 ga.	2	0.75	19	6
A36P24AL	Aluminum	33.00 x 21.00	838 x 533	0.10 in./3 mm	2	0.75	19	6
A36P30	Painted steel	33.00 x 27.00	838 x 686	12 ga.	4	0.75	19	6
A36P30G	Conductive steel	33.00 x 27.00	838 x 686	12 ga.	4	0.75	19	6
A36P30SS6	Stainless Steel	33.00 x 27.00	838 x 686	12 ga.	4	0.75	19	6
A36P30AL	Aluminum	33.00 x 27.00	838 x 686	0.10 in./3 mm	4	0.75	19	6
A36P36	Painted steel	33.00 x 33.00	838 x 838	12 ga.	4	0.75	19	8
A36P36G	Conductive steel	33.00 x 33.00	838 x 838	12 ga.	4	0.75	19	8
A36P36SS6	Stainless Steel	33.00 x 33.00	838 x 838	12 ga.	4	0.75	19	8
A40P24	Painted steel	37.00 x 21.00	940 x 533	12 ga.	4	0.75	19	6
A40P24G	Conductive steel	37.00 x 21.00	940 x 533	12 ga.	4	0.75	19	6
A40P30	Painted steel	37.00 x 29.00	940 x 737	12 ga.	4	0.75	19	4 (no D dim. center hole)
A40P30G	Conductive steel	37.00 x 29.00	940 x 737	12 ga.	4	0.75	19	4 (no D dim. center hole)
A42P24	Painted steel	39.00 x 21.00	991 x 533	12 ga.	2	0.75	19	6
A42P24G	Conductive steel	39.00 x 21.00	991 x 533	12 ga.	2	0.75	19	6
A42P30	Painted steel	39.00 x 27.00	991 x 686	12 ga.	4	0.75	19	6
A42P30G	Conductive steel	39.00 x 27.00	991 x 686	12 ga.	4	0.75	19	6
A42P30SS6	Stainless Steel	39.00 x 27.00	991 x 686	12 ga.	4	0.75	19	6
A42P36	Painted steel	39.00 x 33.00	991 x 838	12 ga.	4	0.75	19	8
A42P36G	Conductive steel	39.00 x 33.00	991 x 838	12 ga.	4	0.75	19	8
A42P36SS6	Stainless Steel	39.00 x 33.00	991 x 838	12 ga.	4	0.75	19	8
A42P42	Painted steel	39.00 x 39.00	991 x 991	12 ga.	4	0.75	19	8

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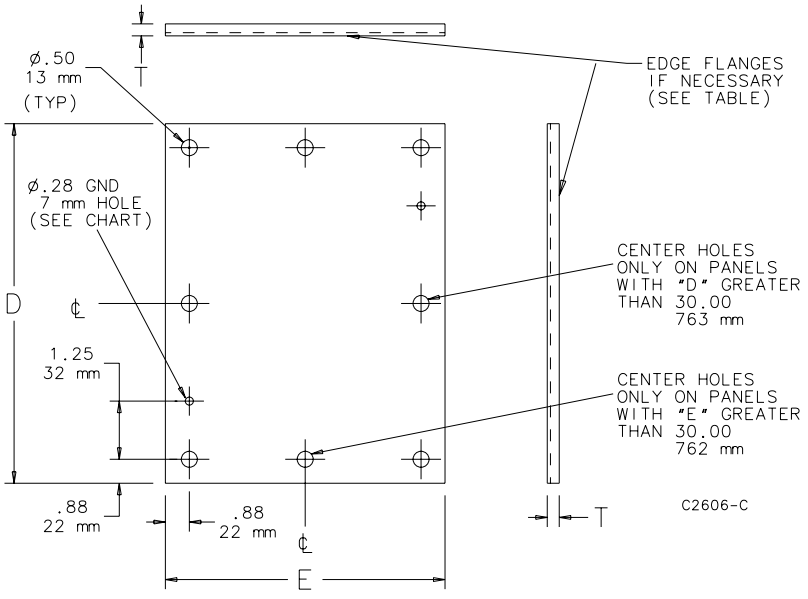
Panels for Enclosures

Catalog Number	Material	Panel Size D x E (in.)	Panel Size D x E (mm)	Panel Gauge or Thickness	Edge Flanges	T (in.)	T (mm)	Number of Holes
A42P42G	Conductive steel	39.00 x 39.00	991 x 991	12 ga.	4	0.75	19	8
A48P24	Painted steel	45.00 x 21.00	1143 x 533	12 ga.	2	0.75	19	6
A48P24G	Conductive steel	45.00 x 21.00	1143 x 533	12 ga.	2	0.75	19	6
A48P30	Painted steel	45.00 x 27.00	1143 x 686	12 ga.	4	0.75	19	6
A48P30G	Conductive steel	45.00 x 27.00	1143 x 686	12 ga.	4	0.75	19	6
A48P36	Painted steel	45.00 x 33.00	1143 x 838	12 ga.	4	0.75	19	8
A48P36G	Conductive steel	45.00 x 33.00	1143 x 838	12 ga.	4	0.75	19	8
A48P36SS6	Stainless Steel	45.00 x 33.00	1143 x 838	12 ga.	4	0.75	19	8
A48P36AL	Aluminum	45.00 x 33.00	1143 x 838	0.10 in./3 mm	4	0.75	19	8
A48P42	Painted steel	45.00 x 39.00	1143 x 991	12 ga.	4	0.75	19	8
A48P42G	Conductive steel	45.00 x 39.00	1143 x 991	12 ga.	4	0.75	19	8
A48P48	Painted steel	44.00 x 44.00	1118 x 1118	10 ga.	4	0.88	22	8
A48P48G	Conductive steel	44.00 x 44.00	1118 x 1118	10 ga.	4	0.88	22	8
A54P42	Painted steel	50.00 x 38.00	1270 x 965	12 ga.	4	0.75	19	8
A54P42G	Conductive steel	50.00 x 38.00	1270 x 965	10 ga.	4	0.75	19	8
A60P24	Painted steel	57.00 x 21.00	1448 x 533	12 ga.	4	0.75	19	6
A60P24G	Conductive steel	57.00 x 21.00	1448 x 533	12 ga.	4	0.75	19	6
A60P30	Painted steel	57.00 x 27.00	1448 x 686	12 ga.	4	0.75	19	6
A60P30G	Conductive steel	57.00 x 27.00	1448 x 686	12 ga.	4	0.75	19	6
A60P36	Painted steel	57.00 x 33.00	1448 x 838	12 ga.	4	0.75	19	8
A60P36G	Conductive steel	57.00 x 33.00	1448 x 838	12 ga.	4	0.75	19	8
A60P36SS6	Stainless Steel	57.00 x 33.00	1448 x 838	12 ga.	4	0.75	19	8
A60P36AL	Aluminum	57.00 x 33.00	1448 x 838	0.10 in./3 mm	4	0.75	19	8
A60BFP42	Painted steel	56.00 x 38.00	1422 x 965	10 ga.	4	0.88	22	10
A60BFP42G	Conductive steel	56.00 x 38.00	1422 x 965	10 ga.	4	0.88	22	10
A60P48	Painted steel	56.00 x 44.00	1422 x 1118	10 ga.	4	0.88	22	12
A60P48G	Conductive steel	56.00 x 44.00	1422 x 1118	10 ga.	4	0.88	22	12
A60P60	Painted steel	56.00 x 56.00	1422 x 1422	10 ga.	4	0.88	22	10
A60P60G	Conductive steel	56.00 x 56.00	1422 x 1422	10 ga.	4	0.88	22	10
A72P36	Painted steel	69.00 x 33.00	1753 x 838	12 ga.	4	0.75	19	8
A72P36G	Conductive steel	69.00 x 33.00	1753 x 838	12 ga.	4	0.75	19	8
A72P60	Painted steel	68.00 x 56.00	1727 x 1422	10 ga.	4	0.88	22	12
A72P60G	Conductive steel	68.00 x 56.00	1727 x 1422	10 ga.	4	0.88	22	12
A72P72	Painted steel	68.00 x 68.00	1727 x 1727	10 ga.	4	0.88	22	10
A72P72G	Conductive steel	68.00 x 68.00	1727 x 1727	10 ga.	4	0.88	22	10



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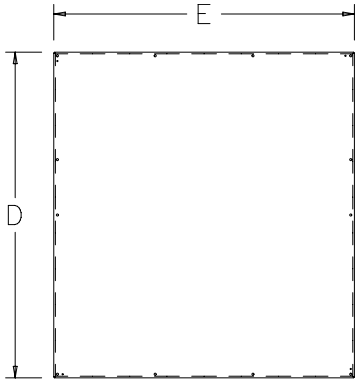
Panels for Enclosures

Panels for Large Bulletin A27, A28, A28S4 and A34 Multi-Door Enclosures

Extra panels for large enclosures (Bulletins A27, A28, A28S4 and A34) can be ordered for panel assembly prior to receiving the enclosures (enclosures include panels). Panels are 12 gauge steel with .88-in. (22-mm) flanges on four sides. Finish is white polyester powder paint or a conductive, corrosion-resistant coating. Two extra holes are provided for lifting and installing panels. Mounting hardware included with enclosure.

Bulletin: PNLFS

Catalog Number	Finish	Panel Size D x E (in.)	Panel Size D x E (mm)	Number of Holes	Fits Enclosure Height
A72PM28	Painted steel	60.00 x 21.75	1524 x 552	8	72 in.
A72PM28G	Conductive	60.00 x 21.75	1524 x 552	8	72 in.
A72PM34	Painted steel	60.00 x 27.75	1524 x 705	8	72 in.
A72PM34G	Conductive	60.00 x 27.75	1524 x 705	8	72 in.
A72PM40	Painted steel	60.00 x 33.75	1524 x 857	8	72 in.
A72PM40G	Conductive	60.00 x 33.75	1829 x 857	8	72 in.
A72PM54	Painted steel	60.00 x 48.00	1524 x 1219	10	72 in.
A72PM54G	Conductive	60.00 x 48.00	1524 x 1219	10	72 in.
A72PM66	Painted steel	60.00 x 60.00	1524 x 1524	10	72 in.
A72PM66G	Conductive	60.00 x 60.00	1524 x 1524	10	72 in.
A72PM78	Painted steel	60.00 x 72.00	1524 x 1829	12	72 in.
A72PM78G	Conductive	60.00 x 72.00	1524 x 1829	12	72 in.
A84PM40	Painted steel	72.00 x 33.75	1829 x 857	8	84 in.
A84PM40G	Conductive	72.00 x 33.75	1829 x 857	8	84 in.
A84PM78	Painted steel	72.00 x 72.00	1829 x 1829	12	84 in.
A84PM78G	Conductive	72.00 x 72.00	1829 x 1829	12	84 in.
A86PM37	Painted steel	78.00 x 34.00	1981 x 864	8	86 in.
A86PM37G	Conductive	78.00 x 34.00	1981 x 864	8	86 in.
A86PM75	Painted steel	78.00 x 70.00	1981 x 1778	12	86 in.
A86PM75G	Conductive	78.00 x 70.00	1981 x 1778	12	86 in.
A90PM40	Painted steel	78.00 x 33.75	1981 x 857	8	90 in.
A90PM40G	Conductive	78.00 x 33.75	1981 x 857	8	90 in.
A90PM78	Painted steel	78.00 x 72.00	1981 x 1829	12	90 in.
A90PM78G	Conductive	78.00 x 72.00	1981 x 1829	12	90 in.



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Panels for Enclosures

Panels for Free-Stand Type 1 Large One-Door Enclosures

Panels for free-stand Type 1 large one-door standard and disconnect enclosures are 12 gauge steel. Panels have either polyester powder paint finish or a conductive, corrosion-resistant coating.

Bulletin: A38P

Catalog Number	Finish	Panel Size D x E (in.)	Panel Size D x E (mm)
A37P21N	Painted steel	37.16 x 21.50	944 x 546
A37P21NG	Conductive	37.16 x 21.50	944 x 546
A49P21N	Painted steel	49.16 x 21.50	1249 x 546
A49P21NG	Conductive	49.16 x 21.50	1249 x 546
A61P21N	Painted steel	61.16 x 21.50	1553 x 546
A73P21N	Painted steel	73.16 x 21.50	1858 x 546
A73P21NG	Conductive	73.16 x 21.50	1858 x 546
A49P32N	Painted steel	49.16 x 32.00	1249 x 813
A49P32NG	Conductive	49.16 x 32.00	1249 x 813
A61P32N	Painted steel	61.16 x 32.00	1553 x 813
A61P32NG	Conductive	61.16 x 32.00	1553 x 813
A73P32N	Painted steel	73.16 x 32.00	1858 x 813
A73P32NG	Conductive	73.16 x 32.00	1858 x 813

Panels for Free-Stand Type 1 Large Two-Door Enclosures

Panels for free-stand Type 1 large two-door standard and disconnect enclosures are 10 gauge steel. Panels have either polyester powder paint finish or a conductive, corrosion-resistant coating.

Bulletin: A38P

Catalog Number	Finish	Panel Size D x E (in.)	Panel Size D x E (mm)
A37P48N	Painted steel	37.16 x 48.00	944 x 1219
A37P48NG	Conductive	37.16 x 48.00	944 x 1219
A49P48N	Painted steel	49.16 x 48.00	1249 x 1219
A49P48NG	Conductive	49.16 x 48.00	1249 x 1219
A49P68N	Painted steel	49.16 x 68.00	1249 x 1727
A49P68NG	Conductive	49.16 x 68.00	1249 x 1727
A61P68N	Painted steel	61.16 x 68.00	1553 x 1727
A61P68NG	Conductive	61.16 x 68.00	1553 x 1727
A73P68N	Painted steel	73.16 x 68.00	1858 x 1727
A73P68NG	Conductive	73.16 x 68.00	1858 x 1727

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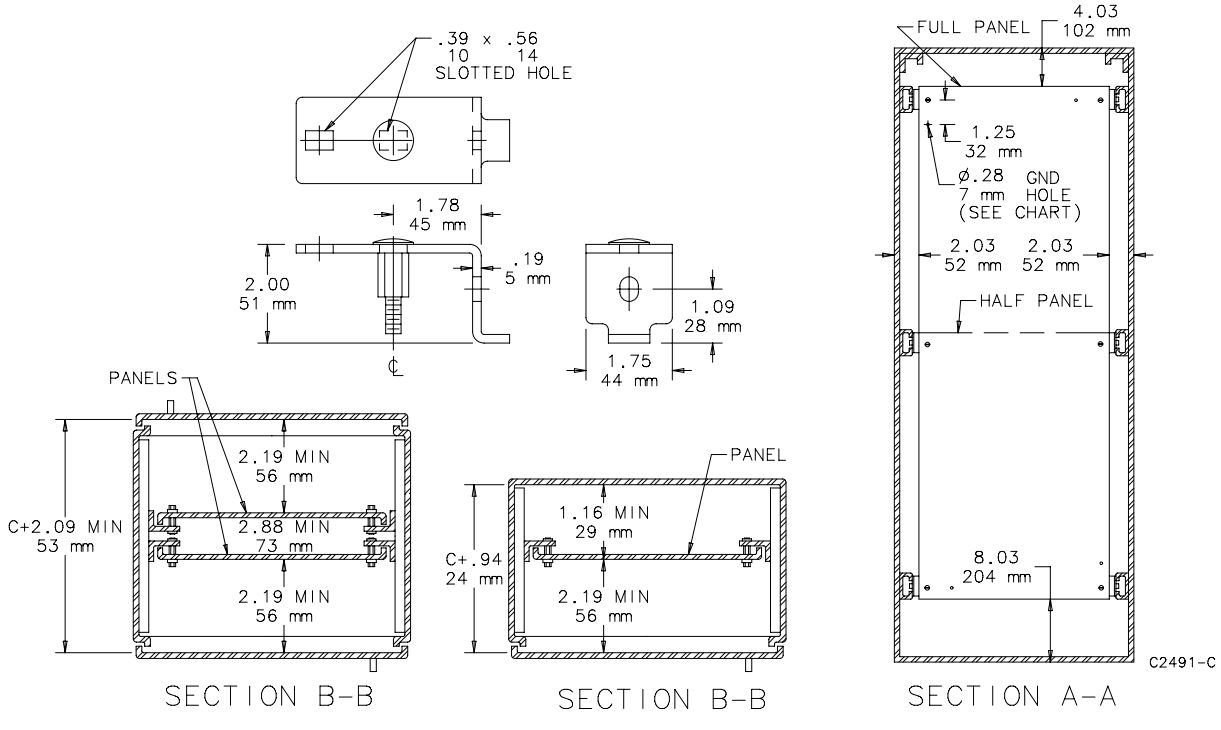
Panels for Free-Stand Type 4, 4X and 12 Single- and Dual-Access One-Door Enclosures with Mounting Channel

Panels for one-door, single-access and one-door, dual-access Free-Stand Type 12 Enclosures, Free-Stand Type 4 Enclosures and One-Door Type 4X Free-Stand Fiberglass Enclosures. Panels are 12 gauge steel and can be positioned anywhere along horizontal mounting channels (see dimension drawing Sections B-B for limitations). Half-length panels can be located in the upper or lower portion of the enclosure. Panels are finished with white polyester powder paint or a conductive, corrosion-resistant coating and furnished with plated mounting hardware.

Bulletin: PNL30

Catalog Number	Description	Finish	Panel Size (in.)	Panel Size (mm)	Fits Enclosure A x B (in.)	Fits Enclosure A x B (mm)
A60P24F1	Full Panel	Painted steel	48.00 x 20.00	1218 x 508	60.00 x 24.00	1524 x 610
A60P24F1G	Full Panel	Conductive	48.00 x 20.00	1218 x 508	60.00 x 24.00	1524 x 610
A60P24F2	Half Panel	Painted steel	24.88 x 20.00	632 x 508	60.00 x 24.00	1524 x 610
A60P24F2G	Half Panel	Conductive	24.88 x 20.00	632 x 508	60.00 x 24.00	1524 x 610
A72P24F1	Full Panel	Painted steel	60.00 x 20.00	1524 x 508	72.00 x 24.00	1829 x 610
A72P24F1G	Full Panel	Conductive	60.00 x 20.00	1524 x 508	72.00 x 24.00	1829 x 610
A72P24F2	Half Panel	Painted steel	30.88 x 20.00	784 x 508	72.00 x 24.00	1829 x 610
A72P24F2G	Half Panel	Conductive	30.88 x 20.00	784 x 508	72.00 x 24.00	1829 x 610
A90P24F1	Full Panel	Painted steel	78.00 x 20.00	1981 x 508	90.00 x 24.00	2286 x 610
A90P24F1G	Full Panel	Conductive	78.00 x 20.00	1981 x 508	90.00 x 24.00	2286 x 610
A90P24F2	Half Panel	Painted steel	39.88 x 20.00	1013 x 508	90.00 x 24.00	2286 x 610
A90P24F2G	Half Panel	Conductive	39.88 x 20.00	1013 x 508	90.00 x 24.00	2286 x 610
A72P30F1	Full Panel	Painted steel	60.00 x 26.00	1524 x 660	72.00 x 30.00	1829 x 762
A72P30F1G	Full Panel	Conductive	60.00 x 26.00	1524 x 660	72.00 x 30.00	1829 x 762
A72P30F2	Half Panel	Painted steel	30.88 x 26.00	784 x 660	72.00 x 30.00	1829 x 762
A72P30F2G	Half Panel	Conductive	30.88 x 26.00	784 x 660	72.00 x 30.00	1829 x 762
A60P36F1	Full Panel	Painted steel	48.00 x 32.00	1219 x 813	60.00 x 36.00	1524 x 914
A60P36F1G	Full Panel	Conductive	48.00 x 32.00	1219 x 813	60.00 x 36.00	1524 x 914
A60P36F2	Half Panel	Painted steel	24.88 x 32.00	632 x 813	60.00 x 36.00	1524 x 914
A60P36F2G	Half Panel	Conductive	24.88 x 32.00	632 x 813	60.00 x 36.00	1524 x 914
A72P36F1	Full Panel	Painted steel	60.00 x 32.00	1524 x 813	72.00 x 36.00	1829 x 914
A72P36F1G	Full Panel	Conductive	60.00 x 32.00	1524 x 813	72.00 x 36.00	1829 x 914
A72P36F2	Half Panel	Painted steel	30.88 x 32.00	784 x 813	72.00 x 36.00	1829 x 914
A72P36F2G	Half Panel	Conductive	30.88 x 32.00	784 x 813	72.00 x 36.00	1829 x 914
A90P36F1	Full Panel	Painted steel	78.00 x 32.00	1981 x 813	90.00 x 36.00	2286 x 914
A90P36F1G	Full Panel	Conductive	78.00 x 32.00	1981 x 813	90.00 x 36.00	2286 x 914
A90P36F2	Half Panel	Painted steel	39.88 x 32.00	1013 x 813	90.00 x 36.00	2286 x 914
A90P36F2G	Half Panel	Conductive	39.88 x 32.00	1013 x 813	90.00 x 36.00	2286 x 914

Use combinations of panels for 3-5 door A 28 enclosures.



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Panels for Enclosures

Panels for Free-Standing Type 4, 4X and 12 Single- and Dual-Access Two-Door Enclosures with Mounting Channel

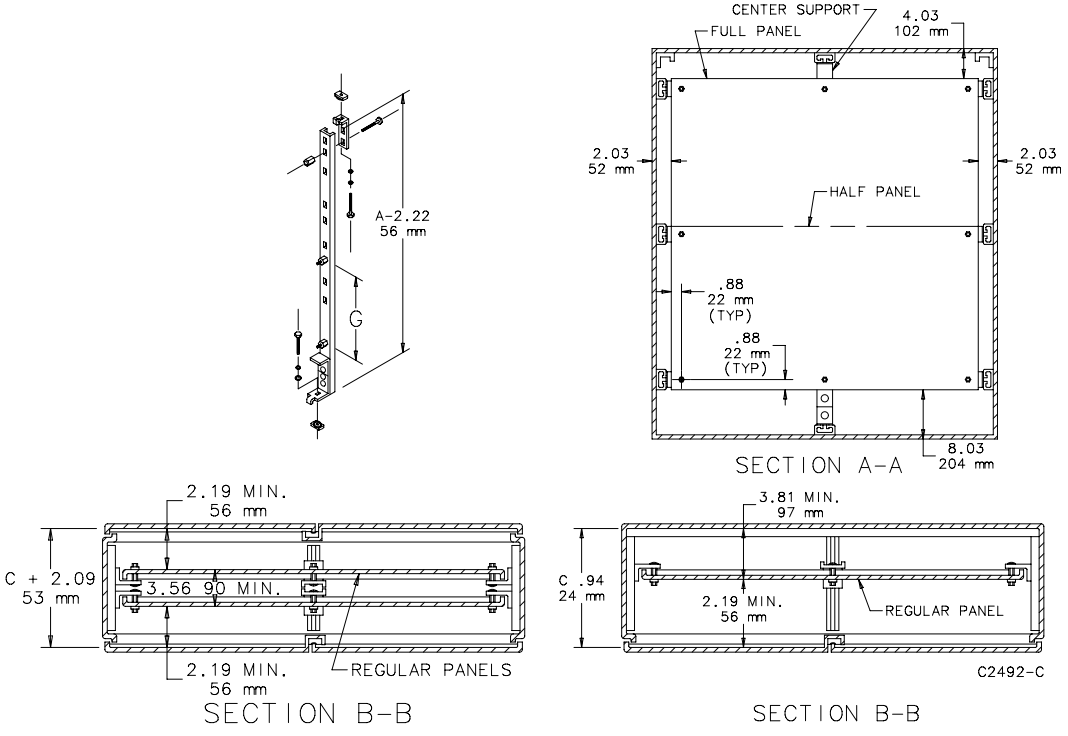
Panels for two-door single access and two-door dual access Free-Stand Type 4, 4X and 12 Enclosures with mounting channel are 10 gauge steel and can be positioned anywhere along horizontal mounting channels (see Sections B-B for limitations). Half-length panels can be located in the upper or lower portion of the enclosure. Some assembly is required.

Panels are finished with white polyester powder paint or a conductive, corrosion-resistant coating and furnished with plated mounting hardware.

Center support is furnished with each full panel or half panel for two-door enclosures. The center support attaches to the top and bottom mounting channels and can be positioned from front to back in the enclosure. The center support can be used with heavy duty panel supports to support panels of various heights.

Bulletin: PNL30

Catalog Number	Description	Fits Enclosure A x B (in.)	Fits Enclosure A x B (mm)	Panel Size (in.)	Panel Size (mm)	G (in.)	G (mm)
A60P48F1	Full Panel	60.00 x 48.00	1524 x 1219	48.00 x 44.00	1219 x 1118	23.12	587
A60P48F1G	Full Panel	60.00 x 48.00	1524 x 1219	48.00 x 44.00	1219 x 1118	23.12	587
A72P48F1	Full Panel	72.00 x 48.00	1829 x 1219	60.00 x 44.00	1524 x 1118	29.12	740
A72P48F1G	Full Panel	72.00 x 48.00	1829 x 1219	60.00 x 44.00	1524 x 1118	29.12	740
A72P48F2	Half Panel	72.00 x 48.00	1829 x 1219	30.88 x 44.00	784 x 1118	29.12	740
A72P48F2G	Half Panel	72.00 x 48.00	1829 x 1219	30.88 x 44.00	784 x 1118	29.12	740
A90P48F1	Full Panel	90.00 x 48.00	2286 x 1219	78.00 x 44.00	1981 x 1118	38.12	968
A90P48F1G	Full Panel	90.00 x 48.00	2286 x 1219	78.00 x 44.00	1981 x 1118	38.12	968
A90P48F2	Half Panel	90.00 x 48.00	2286 x 1219	39.88 x 44.00	1013 x 1118	38.12	968
A90P48F2G	Half Panel	90.00 x 48.00	2286 x 1219	39.88 x 44.00	1013 x 1118	38.12	968
A72P60F1	Full Panel	72.00 x 60.00	1829 x 1524	60.00 x 56.00	1524 x 1422	29.12	740
A72P60F1G	Full Panel	72.00 x 60.00	1829 x 1524	60.00 x 56.00	1524 x 1422	29.12	740
A72P60F2	Half Panel	72.00 x 60.00	1829 x 1524	30.88 x 56.00	784 x 1422	29.12	740
A72P60F2G	Half Panel	72.00 x 60.00	1829 x 1524	30.88 x 56.00	784 x 1422	29.12	740
A72P72F1	Full Panel	72.00 x 72.00	1829 x 1829	60.00 x 68.00	1524 x 1727	29.12	740
A72P72F1G	Full Panel	72.00 x 72.00	1829 x 1829	60.00 x 68.00	1524 x 1727	29.12	740
A72P72F2	Half Panel	72.00 x 72.00	1829 x 1829	30.88 x 68.00	784 x 1727	29.12	740
A72P72F2G	Half Panel	72.00 x 72.00	1829 x 1829	30.88 x 68.00	784 x 1727	29.12	740
A90P72F1	Full Panel	90.00 x 72.00	2286 x 1829	78.00 x 68.00	1981 x 1727	38.12	968
A90P72F1G	Full Panel	90.00 x 72.00	2286 x 1829	78.00 x 68.00	1981 x 1727	38.12	968
A90P72F2	Half Panel	90.00 x 72.00	2286 x 1829	39.88 x 68.00	1013 x 1727	38.12	968
A90P72F2G	Half Panel	90.00 x 72.00	2286 x 1829	39.88 x 68.00	1013 x 1727	38.12	968



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Panels for Enclosures

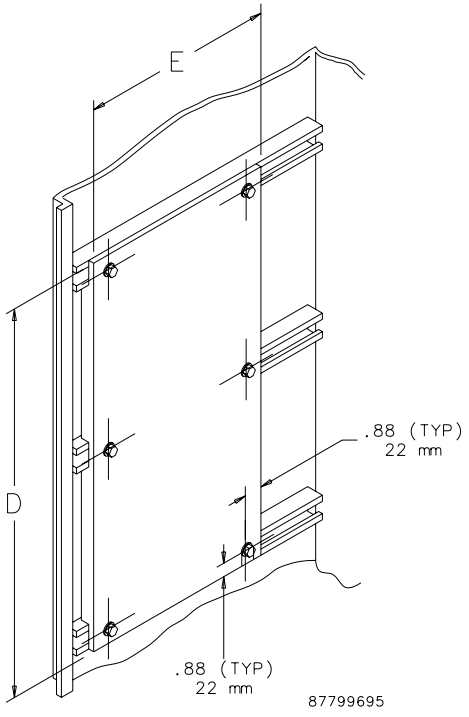
Side-Mounted Panels

Panels provide extra mounting space on the sides of enclosures. 12 gauge steel side-mounting panels are painted white. Conductive panels are steel with a conductive, corrosion-resistant coating. Panels attach securely to mounting channels. Plated steel mounting hardware is furnished.

Bulletin: PNL30

Catalog Number	Description	Panel Size D x E in./mm	Fits Enclosure A in./mm
A60SMP14	Painted steel	48.00 x 14.00 1219 x 356	60.00 1524
A60SMP14G	Conductive	48.00 x 14.00 1219 x 356	60.00 1524
A72SMP14	Painted steel	60.00 x 14.00 1524 x 356	72.00 1829
A72SMP14G	Conductive	60.00 x 14.00 1524 x 356	72.00 1829
A72SMP20	Painted steel	60.00 x 20.00 1524 x 508	72.00 1829
A72SMP20G	Conductive	60.00 x 20.00 1524 x 508	72.00 1829
A90SMP14	Painted steel	78.00 x 14.00 1981 x 356	90.00 2286
A90SMP14G	Conductive	78.00 x 14.00 1981 x 356	90.00 2286
A90SMP20	Painted steel	78.00 x 20.00 1981 x 508	90.00 2286
A90SMP20G	Conductive	78.00 x 20.00 1981 x 508	90.00 2286

A90SMP14 and A90SMP14G will not fit 18.06-in.deep two-door enclosures (FSD style) if regular panel is also installed.
A90SMP20 and A90SMP20G will not fit 20.12-in. deep enclosures. Will not fit 24.12-in. deep two-door enclosures (FSD style) if regular panel is also installed.

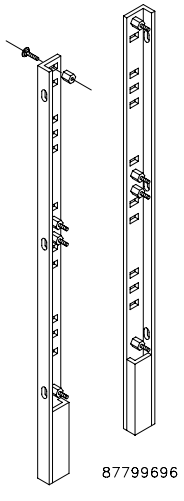


Heavy Duty Panel Supports

Heavy Duty Panel Supports, sold in pairs, are used in place of the panel supports furnished with panels when heavy equipment will be installed on the panels. They extend to the bottom of the enclosure. Adjustable mounting studs allow mounting of different height panels or a combination of panels. Use mounting hardware furnished with panels.

Bulletin: A80

Catalog Number	Fits Enclosure A in./mm	Support Length in./mm
A60FSHDPS	60.00 1524	57.25 1454
A72FSHDPS	72.00 1829	69.25 1759
A90FSHDPS	90.00 2286	87.25 2216



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Panels for Enclosures

Center Panel Supports

Center panel supports are used with Free-Stand Type 12 (Bulletin A30) two-door enclosures. They permit the installation of panels, swing-out panels and rack-mounting angles sized for one-door enclosures. The Center Panel Support can be positioned from front to back of the enclosure.

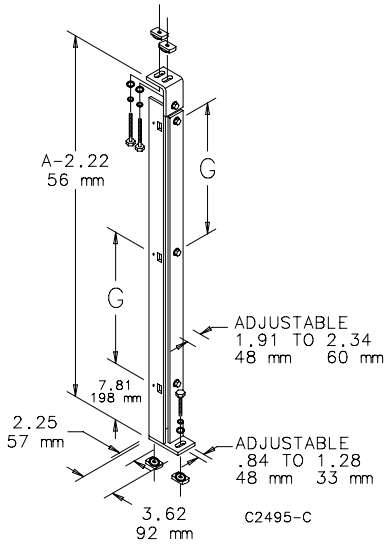
Bulletin: A80

Standard Product **Panel Supports**

Catalog Number	Fits Enclosure A (in.)	Fits Enclosure A (mm)	G (in.)	G (mm)
A60FSCPS	60.00	1524	23.12	587
A72FSCPS	72.00	1829	29.12	740
A90FSCPS	90.00	2286	38.12	968

Accessory Width with Center Panel Supports

Two Door Enclosure Width (in.)	Two Door Enclosure Width (mm)	Accessory Width (in.)	Accessory Width (mm)
48.00	1219	24.00	610
60.00	1524	30.00	762
72.00	1829	36.00	914



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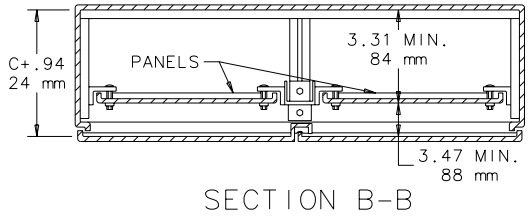
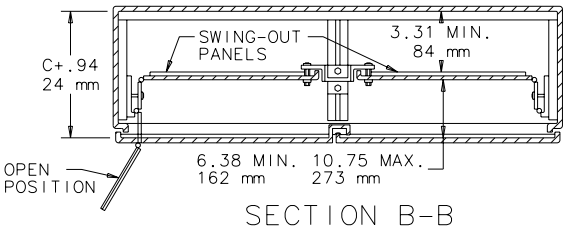
Panels for Enclosures

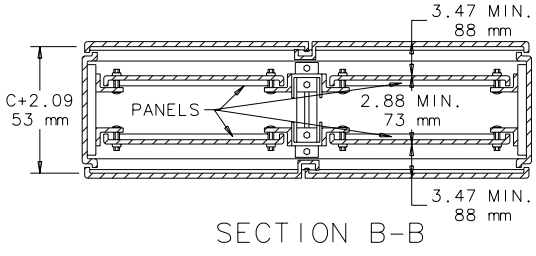
Center Panel Supports Enclosure Section Views



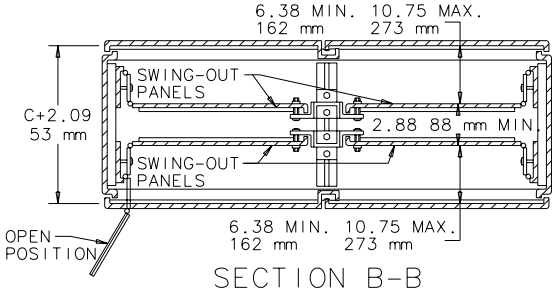
Showing two panels (for one-door enclosures)and center panel support mounted in two-door enclosure.



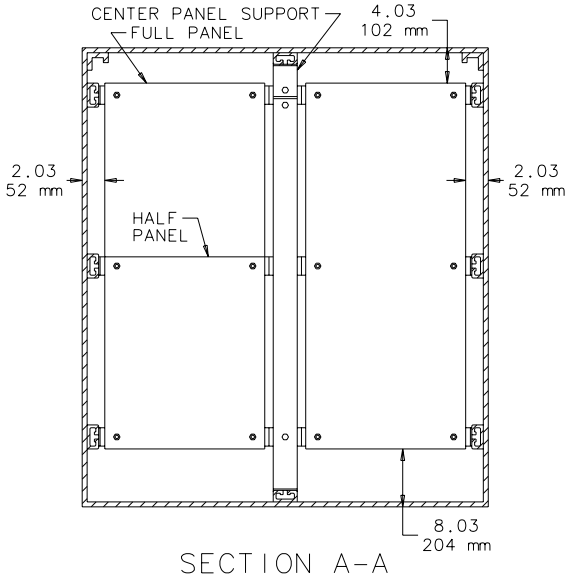
Showing four swing-out panels and center panel support mounted in two-door enclosure.



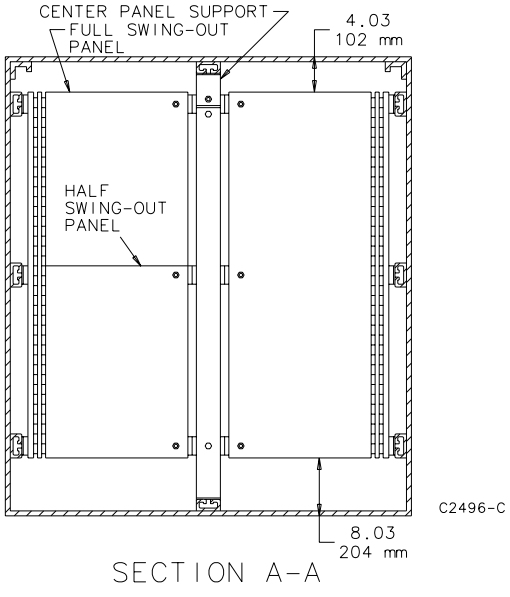
Showing four panels (for one-door enclosures) and two center panel supports mounted in two-door access enclosure.



Showing four swing-out panels and two center panel supports mounted in two-door dual access enclosure.



Panels shown are for one-door free-stand enclosures. Half panel fits in top or bottom half of enclosure.



Showing swing-out panels installed in one-door enclosure.

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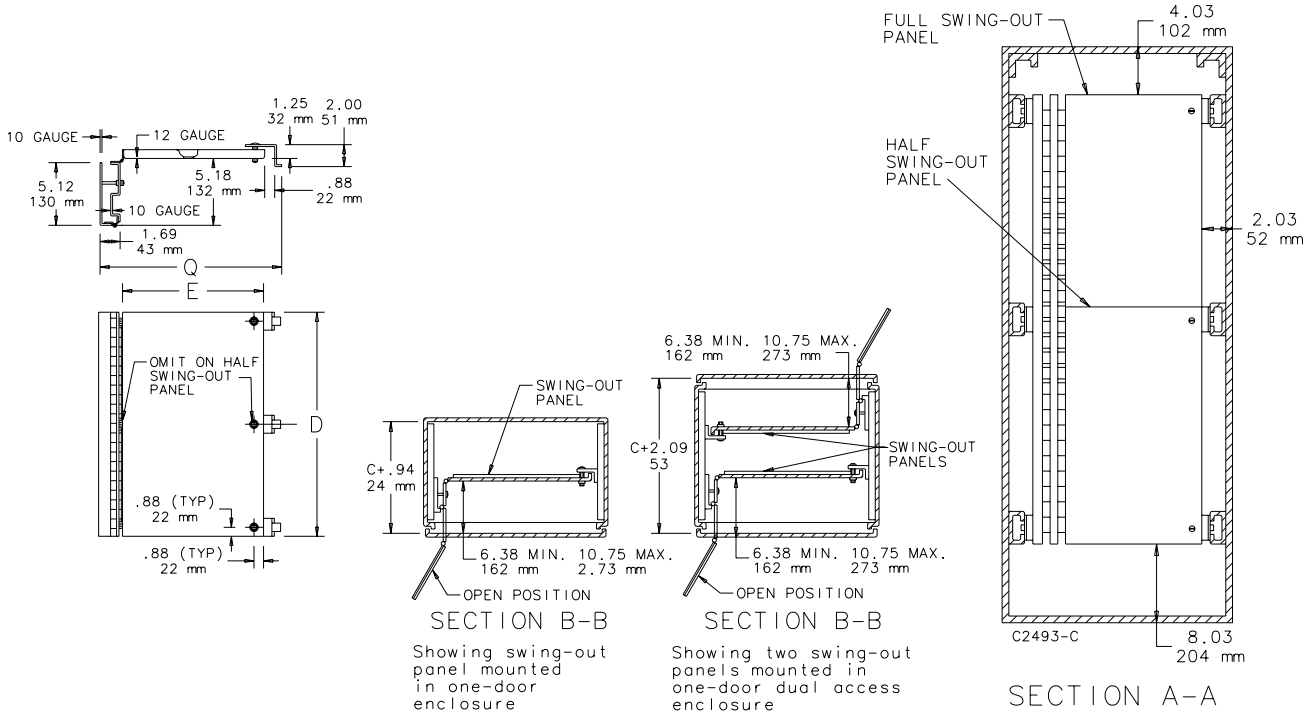
Panels for Enclosures

Swing-Out Panels for Free-Stand Type 4, 4X and 12 Enclosures with Mounting Channel

Panels for Free-Stand Type 12 Enclosures, Free-Stand Type 4 Enclosures and One-Door Type 4X Free-Stand Fiberglass Enclosures. Full-length and half-length swing-out panels are available. Half-length panels can be located in the upper or lower portion of the enclosures. Swing-out panels have a 10 gauge steel support frame and two heavy-gauge continuous hinges which permit the panel to swing completely out of the enclosure if it is located within approximately 10.75 in. (273 mm) of the door. These panels are 12 gauge steel and can be mounted on either side of the enclosure. Panels are finished with white polyester powder paint and furnished with plated mounting hardware.

Bulletin: PNL30

Catalog Number	Description	Panel Size D x E (in.)	Panel Size D x E (mm)	Fits Enclosure A x B (in.)	Fits Enclosure A x B (mm)	Q (in.)	Q (mm)
A72SP24F3	Full Panel	60.00 x 18.81	1524 x 478	72.00 x 24.00	1829 x 610	21.84	555
A72SP24F4	Half Panel	30.88 x 18.81	784 x 478	72.00 x 24.00	1829 x 610	21.84	555
A72SP30F3	Full Panel	60.00 x 24.81	1524 x 630	72.00 x 30.00	1829 x 762	27.84	707
A72SP30F4	Half Panel	30.88 x 24.81	784 x 630	72.00 x 30.00	1829 x 762	27.84	707
A72SP36F3	Full Panel	60.00 x 30.81	1524 x 783	72.00 x 36.00	1829 x 914	33.84	860
A72SP36F4	Half Panel	30.88 x 30.81	784 x 783	72.00 x 36.00	1829 x 914	33.84	860
A90SP36F3	Full Panel	78.00 x 30.81	1981 x 783	90.00 x 36.00	2286 x 914	33.84	860
A90SP36F4	Half Panel	39.88 x 30.81	1013 x 783	90.00 x 36.00	2286 x 914	33.84	860

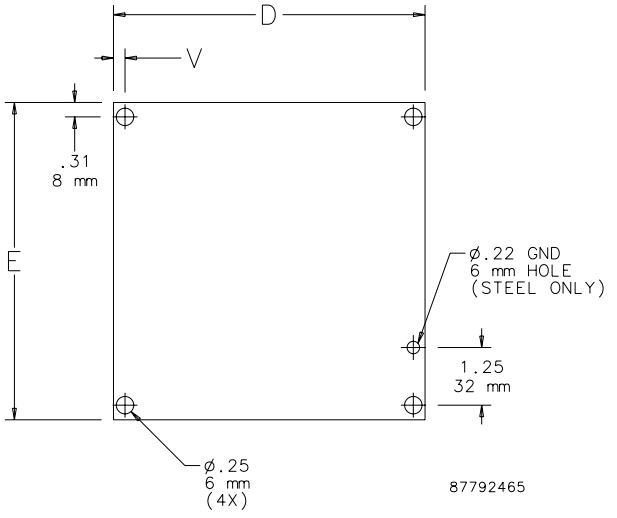


Panels for WiFi Cabinets and Small Wall-Mount Enclosures

Panels are available in both steel and wood. Steel panels are 14 gauge steel with a white polyester powder paint finish. Wood panels are 3/4-in. plywood and are unfinished. Wood panels are supplied with Fiberglass Hinged-Cover and POLYPRO® Type 4X WiFi Cabinets.

Bulletin: DWS12, PNLJ, PNLWM

Catalog Number	Material	Panel Size D x E (in.)	Panel Size D x E (mm)	V (in.)	V (mm)
A6P6	Steel	4.88 x 4.88	124 x 124	0.31	8
A6P6WD	Wood	4.88 x 4.88	124 x 124	0.31	8
A16P14	Steel	14.75 x 12.88	375 x 327	0.25	6
A16P14WD	Wood	14.75 x 12.88	375 x 327	0.25	6
A18P16	Steel	16.75 x 14.88	425 x 378	0.25	6
A18P16WD	Wood	16.75 x 14.88	425 x 378	0.25	6



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Main Circuit Breaker, Allen Bradley 140U-J2D3-D12

SELECTION GUIDE

LISTEN.
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SOLVE.SM

BULLETIN 140U
Molded Case Circuit Breakers

ALLEN-BRADLEY • ROCKWELL SOFTWARE
Rockwell Automation

Molded Case Circuit Breakers

Product Overview

Bulletin 140U Molded Case Circuit Breakers

- 15…1200 A Molded Case Circuit Breakers
  - – Thermal-Magnetic 15…800 A
  - – Electronic 70…1200 A
    - • LS — Long Time/Short Time
    - • LSI — Long Time/Short Time/High Instantaneous
    - • LSG — Long Time/Short Time/Ground Fault
    - • LSIG — Long Time/Short Time/High Instantaneous/Ground Fault
  - – Molded Case Switches 125…1200 A
- • Factory- or field-installed accessories
- • Flex cable operating mechanisms
- • Rotary variable-depth operating mechanisms
- • High interrupting ratings in compact dimensions
- • Globally rated and approved product line for worldwide application

Conformity to Standards

UL 489
CSA 22.2, No. 5
IEC 60947-2

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Product Selection — 400 A, K-Frame..... 21
Product Selection — 600 A, L-Frame..... 26
Product Selection — 800 A, M-Frame..... 31
Product Selection — 1200 A, N-Frame..... 36

Approvals

UL Listed
CSA Certified
CE
KEMA-KEUR

Frame Reference	**G-Frame**	**H-Frame**	**J-Frame**	**K-Frame**	**L-Frame**	**M-Frame**	**N-Frame**
Max. Current I_n	100 A	125 A	250 A	400 A	600 A	800 A	1200 A
Current Range	15…100 A	15…125 A	70…250 A	100…400 A	300…600 A	300…800 A	600…1200 A
Thermal Magnetic	✓	✓	✓	✓	✓	✓	—
Electronic:	—	—	✓	✓	✓	✓	✓
LS	—	—	✓	✓	✓	✓	✓
LSI	—	—	✓	✓	✓	✓	✓
LSG	—	—	✓	✓	✓	✓	✓
LSIG	—	—	✓	✓	✓	✓	✓
Interrupting Ratings:							
380…415V (I_{cu})	14 22	25 40 70	25 40 70	40 65 100	45 70	50 70	50 70 100
480V	14 22	25 35 65	25 35 65	35 65 100	35 65	50 65	50 65 100
600V	14 22	18 22 25	18 18 25	25 35 50	25 35	25 35	25 35 50
690V (I_{cu})	14 22	3 4 6	6 6 7	10 13 18	20 25	20 25	20 25 30
Molded Case Switches	✓	✓	✓	✓	✓	✓	✓
Flex Cable Operators	✓	✓	✓	✓	✓	✓	✓
Rotary Operators	✓	✓	✓	✓	✓	✓	✓
Internal Control Modules (Field installed)	✓	✓	✓	✓	✓	✓	✓
Standards Compliance	✓	✓	✓	✓	✓	✓	✓
UL 489	✓	✓	✓	✓	✓	✓	✓
UL File E197878, Guide No. DIV Q	✓	✓	✓	✓	✓	✓	✓
CSA 22.2, No. 5	✓	✓	✓	✓	✓	✓	✓
CSA File Nos. 216034, 216035, 219884 Class No. 1432-01	✓	✓	✓	✓	✓	✓	✓
IEC 60947-2	✓	✓	✓	—	✓	✓	✓
CE	✓	✓	✓	—	✓	✓	✓
KEMA-KEUR	✓	✓	✓	✓	✓	✓	✓

Examples given in this section are for reference purposes. This basic explanation should not be used for product selection; not all combinations will produce a valid cat. no. Refer to the tables on the following pages for descriptions of options.

Complete Circuit Breaker Assemblies

140U –	H	6	C	3	– C50 –	H	
a	*b*	*c*	*d*	*e*	*f*	*g*	*h*

a

Bulletin No.	
Code	Description
140U	Molded Case Circuit Breaker

b

Frame/Rating	
Code	Description
H	125 A
J	250 A
K	400 A
L	600 A
M	800 A
N	1200 A

c

Interrupting Rating/Breaking Capacity (based on I_c at 480V)	
Code	Description
2	20…29 kA
3	30…39 kA
5	50…59 kA
6	60…69 kA
8	80…89 kA
0	≥100 kA

d

Protection Type	
Code	Description
C	Fixed Thermal/Fixed Magnetic
D	Fixed Thermal/Adjust Magnetic
E	Adjust Thermal/Fixed Magnetic
F	Adjust Thermal/Adjust Magnetic
G	Electronic (LSG — Long, short, ground fault)
H	Electronic (LSI — Long, short, high instant)
I	Electronic (LSIG — Long, short, high instant, ground fault)
L	Electronic (LS — Long and Short time)
S	Molded Case Switch (Isolator)

e

Poles	
Code	Description
1	1 poles
2	2 poles
3	3 poles

f

Current Range	
Code	Description
C	10 rr. A
D	100 rr0 A
E	1000 rr00 A

g

Internal Control Modules	
Code	Description
A	1 Auxiliary contact
B	2 Auxiliary contacts
D	1 Alarm contact
F	1 Auxiliary + 1 Alarm contact
G	Undervoltage release only
P	Shunt trip only
Control Module Combinations	
Code	Description
H	1 Auxiliary contact + undervoltage release
J	2 Auxiliary contacts + undervoltage release
L	1 Auxiliary + 1 Alarm contact + undervoltage release
N	1 Alarm contact + undervoltage release
Q	1 Auxiliary contact + shunt trip
R	2 Auxiliary contacts + shunt trip
T	1 Auxiliary + 1 Alarm contact + shunt trip
V	1 Alarm contact + shunt trip

h

Voltage Code	
See the following pages for voltage code descriptions:	
All frame sizes	Page 41

Molded Case Circuit Breakers

Catalog Number Explanation

Examples given in this section are for reference purposes. This basic explanation should not be used for product selection; not all combinations will produce a valid cat. no. Refer to the tables on the following pages for descriptions of options.

Frames

140U – J 3 X 3
a b c d e

a

Bulletin No.	
Code	Description
140U	Molded Case Circuit Breaker

b

Frame/Rating	
Code	Description
J	250 A
K	400 A
Q	600 A
M	800 A

c

Interrupting Rating/Breaking Capacity (based on I_c at 480V)	
Code	Description
2	20…29 kA
3	30…39 kA
5	50…59 kA
6	60…69 kA
8	80…89 kA
0	≥100 kA

d

Protection Type	
Code	Description
X	Frame Only

e

Poles	
Code	Description
3	3 poles

Trip Units

140U – J T D 3 – D25
a b c d e f

a

Bulletin No.	
Code	Description
140U	Molded Case Circuit Breaker

b

Frame/Rating	
Code	Description
J	250 A
K	400 A
L	600 A
M	800 A

c

Trip Unit	
Code	Description
T	Trip Unit

d

Protection Type	
Code	Description
C	Fixed Thermal/Fixed Magnetic
D	Fixed Thermal/Adjust Magnetic
E	Adjust Thermal/Fixed Magnetic
F	Adjust Thermal/Adjust Magnetic
G	Electronic (LSG — Long, short, ground fault)
H	Electronic (LSI — Long, short, high instant)
I	Electronic (LSIG — Long, short, high instant, ground fault)
L	Electronic (LS — Long and Short time)
S	Molded Case Switch (isolator)

e

Poles	
Code	Description
3	3 poles

f

Current Range	
Code	Description
C	10 rr. A
D	100 rr0 A
E	1000 rr00 A

Product Selection — 100 A, G-Frame

- UL 489
- CSA 22.2, No. 5

Note: Terminal box lugs provided as standard

Note: Accessories cannot be field installed to the G-Frame circuit breakers. Circuit breakers with 1 auxiliary contact are also available.

14 kA, Thermal-Magnetic, Fixed Thermal-Fixed Magnetic

Rated Current I_n [A]	Thermal Trip [A] $I_r = I_n$ (Fixed)	Magnetic Trip [A] $I_m = 10 \times I_n$	Interrupt Rating (50/60 Hz) I_{cu} /I_{cs} [kA]			Interrupt Rating [kA] ∗	2 Poles	2 Poles w/ 1 aux. contact
			208V AC	240V AC	480V AC	125/250 V DC ∗	Cat. No.	Cat. No.
15	15	150	65	65	14	10	140U-G1C2-C15	140U-G1C2-C15-A
20	20	200	65	65	14	10	140U-G1C2-C20	140U-G1C2-C20-A
25	25	250	65	65	14	10	140U-G1C2-C25	140U-G1C2-C25-A
30	30	300	65	65	14	10	140U-G1C2-C30	140U-G1C2-C30-A
35	35	350	65	65	14	10	140U-G1C2-C35	140U-G1C2-C35-A
40	40	400	65	65	14	10	140U-G1C2-C40	140U-G1C2-C40-A
45	45	450	65	65	14	10	140U-G1C2-C45	140U-G1C2-C45-A
50	50	500	65	65	14	10	140U-G1C2-C50	140U-G1C2-C50-A

∗ Time constant is 8 ms min.

22 kA, Thermal-Magnetic, Fixed Thermal-Fixed Magnetic

Rated Current I_n [A]	Thermal Trip [A] $I_r = I_n$ (Fixed)	Magnetic Trip [A] $I_m = 10 \times I_n$	Interrupt Rating (50/60 Hz) I_{cu} /I_{cs} [kA]			Interrupt Rating [kA] ∗	3 Poles	3 Poles w/ 1 aux. contact
			208V AC	240V AC	480V AC	125/250 V DC ∗	Cat. No.	Cat. No.
15	15	150	65	65	22	10	140U-G2C3-C15	140U-G2C3-C15-A
20	20	200	65	65	22	10	140U-G2C3-C20	140U-G2C3-C20-A
25	25	250	65	65	22	10	140U-G2C3-C25	140U-G2C3-C25-A
30	30	300	65	65	22	10	140U-G2C3-C30	140U-G2C3-C30-A
35	35	350	65	65	22	10	140U-G2C3-C35	140U-G2C3-C35-A
40	40	400	65	65	22	10	140U-G2C3-C40	140U-G2C3-C40-A
45	45	450	65	65	22	10	140U-G2C3-C45	140U-G2C3-C45-A
50	50	500	65	65	22	10	140U-G2C3-C50	140U-G2C3-C50-A
60	60	600	65	65	22	10	140U-G2C3-C60	140U-G2C3-C60-A
70	70	700	65	65	22	10	140U-G2C3-C70	140U-G2C3-C70-A
80	80	800	65	65	22	10	140U-G2C3-C80	140U-G2C3-C80-A
90	90	900	65	65	22	10	140U-G2C3-C90	140U-G2C3-C90-A
100	100	1000	65	65	22	10	140U-G2C3-D10	140U-G2C3-D10-A

∗ Time constant is 8 ms min. and 2 poles of a 3-pole circuit breaker.

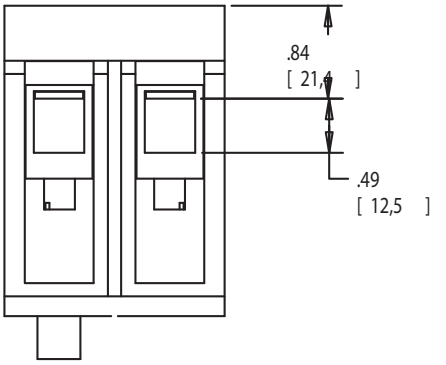
External Accessories

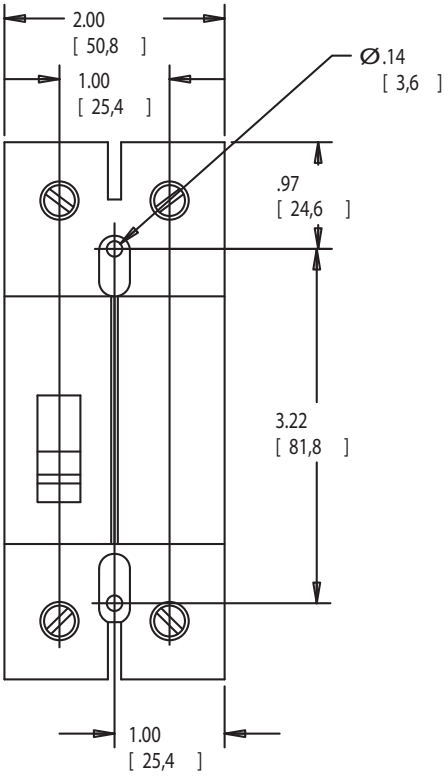
	Description		Cat. No.
	Rotary, Variable-Depth Operating Mechanism UL Type 3/12/4/4X, IP 66 Rotary Handle 12 in. (30.48 cm) operating rod	Black Handle	140U-G-RVM12B
		Red/Yellow Handle	140U-G-RVM12R
	DIN Rail Adapter Allows 2-pole G-frame MCCB to mount to 35 mm DIN Rail	Qty: 1	140U-G-DRA2
	DIN Rail Adapter Allows 3-pole G-frame MCCB to mount to 35 mm DIN Rail	Qty: 1	140U-G-DRA3
	Padlock Kit Padlocking Hasp Lock-OFF only	Qty: 1	140U-G-PL

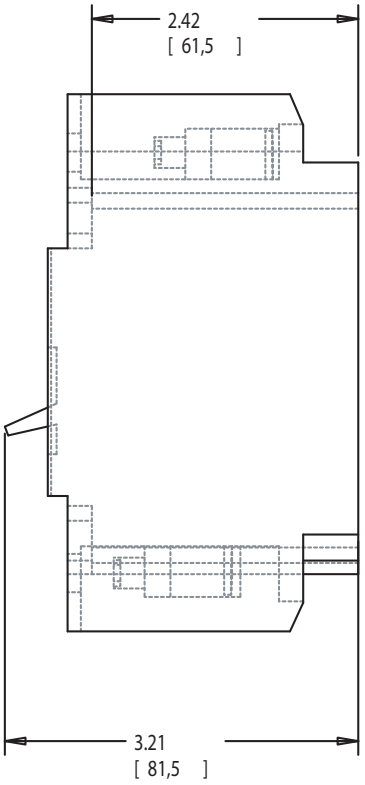
Dimensions are in inches (millimeters). Dimensions are not intended to be used for manufacturing purposes.

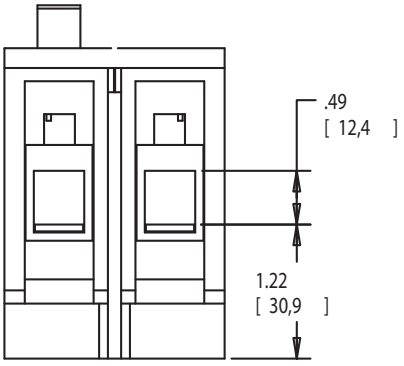
2-Pole Dimensions

15-100 AMP, PRESSURE COLLAR TERMINALS



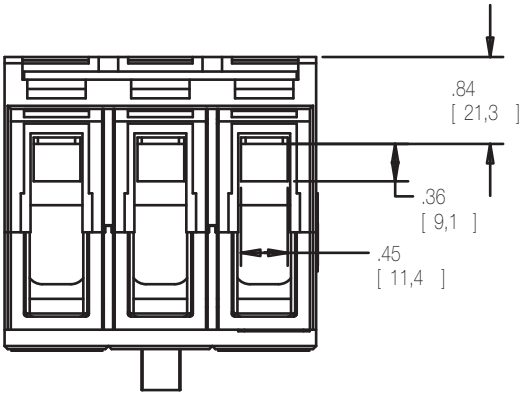


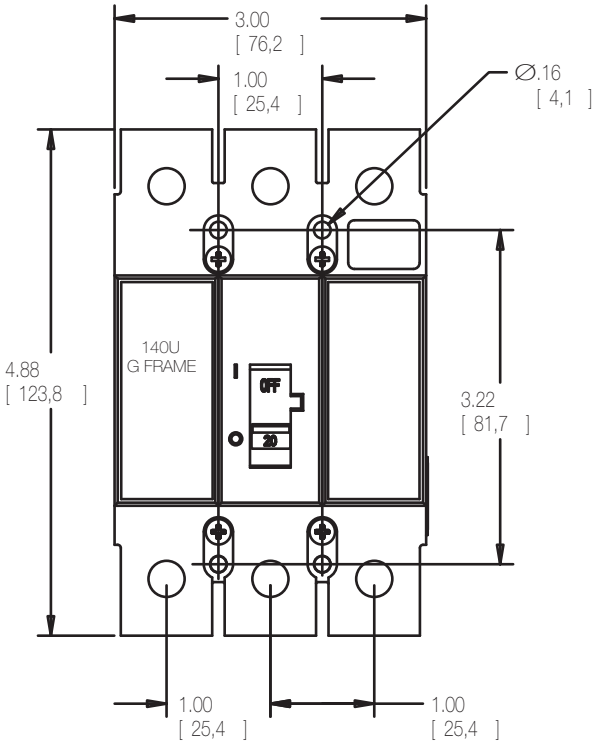


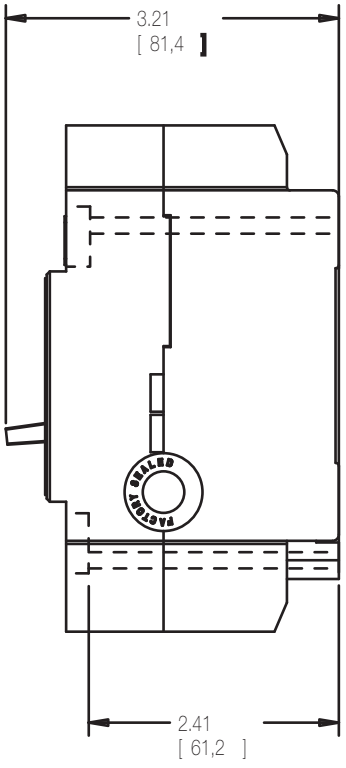


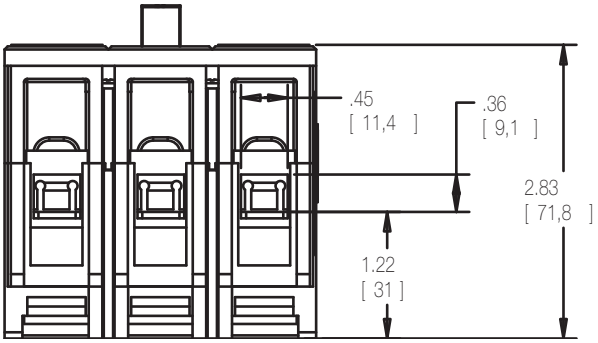
Approximate Dimensions — 100 A, G-Frame, Continued

3-Pole Dimensions









125 A, H-Frame

- UL 489
- CSA 22.2, No. 5
- IEC 60947-2
- CE
- KEMA-KEUR

Note: Terminal box lugs provided as standard

1-Pole 25/18 kA, Thermal-Magnetic, Fixed Thermal-Fixed Magnetic

Rated Current I_n [A]	Magnetic Trip [A] I_m = 10 x I_n	Breaking Capacity (50 Hz) I_{cu} /I_{cs} [kA]		Interrupting Rating (60 Hz) [kA]		Cat. No.
		220…240V		240V	277V	
15	500	25	25	25	18 kA	140U-H1C1-C15
20	500	25	25	25	18 kA	140U-H1C1-C20
25	500	25	25	25	18 kA	140U-H1C1-C25
30	500	25	25	25	18 kA	140U-H1C1-C30
35	500	25	25	25	18 kA	140U-H1C1-C35
40	500	25	25	25	18 kA	140U-H1C1-C40
45	500	25	25	25	18 kA	140U-H1C1-C45
50	500	25	25	25	18 kA	140U-H1C1-C50
60	600	25	25	25	18 kA	140U-H1C1-C60
70	700	25	25	25	18 kA	140U-H1C1-C70
80	800	25	25	25	18 kA	140U-H1C1-C80
90	900	25	25	25	18 kA	140U-H1C1-C90
100	1000	25	25	25	18 kA	140U-H1C1-D10
110	1100	25	25	25	18 kA	140U-H1C1-D11
125	1250	25	25	25	18 kA	140U-H1C1-D12

2-Pole 25/25 kA, Thermal-Magnetic, Fixed Thermal-Fixed Magnetic

Rated Current I_n [A]	Magnetic Trip [A] I_m = 10 x I_n	Breaking Capacity (50 Hz) I_{cu} /I_{cs} [kA]								Interrupting Rating (60 Hz) [kA]			Cat. No.
		220…240V		380…415V		500V		690V		240V	480V	600/347V	
15	500	35	35	25	25	—	—	—	—	35	25	18	140U-H2C2-C15
20	500	35	35	25	25	—	—	—	—	35	25	18	140U-H2C2-C20
25	500	35	35	25	25	—	—	—	—	35	25	18	140U-H2C2-C25
30	500	35	35	25	25	—	—	—	—	35	25	18	140U-H2C2-C30
35	500	35	35	25	25	—	—	—	—	35	25	18	140U-H2C2-C35
40	500	35	35	25	25	—	—	—	—	35	25	18	140U-H2C2-C40
45	500	35	35	25	25	—	—	—	—	35	25	18	140U-H2C2-C45
50	500	35	35	25	25	—	—	—	—	35	25	18	140U-H2C2-C50
60	600	35	35	25	25	—	—	—	—	35	25	18	140U-H2C2-C60
70	700	35	35	25	25	—	—	—	—	35	25	18	140U-H2C2-C70
80	800	35	35	25	25	—	—	—	—	35	25	18	140U-H2C2-C80
90	900	35	35	25	25	—	—	—	—	35	25	18	140U-H2C2-C90
100	1000	35	35	25	25	—	—	—	—	35	25	18	140U-H2C2-D10
110	1100	35	35	25	25	—	—	—	—	35	25	18	140U-H2C2-D11
125	1250	35	35	25	25	—	—	—	—	35	25	18	140U-H2C2-D12

Product Selection — 125 A, H-Frame, Continued

2-Pole 40/35 kA, Thermal-Magnetic, Fixed Thermal-Fixed Magnetic

Rated Current I_n [A]	Thermal Trip [A] $I_r = I_n$ (Fixed)	Magnetic Trip [A] $I_m = 10 \times I_n$	Breaking Capacity (50 Hz) I_{cu} / I_{cs} [kA]								Interrupting Rating (60 Hz) [kA]			Cat. No.
			220…240V		380…415V		500V		690V		240V	480V	600/347V	
15	Fixed	500	85	43	40	30	—	—	—	—	85	35	22	140U-H3C2-C15
20	Fixed	500	85	43	40	30	—	—	—	—	85	35	22	140U-H3C2-C20
25	Fixed	500	85	43	40	30	—	—	—	—	85	35	22	140U-H3C2-C25
30	Fixed	500	85	43	40	30	—	—	—	—	85	35	22	140U-H3C2-C30
35	Fixed	500	85	43	40	30	—	—	—	—	85	35	22	140U-H3C2-C35
40	Fixed	500	85	43	40	30	—	—	—	—	85	35	22	140U-H3C2-C40
45	Fixed	500	85	43	40	30	—	—	—	—	85	35	22	140U-H3C2-C45
50	Fixed	500	85	43	40	30	—	—	—	—	85	35	22	140U-H3C2-C50
60	Fixed	600	85	43	40	30	—	—	—	—	85	35	22	140U-H3C2-C60
70	Fixed	700	85	43	40	30	—	—	—	—	85	35	22	140U-H3C2-C70
80	Fixed	800	85	43	40	30	—	—	—	—	85	35	22	140U-H3C2-C80
90	Fixed	900	85	43	40	30	—	—	—	—	85	35	22	140U-H3C2-C90
100	Fixed	1000	85	43	40	30	—	—	—	—	85	35	22	140U-H3C2-D10
110	Fixed	1100	85	43	40	30	—	—	—	—	85	35	22	140U-H3C2-D11
125	Fixed	1250	85	43	40	30	—	—	—	—	85	35	22	140U-H3C2-D12

2-Pole 70/65 kA, Thermal-Magnetic, Fixed Thermal-Fixed Magnetic

Rated Current I_n [A]	Thermal Trip [A] $I_r = I_n$ (Fixed)	Magnetic Trip [A] $I_m = 10 \times I_n$	Breaking Capacity (50 Hz) I_{cu} / I_{cs} [kA]								Interrupting Rating (60 Hz) [kA]			Cat. No.
			220…240V		380…415V		500V		690V		240V	480V	600/347V	
15	Fixed	500	100	50	70	35	—	—	—	—	100	65	25	140U-H6C2-C15
20	Fixed	500	100	50	70	35	—	—	—	—	100	65	25	140U-H6C2-C20
25	Fixed	500	100	50	70	35	—	—	—	—	100	65	25	140U-H6C2-C25
30	Fixed	500	100	50	70	35	—	—	—	—	100	65	25	140U-H6C2-C30
35	Fixed	500	100	50	70	35	—	—	—	—	100	65	25	140U-H6C2-C35
40	Fixed	500	100	50	70	35	—	—	—	—	100	65	25	140U-H6C2-C40
45	Fixed	500	100	50	70	35	—	—	—	—	100	65	25	140U-H6C2-C45
50	Fixed	500	100	50	70	35	—	—	—	—	100	65	25	140U-H6C2-C50
60	Fixed	600	100	50	70	35	—	—	—	—	100	65	25	140U-H6C2-C60
70	Fixed	700	100	50	70	35	—	—	—	—	100	65	25	140U-H6C2-C70
80	Fixed	800	100	50	70	35	—	—	—	—	100	65	25	140U-H6C2-C80
90	Fixed	900	100	50	70	35	—	—	—	—	100	65	25	140U-H6C2-C90
100	Fixed	1000	100	50	70	35	—	—	—	—	100	65	25	140U-H6C2-D10
110	Fixed	1100	100	50	70	35	—	—	—	—	100	65	25	140U-H6C2-D11
125	Fixed	1250	100	50	70	35	—	—	—	—	100	65	25	140U-H6C2-D12

3-Pole 25/25 kA, Thermal-Magnetic, Fixed Thermal-Fixed Magnetic

Rated Current I_n [A]	Thermal Trip [A] $I_r = I_n$ (Fixed)	Magnetic Trip [A] $I_m = 10 \times I_n$	Breaking Capacity (50 Hz) I_{cu} / I_{cs} [kA]								Interrupting Rating (60 Hz) [kA]			Cat. No.
			220…240V		380…415V		500V		690V		240V	480V	600/347V	
15	15	500	35	35	25	25	22	17	3	3	35	25	18	140U-H2C3-C15
20	20	500	35	35	25	25	22	17	3	3	35	25	18	140U-H2C3-C20
25	25	500	35	35	25	25	22	17	3	3	35	25	18	140U-H2C3-C25
30	30	500	35	35	25	25	22	17	3	3	35	25	18	140U-H2C3-C30
35	35	500	35	35	25	25	22	17	3	3	35	25	18	140U-H2C3-C35
40	40	500	35	35	25	25	22	17	3	3	35	25	18	140U-H2C3-C40
45	40	500	35	35	25	25	22	17	3	3	35	25	18	140U-H2C3-C45
50	50	500	35	35	25	25	22	17	3	3	35	25	18	140U-H2C3-C50
60	60	600	35	35	25	25	22	17	3	3	35	25	18	140U-H2C3-C60
70	70	700	35	35	25	25	22	17	3	3	35	25	18	140U-H2C3-C70
80	80	800	35	35	25	25	22	17	3	3	35	25	18	140U-H2C3-C80
90	90	900	35	35	25	25	22	17	3	3	35	25	18	140U-H2C3-C90
100	100	1000	35	35	25	25	22	17	3	3	35	25	18	140U-H2C3-D10
110	110	1100	35	35	25	25	—	—	—	—	35	25	18	140U-H2C3-D11
125	125	1250	35	35	25	25	—	—	—	—	35	25	18	140U-H2C3-D12

3-Pole 40/35 kA, Thermal-Magnetic, Fixed Thermal-Fixed Magnetic

Rated Current I_n [A]	Thermal Trip [A] $I_r = I_n$ (Fixed)	Magnetic Trip [A] $I_m = 10 \times I_n$	Breaking Capacity (50 Hz) I_{cu} / I_{cs} [kA]								Interrupting Rating (60 Hz) [kA]			Cat. No.
			220…240V		380…415V		500V		690V		240V	480V	600/347V	
15	15	500	85	43	40	30	25	18	4	3	85	35	22	140U-H3C3-C15
20	20	500	85	43	40	30	25	18	4	3	85	35	22	140U-H3C3-C20
25	25	500	85	43	40	30	25	18	4	3	85	35	22	140U-H3C3-C25
30	30	500	85	43	40	30	25	18	4	3	85	35	22	140U-H3C3-C30
35	35	500	85	43	40	30	25	18	4	3	85	35	22	140U-H3C3-C35
40	40	500	85	43	40	30	25	18	4	3	85	35	22	140U-H3C3-C40
45	45	500	85	43	40	30	25	18	4	3	85	35	22	140U-H3C3-C45
50	50	500	85	43	40	30	25	18	4	3	85	35	22	140U-H3C3-C50
60	60	600	85	43	40	30	25	18	4	3	85	35	22	140U-H3C3-C60
70	70	700	85	43	40	30	25	18	4	3	85	35	22	140U-H3C3-C70
80	80	800	85	43	40	30	25	18	4	3	85	35	22	140U-H3C3-C80
90	90	900	85	43	40	30	25	18	4	3	85	35	22	140U-H3C3-C90
100	100	1000	85	43	40	30	25	18	4	3	85	35	22	140U-H3C3-D10
110	110	1100	85	43	40	30	25	18	4	3	85	35	22	140U-H3C3-D11
125	125	1250	85	43	40	30	25	18	4	3	85	35	22	140U-H3C3-D12

3-Pole 70/65 kA, Thermal-Magnetic, Fixed Thermal-Fixed Magnetic

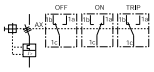
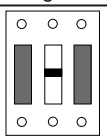
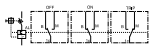
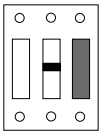
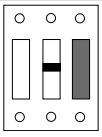
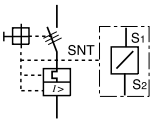
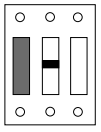
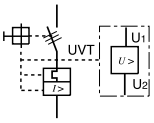
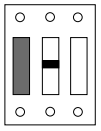
Rated Current I_n [A]	Thermal Trip [A] $I_r = I_n$ (Fixed)	Magnetic Trip [A] $I_m = 10 \times I_n$	Breaking Capacity (50 Hz) I_{cu} / I_{cs} [kA]								Interrupting Rating (60 Hz) [kA]			Cat. No.
			220…240V		380…415V		500V		690V		240V	480V	600/347V	
15	15	500	100	50	70	35	35	18	6	3	100	65	25	140U-H6C3-C15
20	20	500	100	50	70	35	35	18	6	3	100	65	25	140U-H6C3-C20
25	25	500	100	50	70	35	35	18	6	3	100	65	25	140U-H6C3-C25
30	30	500	100	50	70	35	35	18	6	3	100	65	25	140U-H6C3-C30
35	35	500	100	50	70	35	35	18	6	3	100	65	25	140U-H6C3-C35
40	40	500	100	50	70	35	35	18	6	3	100	65	25	140U-H6C3-C40
45	45	500	100	50	70	35	35	18	6	3	100	65	25	140U-H6C3-C45
50	50	500	100	50	70	35	35	18	6	3	100	65	25	140U-H6C3-C50
60	60	600	100	50	70	35	35	18	6	3	100	65	25	140U-H6C3-C60
70	70	700	100	50	70	35	35	18	6	3	100	65	25	140U-H6C3-C70
80	80	800	100	50	70	35	35	18	6	3	100	65	25	140U-H6C3-C80
90	90	900	100	50	70	35	35	18	6	3	100	65	25	140U-H6C3-C90
100	100	1000	100	50	70	35	35	18	6	3	100	65	25	140U-H6C3-D10
110	110	1100	100	50	70	35	35	18	6	3	100	65	25	140U-H6C3-D11
125	125	1250	100	50	70	35	35	18	6	3	100	65	25	140U-H6C3-D12

Molded Case Switch — UL 1087

Rated Current I_n [A]	Thermal Trip [A] $I_r = I_n$ (Fixed)	Magnetic Trip [A] $I_m = 10 \times I_n$	Breaking Capacity (50 Hz) I_{cu} / I_{cs} [kA]								Interrupting Rating (60 Hz) [kA]			Cat. No.
			220…240V		380…415V		500V		690V		240V	480V	600/347V	
125	—	1250	100	50	70	35	35	18	6	3	100	65	25	140U-H6S3-D12

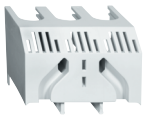
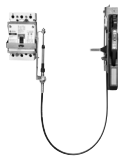
Accessories — 125 A, H-Frame

Internal Control Modules — Field Installed

	Description		Diagram	Mounting Location	Cat. No.
	Auxiliary Contact (AX) Electrically indicates "ON/OFF" status of breakers	(1) 1a-1b			140U-H-EA1
		(2) 1a-1b		*Left AND Right side*	140U-H-EA2
	Alarm Contact (AL) Electrically indicates when the breaker is in the "TRIPPED" state	(1) 1M (make)-1B (break)			140U-H-ER1
				Right side ONLY	
	Auxiliary/Alarm Contact (AX/AL) Combination Combination of auxiliary contact and alarm contact	(1) 1a-1b (1) 1M (make)-1B (break)			140U-H-EA1R1
				Right side ONLY	
	Shunt Trip (SNT) Provides remote tripping of the circuit breaker Undervoltage trip not available when shunt trip is used	24…60V, 50/60/DC			140U-H-SNJ
		110…240V, 50/60/DC			140U-H-SND
		380…440V AC, 220…250V DC			140U-H-SNN
		380…600V, 50/60 Hz		*Left side ONLY*	140U-H-SNB
	Undervoltage Release (UVT) Automatically trips breaker when voltage falls between preset value, 35…70% Shunt trip is not available when undervoltage release is used	24V, 50/60 Hz			140U-H-UJ
		110…127V, 50/60 Hz			140U-H-UD
		208…240V, 50/60 Hz			140U-H-UA
		380…500V, 50/60 Hz			140U-H-UB
		525…600V, 50/60 Hz		*Left side ONLY*	140U-H-UC

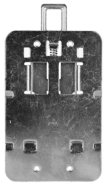
Note: For Factory-Installed internal control modules, please see page 41

External Accessories

	Description		Cat. No.
	Terminal End Cover 6.4 mm (0.25 in.) Diameter Cable Entry		140U-H-TC2
	Terminal End Cover 10.4 mm (0.41 in.) Diameter Cable Entry		140U-H-TC4
	**Terminal Shields** IP20 Ingress Protection Rating		140U-H-TS
	**Flex-Cable Operating Mechanism** Includes handle, cable, operating, and bail mechanism Pre-assembled and adjusted Non-Metallic - UL IP66, Type 1/3/12/4/4X Flange Mount Operating Handle	3 ft (0.9 m) Cable	140U-H-FCX03
		4 ft (1.3 m) Cable	140U-H-FCX04
		6 ft (1.9 m) Cable	140U-H-FCX06
		10 ft (3.0 m) Cable	140U-H-FCX10
	Flex-Cable Operating Mechanism Includes handle, cable, operating, and bail mechanism Pre-assembled and adjusted Stainless Steel - Type 4/4X Flange Mount Operating Handle	3 ft (0.9 m) Cable	140U-H-FCS03
		4 ft (1.2 m) Cable	140U-H-FCS04
		6 ft (1.9 m) Cable	140U-H-FCS06
		10 ft (3.0 m) Cable	140U-H-FCS10
	Rotary, Variable-Depth Operating Mechanism UL Type 3/12/4/4X, IP 66 Rotary Handle 12 in. (30.48 cm) operating rod	Black Handle	140U-H-RVM12B
		Red/Yellow Handle	140U-H-RVM12R
	Rotary, Variable-Depth Operating Mechanism UL Type 3/12/4/4X, IP 66 Rotary Handle 21 in. (53.34 cm) operating rod	Black Handle	140U-H-RVM21B
		Red/Yellow Handle	140U-H-RVM21R
	Rotary, Variable-Depth Operating Mechanism with Internal NFPA 79 Operating Handle Type 3/4/4X/12 IP66 Rotary Handle 12 in. (30.48 cm) operating rod	Black Handle	140U-H-NVM12B
		Red/Yellow Handle	140U-H-NVM12R
	Rotary, Variable-Depth Operating Mechanism with Internal NFPA 79 Operating Handle Type 3/4/4X/12 IP66 Rotary Handle 21 in. (53.34 cm) operating rod	Black Handle	140U-H-NVM21B
		Red/Yellow Handle	140U-H-NVM21R
	Motor Operator Remotely opens, closes, and resets the circuit breaker 110…240V AC	For use with 3- or 4-Pole MCCBs, 110…240V AC/DC	140U-H-EOPD
	Motor Operator Remotely opens, closes, and resets the circuit breaker 24V DC	For use with 3- or 4-Pole MCCBs, 24V DC	140U-H-EOPZ
	Mounting Hardware (4) M4 - 0.7 x 75 mm	For use with 3- or 4-Pole MCCBs	140U-H-MHM

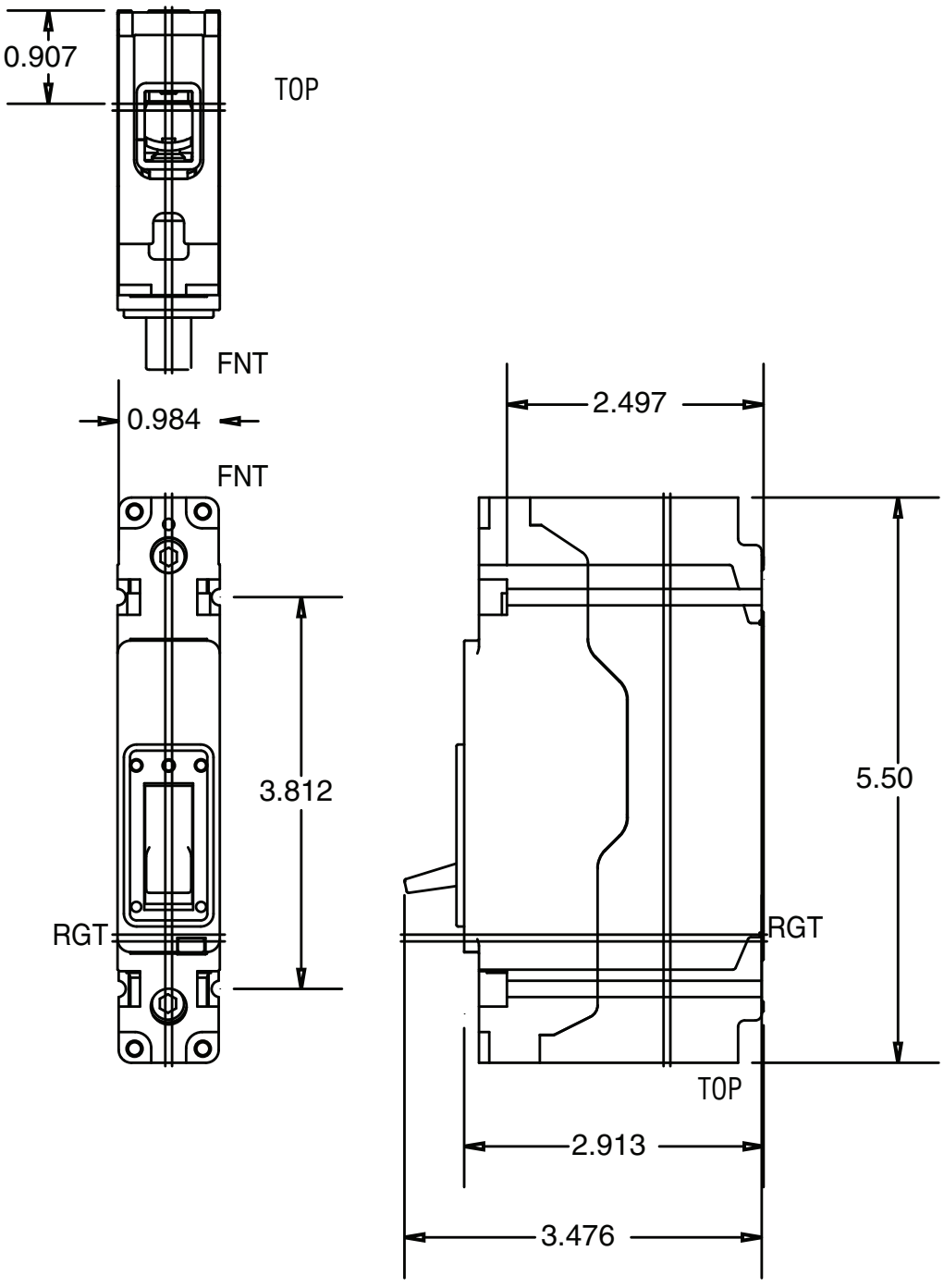
Accessories — 125 A, H-Frame, Continued

External Accessories, Continued

	Description			Cat. No.
	Rotary, Direct Couple Operating Mechanism Rotary Handle - IP42 UL Type 1 Breaker Mounted		Black Handle	140U-H-RCB
			Red/Yellow Handle	140U-H-RCR
	End Cap Kit Provides three-phase connections for terminal or bolt-on connections Metric Hardware Provided		Qty: 1	140U-H-ECM
	Phase Barriers Provides additional phase clearance when special connections that extend past the circuit breaker housing are required		Qty: 2	140U-H-PB
	Padlock Kit Padlocking Hasp Lock-OFF only		Qty: 1	140U-H-PL
	Plug-in Base Adapters Plug-in provides power terminations and adapter for applications where the ability to quickly remove or replace the circuit breakers is required	For use with 3-Pole MCCBs	Qty: 1	140U-H-PAD3
	Plug-in Base Auxiliary Contacts Provides auxiliary contact functions to detect breaker installation status	For use with 3- or 4-Pole MCCBs	Qty: 1	140U-H-PDK
	**DIN Rail Adapter** Allows H-frame MCCB to mount to 35 mm DIN Rail	For use with 3-Pole H-Frame MCCBs	Qty: 1	140U-H-DRA
 Cat. No. 140U-H-MTL3AN	**Multi-Tap Terminal Lug Kit —** with IP20 terminal cover	(3) #14…#2 AWG or (3) 2.5…35 mm²	Qty: 3 with terminal shield	140U-H-MTL3A
			Qty: 3	140U-H-MTL3AN
	Multi-Tap Terminal Lug Kit — with IP20 terminal cover	(6) #14…#6 AWG or (6) 2.5…10 mm²	Qty: 3 with terminal shield	140U-H-MTL6A
		(6) #14…#6 AWG or (6) 2.5…10 mm²	Qty: 3	140U-H-MTL6AN

Dimensions are in inches (millimeters). Dimensions are not intended to be used for manufacturing purposes.

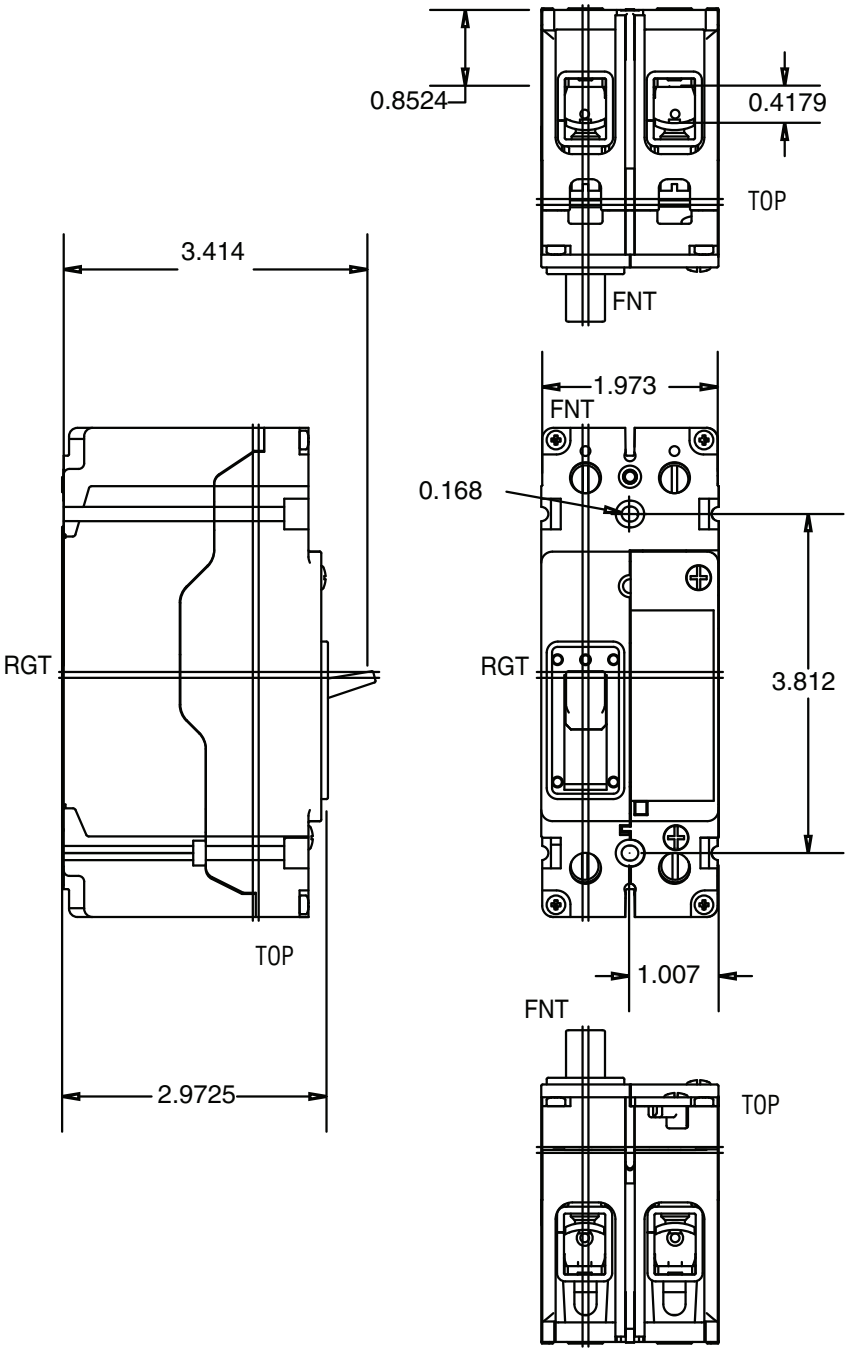
1-Pole Molded Case Circuit Breakers



Approximate Dimensions — 125 A, H-Frame, Continued

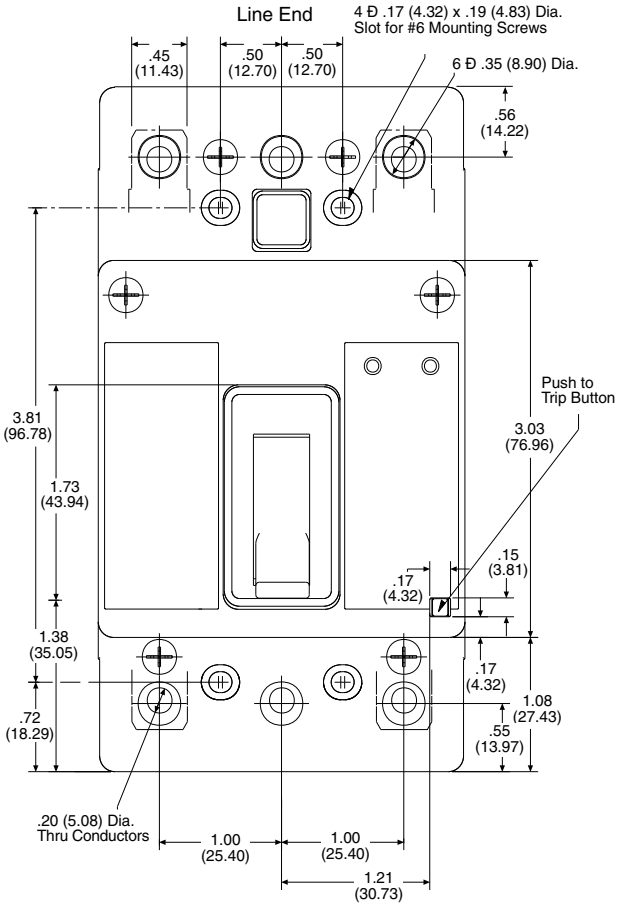
Dimensions are in inches. Dimensions are not intended to be used for manufacturing purposes.

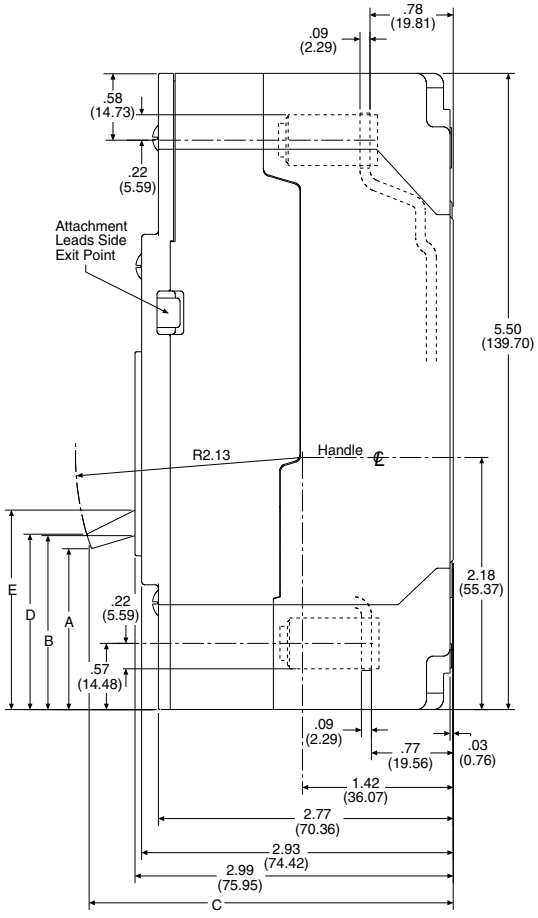
2-Pole Molded Case Circuit Breakers

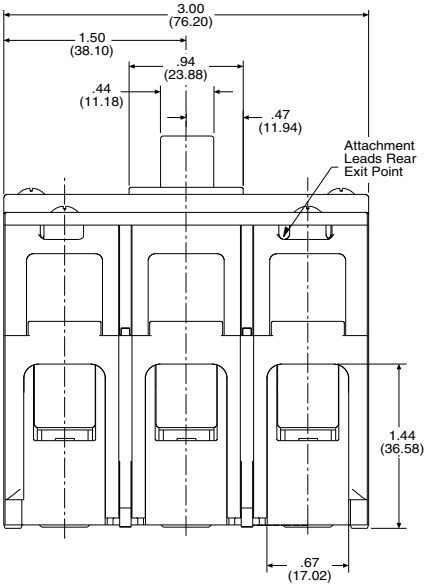


Dimensions are in inches (millimeters). Dimensions are not intended to be used for manufacturing purposes.

3-Pole Molded Case Circuit Breakers







Breaker Status	Dimension				
	A	B	C	D	E
On	2.71 (68.83)	2.53 (64.26)	3.46 (87.88)	2.83 (71.88)	2.75 (69.85)
Off	1.54 (39.12)	1.62 (41.15)	3.46 (87.88)	1.66 (42.16)	1.84 (46.74)
Tripped	2.33 (59.18)	2.23 (56.64)	3.54 (89.92)	2.46 (67.48)	2.45 (62.23)
Reset	1.39 (35.31)	1.49 (37.85)	3.42 (86.87)	1.52 (38.61)	1.70 (43.18)

Product Selection — 250 A, J-Frame

- UL 489
- CSA 22.2, No. 5
- IEC 60947-2
- CE
- KEMA-KEUR (Pending)

Note: Terminal box lugs must be ordered separately. See page 19

Breaker Frames

Rated Current I_n [A]	Breaking Capacity (50 Hz) I_{cu} / I_{cs} [kA]								Interrupting Rating (60 Hz) [kA]			Cat. No.
	220…240V		380…415V		500V		690V		240V	480V	600V	
250	65	65	25	25	20	12	6	3	65	25	18	140U-J2X3
	85	85	40	40	35	20	6	3	85	35	18	140U-J3X3
	100	100	70	70	42	20	7	3	100	65	25	140U-J6X3

Trip Units

Thermal-Magnetic

Rated Operational Current I_n	Adjustment Range [A]		Cat. No.
	Thermal Trip $I_r = I_n$ (Fixed)	Magnetic Trip I_m = 5…10 x I_r	
90	90	450…900	140U-JTD3-C90
100	100	500…1000	140U-JTD3-D10
125	125	600…1250	140U-JTD3-D12
150	150	750…1500	140U-JTD3-D15
175	175	875…1750	140U-JTD3-D17
200	200	1000…2000	140U-JTD3-D20
225	225	1125…2250	140U-JTD3-D22
250	250	1250…2500	140U-JTD3-D25

Electronic

Rated Operational Current I_n	Adjustment Range [A]		Protection Type	Cat. No.
	Thermal Trip I_r = 0.4…1.0 x I_n	Magnetic Trip I_m = 2…14 x I_r		
50	20…50	40…700	LS	140U-JTL3-C50
50	20…50	40…700	LSI	140U-JTH3-C50
50	20…50	40…700	LSG	140U-JTG3-C50
50	20…50	40…700	LSIG	140U-JTI3-C50
100	40…100	80…1400	LS	140U-JTL3-D10
100	40…100	80…1400	LSI	140U-JTH3-D10
100	40…100	80…1400	LSG	140U-JTG3-D10
100	40…100	80…1400	LSIG	140U-JTI3-D10
160	63…160	126…2240	LS	140U-JTL3-D16
160	63…160	126…2240	LSI	140U-JTH3-D16
160	63…160	126…2240	LSG	140U-JTG3-D16
160	63…160	126…2240	LSIG	140U-JTI3-D16
250	100…250	200…3500	LS	140U-JTL3-D25
250	100…250	200…3500	LSI	140U-JTH3-D25
250	100…250	200…3500	LSG	140U-JTG3-D25
250	100…250	200…3500	LSIG	140U-JTI3-D25

Assembled Circuit Breakers with Thermal-Magnetic Trip Units

Rated Operational Current I_n	Breaking Capacity/ Interrupting Rating [kA]❄		Cat. No.	Breaking Capacity/ Interrupting Rating [kA]❄		Cat. No.	Breaking Capacity/ Interrupting Rating [kA]❄		Cat. No.
	400V	480V		400V	480V		400V	480V	
90	25	25	140U-J2D3-C90	40	35	140U-J3D3-C90	70	65	140U-J6D3-C90
100	25	25	140U-J2D3-D10	40	35	140U-J3D3-D10	70	65	140U-J6D3-D10
125	25	25	140U-J2D3-D12	40	35	140U-J3D3-D12	70	65	140U-J6D3-D12
150	25	25	140U-J2D3-D15	40	35	140U-J3D3-D15	70	65	140U-J6D3-D15
175	25	25	140U-J2D3-D17	40	35	140U-J3D3-D17	70	65	140U-J6D3-D17
200	25	25	140U-J2D3-D20	40	35	140U-J3D3-D20	70	65	140U-J6D3-D20
225	25	25	140U-J2D3-D22	40	35	140U-J3D3-D22	70	65	140U-J6D3-D22
250	25	25	140U-J2D3-D25	40	35	140U-J3D3-D25	70	65	140U-J6D3-D25

❄ Full ratings are found in the breaker frames table on this page

Assembled Circuit Breakers with Electronic Trip Units

Rated Operational Current I_n	Protection Type	Breaking Capacity/ Interrupting Rating [kA]❄ 400V	480V	Cat. No.	Breaking Capacity/ Interrupting Rating [kA]❄ 400V	480V	Cat. No.	Breaking Capacity/ Interrupting Rating [kA]❄ 400V	480V	Cat. No.
50	LS	25	25	140U-J2L3-C50	40	35	140U-J3L3-C50	70	65	140U-J6L3-C50
50	LSI	25	25	140U-J2H3-C50	40	35	140U-J3H3-C50	70	65	140U-J6H3-C50
50	LSG	25	25	140U-J2G3-C50	40	35	140U-J3G3-C50	70	65	140U-J6G3-C50
50	LSIG	25	25	140U-J2I3-C50	40	35	140U-J3I3-C50	70	65	140U-J6I3-C50
100	LS	25	25	140U-J2L3-D10	40	35	140U-J3L3-D10	70	65	140U-J6L3-D10
100	LSI	25	25	140U-J2H3-D10	40	35	140U-J3H3-D10	70	65	140U-J6H3-D10
100	LSG	25	25	140U-J2G3-D10	40	35	140U-J3G3-D10	70	65	140U-J6G3-D10
100	LSIG	25	25	140U-J2I3-D10	40	35	140U-J3I3-D10	70	65	140U-J6I3-D10
160	LS	25	25	140U-J2L3-D16	40	35	140U-J3L3-D16	70	65	140U-J6L3-D16
160	LSI	25	25	140U-J2H3-D16	40	35	140U-J3H3-D16	70	65	140U-J6H3-D16
160	LSG	25	25	140U-J2G3-D16	40	35	140U-J3G3-D16	70	65	140U-J6G3-D16
160	LSIG	25	25	140U-J2I3-D16	40	35	140U-J3I3-D16	70	65	140U-J6I3-D16
250	LS	25	25	140U-J2L3-D25	40	35	140U-J3L3-D25	70	65	140U-J6L3-D25
250	LSI	25	25	140U-J2H3-D25	40	35	140U-J3H3-D25	70	65	140U-J6H3-D25
250	LSI	25	25	140U-J2G3-D25	40	35	140U-J3H3-D25	70	65	140U-J6G3-D25
250	LSIG	25	25	140U-J2I3-D25	40	35	140U-J3I3-D25	70	65	140U-J6I3-D25

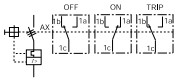
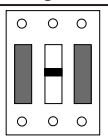
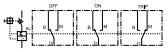
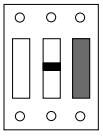
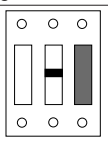
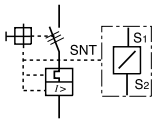
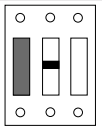
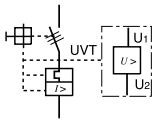
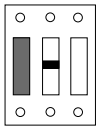
❄ Full ratings are found in the breaker frames table on page 16

Molded Case Switch — UL 1087

Rated Current I_n [A]	Thermal Trip $I_r = I_n$ [A]	Magnetic Trip [A] I_m = 10 x I_n	Breaking Capacity (50 Hz) I_{cu} /I_{cs} [kA] 220…240V		380…415V		500V		690V		Interrupting Rating (60 Hz) [kA] 240V	480V	600V	Cat. No.
250	—	2500	100	100	70	70	42	20	7	3	100	65	25	140U-J6S3-D25

Accessories — 250 A, J-Frame

Internal Control Modules — Field Installed

	Description		Diagram	Mounting Location	Cat. No.
	Auxiliary Contact (AX) Electrically indicates "ON/OFF" status of breakers	(1) 1a-1b			140U-H-EA1
		(2) 1a-1b		*Left AND Right side*	140U-H-EA2
	Alarm Contact (AL) Electrically indicates when the breaker is in the "TRIPPED" state	(1) 1M (make)-1B (break)			140U-J-ER1
				Right side ONLY	
	Auxiliary/Alarm Contact (AX/AL) Combination Combination of auxiliary contact and alarm contact	(1) 1a-1b (1) 1M (make)-1B (break)			140U-J-EA1R1
				Right side ONLY	
	Shunt Trip (SNT) Provides remote tripping of the circuit breaker Undervoltage trip not available when shunt trip is used	24…60V, 50/60/DC			140U-H-SNJ
		110…240V, 50/60/DC			140U-H-SND
		380…440V AC, 220…250V DC			140U-H-SNN
		380…600V, 50/60 Hz		*Left side ONLY*	140U-H-SNB
	Undervoltage Release (UVT) Automatically trips breaker when voltage falls between preset value, 35…70% Shunt trip is not available when undervoltage release is used	24V, 50/60 Hz			140U-H-UJ
		110…127V, 50/60 Hz			140U-H-UD
		208…240V, 50/60 Hz			140U-H-UA
		380…500V, 50/60 Hz			140U-H-UB
		525…600V, 50/60 Hz		*Left side ONLY*	140U-H-UC

Note: For Factory-Installed internal control modules, please see page 41

Terminal Lugs

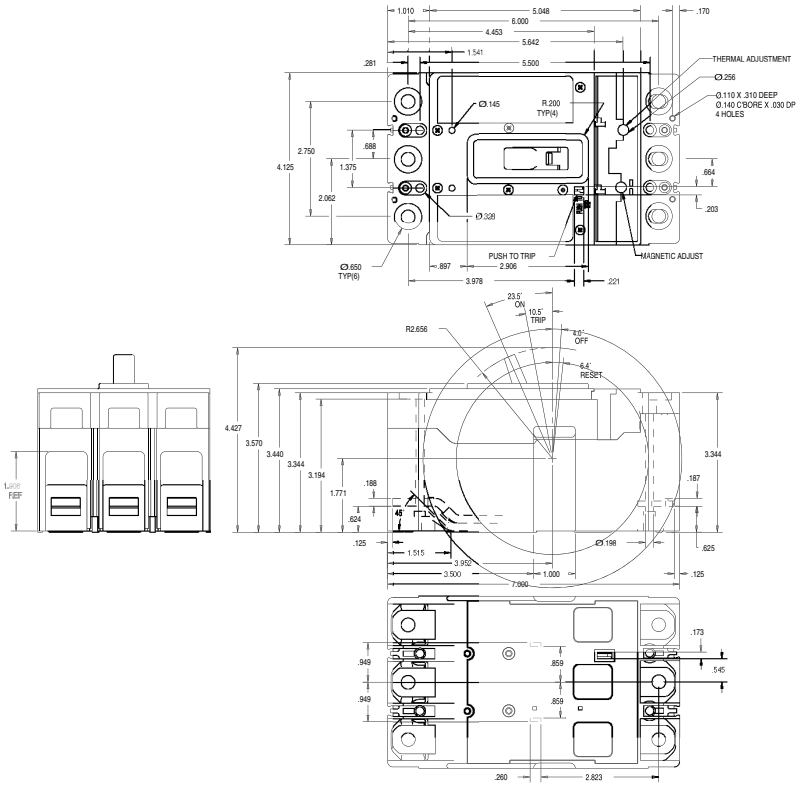
	Description			Frame Size	Cat. No.
	Terminal Lugs	Aluminum lugs, Al or Cu wire (1) 4…350 MCM or (1) 25…185 mm²	Qty: 1	J	140U-J-TLA1
		Stainless Steel Box Lugs, Cu wire Only (1) 4…350 MCM or (1) 25…185 mm²	Qty: 1	J	140U-J-TLS1

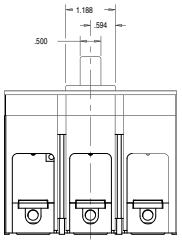
External Accessories

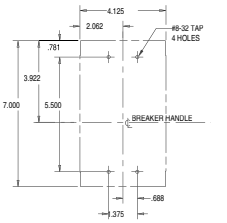
	Description		Cat. No.
	Terminal Shields IP20 Ingress Protection Rating		140U-J-TS
	Flex-Cable Operating Mechanism Includes handle, cable, operating, and bail mechanism Pre-assembled and adjusted Non-Metallic - UL IP66, Type 1/3/12/4/4X Flange Mount Operating Handle	3 ft (0.9 m) Cable	140U-J-FCX03
		4 ft (1.3 m) Cable	140U-J-FCX04
		6 ft (1.9 m) Cable	140U-J-FCX06
		10 ft (3.0 m) Cable	140U-J-FCX10
	Flex-Cable Operating Mechanism Stainless Steel IP66/ UL Type 1/3/12/4/4X Flange-Mount Operating Handle	3 ft (0.9 m) Cable	140U-J-FCS03
		4 ft (1.2 m) Cable	140U-J-FCS04
		6 ft (1.9 m) Cable	140U-J-FCS06
		10 ft (3.0 m) Cable	140U-J-FCS10
	Rotary, Variable-Depth Operating Mechanism UL Type 3/12/4/4X, IP 66 Rotary Handle 12 in. (30.48 cm) operating rod	Black Handle	140U-J-RVM12B
		Red/Yellow Handle	140U-J-RVM12R
	Rotary, Variable-Depth Operating Mechanism UL Type 3/12/4/4X, IP 66 Rotary Handle 21 in. (53.34 cm) operating rod	Black Handle	140U-J-RVM21B
		Red/Yellow Handle	140U-J-RVM21R
	Rotary, Variable-Depth Operating Mechanism with Internal NFPA 79 Operating Handle Type 3/4/4X/12 IP66 Rotary Handle 12 in. (30.48 cm) operating rod	Black Handle	140U-J-NVM12B
		Red/Yellow Handle	140U-J-NVM12R
	Rotary, Variable-Depth Operating Mechanism with Internal NFPA 79 Operating Handle Type 3/4/4X/12 IP66 Rotary Handle 21 in. (53.34 cm) operating rod	Black Handle	140U-J-NVM21B
		Red/Yellow Handle	140U-J-NVM21R
	Rotary, Direct Couple Operating Mechanism Breaker Mounted	Black Handle	140U-J-RCB
		Red/Yellow Handle	140U-J-RCR
	End Cap Kit Provides 3-phase connections for terminal or bolt-on connections Metric Hardware		140U-J-ECM
	Phase Barriers Provides additional phase clearance when special connections that extend past the circuit breaker housing are required	Qty: 2	140U-J-PB
	Padlock Kit Padlocking Hasp Lock-OFF only	Qty: 1	140U-J-PL
	Multi-Tap Terminal Lug Kit — with IP20 terminal cover (3) #14…#2 AWG (3) 2.5…25 mm²	Qty: 3	140U-J-MTL3A
	Multi-Tap Terminal Lugs — with IP20 terminal cover (6) #14…#6 AWG (6) 2.5…10 mm²	Qty: 3	140U-J-MTL6A
	150 A Ground Fault Leakage Module Current pickup settings are selectable from 0.03…10 A with time delays up to. Time delays are also selectable from Instantaneous…1.0 s for 0.10 A settings and above. A current pickup setting of 0.03 A defaults to an Instantaneous time setting regardless of the time dial's position. Two alarm contacts come as standard: a 50% pretrip and a 100% after trip contact, both based only on earth leakage current levels.	For use with 140U J-Frame 3 pole MCCBs rated up to 150 A	140U-J-GFP1503
	250 A Ground Fault Leakage Module Current pickup settings are selectable from 0.03…10 A. Time delays are also selectable from Instantaneous…1.0 s for 0.10 A settings and above. A current pickup setting of 0.03 A defaults to an Instantaneous time setting regardless of the time dial's position. Two alarm contacts come as standard: a 50% pretrip and a 100% after trip contact, both based only on earth leakage current levels.	For use with 140U J-Frame 3-pole MCCBs rated up to 250 A	140U-J-GFP2503
	Motor Operator Remotely opens, closes, and resets the circuit breaker	For use with 3- or 4-Pole MCCBs, 110…240V AC/DC	140U-J-EOPD
		For use with 3- or 4-Pole MCCBs, 24V DC	140U-J-EOPZ
	Mounting Hardware (4) M4 - 0.7 x 90 mm	For use with 3- or 4-Pole MCCBs	140U-J-MHM

Approximate Dimensions — 250 A, J-Frame

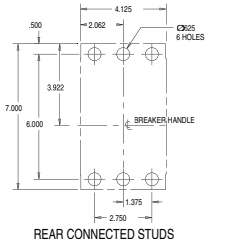
Dimensions are in inches (millimeters). Dimensions are not intended to be used for manufacturing purposes.



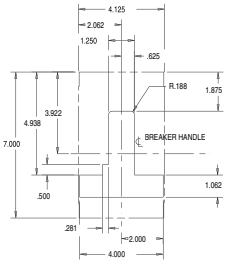




FRONT CONNECTED DRILL PLAN



REAR CONNECTED STUDS



- UL 489
- CSA 22.2, No. 5
- IEC 157-1
- KEMA-KEUR

Note: Terminal lugs must be ordered separately. See page 22

Breaker Frames

Rated Current I_n	Breaking Capacity (50 Hz) I_{cu} / I_{cs} [kA]								Interrupting Rating (60 Hz) [kA]			Cat. No.
	220…240V		380…415V		500V		690V		240V	480V	600V	
400	65	65	40	40	30	30	10	5	65	35	25	140U-K3X3
	100	100	35	35	50	38	13	6	100	65	35	140U-K6X3
	200	200	100	100	65	49	18	9	200	100	50	140U-K0X3

Trip Units and Rating Plugs

Thermal-Magnetic

Rated Operational Current I_n	Adjustment Range [A]		Cat. No.
	Thermal Trip [A] $I_r = I_n$ (Fixed)	Magnetic Trip I_m = 5…10 x I_n	
100	100	500…1000	140U-KTD3-D10
125	125	625…1250	140U-KTD3-D12
150	150	750…1500	140U-KTD3-D15
175	175	895…1750	140U-KTD3-D17
200	200	1000…2000	140U-KTD3-D20
225	225	1125…2250	140U-KTD3-D22
250	250	1250…2500	140U-KTD3-D25
300	300	1500…3000	140U-KTD3-D30
350	350	1750…3500	140U-KTD3-D35
400	400	2000…4000	140U-KTD3-D40

Electronic

Rated Operational Current I_n	Adjustment Range [A]		Protection Type	Cat. No.
	Thermal Trip I_r = 0.5…1.0 x I_n	Magnetic Trip I_m = 2…8 x I_r		
400	200…400*	400…3200	LS	140U-KTL3-D40
			LSI	140U-KTH3-D40
			LSG	140U-KTG3-D40

Rating Plugs

Thermal Trip I_n	Cat. No.	Thermal Trip I_n[A]	Cat. No.
200	140U-KRP3-D20	300	140U-KRP3-D30
225	140U-KRP3-D22	350	140U-KRP3-D35
250	140U-KRP3-D25	400	140U-KRP3-D40

Assembled Circuit Breakers, Thermal-Magnetic Trip Units

Rated Operational Current I_n	Breaking Capacity/ Interrupting Rating [kA]❄		Cat. No.	Breaking Capacity/ Interrupting Rating [kA]❄		Cat. No.	Breaking Capacity/ Interrupting Rating [kA]❄		Cat. No.
	400V	480V		400V	480V		400V	480V	
100	40	35	140U-K3D3-D10	65	65	140U-K6D3-D10	100	100	140U-K0D3-D10
125	40	35	140U-K3D3-D12	65	65	140U-K6D3-D12	100	100	140U-K0D3-D12
150	40	35	140U-K3D3-D15	65	65	140U-K6D3-D15	100	100	140U-K0D3-D15
175	40	35	140U-K3D3-D17	65	65	140U-K6D3-D17	100	100	140U-K0D3-D17
200	40	35	140U-K3D3-D20	65	65	140U-K6D3-D20	100	100	140U-K0D3-D20
225	40	35	140U-K3D3-D22	65	65	140U-K6D3-D22	100	100	140U-K0D3-D22
250	40	35	140U-K3D3-D25	65	65	140U-K6D3-D25	100	100	140U-K0D3-D25
300	40	35	140U-K3D3-D30	65	65	140U-K6D3-D30	100	100	140U-K0D3-D30
350	40	35	140U-K3D3-D35	65	65	140U-K6D3-D35	100	100	140U-K0D3-D35
400	40	35	140U-K3D3-D40	65	65	140U-K6D3-D40	100	100	140U-K0D3-D40

Assembled circuit breakers can be created by adding a trip unit and rating plugs (electronic only) to a circuit breaker frame. Example: Cat. No. **140U-K3X3** + **140U-KTL3-D40** + **140U-KRP3-D35**

❄ Full ratings are found in the breaker frames table on this page

Molded Case Circuit Breakers

Product Selection — 400 A, K-Frame, Continued

Assembled Circuit Breakers, Electronic Trip Units

Rated Current I_n	Thermal Trip I_r = 0.5…1.0 x I_n	Protection Type	Breaking Capacity/ Interrupting Rating [kA]❄ 400V	480V	Cat. No.	Breaking Capacity/ Interrupting Rating [kA]❄ 400V	480V	Cat. No.	Breaking Capacity/ Interrupting Rating [kA]❄ 400V	480V	Cat. No.
400	100…400✶	LS	40	35	140U-K3L3-D40	65	65	140U-K6L3-D40	100	100	140U-K0L3-D40
		LSI	40	35	140U-K3H3-D40	65	65	140U-K6H3-D40	100	100	140U-K0H3-D40
		LSG	40	35	140U-K3G3-D40	65	65	140U-K6G3-D40	100	100	140U-K0G3-D40

✶ Select proper rating plug to cover thermal trip requirement.

❄ Full ratings are found in the breaker frames table on page 21

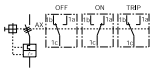
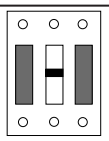
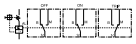
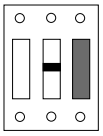
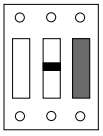
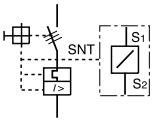
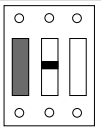
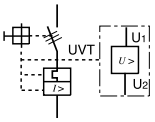
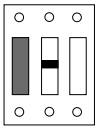
Molded Case Switch — UL 1087

Rated Current I_n	Magnetic Trip 10 x I_n	Breaking Capacity (50 Hz) I_{cu} /I_{cs} [kA] 220…240V		380…415V		500V		690V		Interrupting Rating (60 Hz) [kA] 240V	480V	600V	Cat. No.
400	4000	100	100	65	65	50	38	13	6	100	65	35	140U-K6S3-D40

Optional Terminal Lug Kits

	Description		Pkg. Quantity	Cat. No.
	Terminal Lugs	Aluminum lug, Al or Cu wire (1) 3…350 MCM or (1) 30…185 mm²	1	140U-K-TLA1A
		Aluminum lug, Al or Cu wire (1) 250…500 MCM or (1) 120…240 mm²		140U-K-TLA1
		Aluminum lug, Al or Cu wire (2) 3/0…250 MCM or (2) 95…120 mm²	3 (includes shield)	140U-K-TLA2
	Terminal Lugs	Copper lug, Cu wire only (3) 3…350 MCM or (3) 30…185 mm²	1	140U-K-TLC1A
		Copper lug, Cu wire only (1) 250…500 MCM or (1) 120…240 mm²		140U-K-TLC1
		Copper lug, Cu wire only (2) 3/0…250 MCM or (2) 95…120 mm²	3 (includes shield)	140U-K-TLC2
		Aluminum lug, Al or Cu wire (2) 2/0…250 MCM or (1) 2/0…500 MCM, (2) 70…120 mm² or (1) 70…240 mm²	3 (includes shield)	140U-K-TLA2A
		Aluminum lug, Al or Cu wire (1) 500…750 MCM or (1) 300…400 mm²		140U-K-TLA1B
	Terminal Lugs	Copper lug, Cu wire only (1) 500…750 MCM or (1) 300…400 mm²	3 (includes shield)	140U-K-TLC1B
	Multi-Tap Terminal Lug Kit — with IP20 terminal cover	(3) #12…2/0 AWG or (3) 4…67 mm²	3	140U-K-MTL3A
		(6) #14…#2 AWG or (6) 2.5…33 mm²	3	140U-K-MTL6A

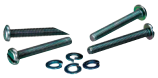
Internal Control Modules — Field Installed

	Description		Diagram		Cat. No.
	Auxiliary Contact (AX) Electrically indicates "ON/OFF" status of breakers	(1) 1a-1b		 *Left AND Right side*	140U-K-EA1
		(2) 1a-1b			140U-K-EA2
	Alarm Contact (AL) Electrically indicates when the breaker is in the "TRIPPED" state	(1) 1M (make)-1B (break)		 *Right side ONLY*	140U-K-ER1
	Auxiliary/Alarm Contact (AX/AL) Combination Combination of auxiliary contact and alarm contact	(1) 1a-1b (1) 1M (make)-1B (break)		 *Right side ONLY*	140U-K-EA1R1
	Shunt Trip (SNT) Provides remote tripping of the circuit breaker Undervoltage trip not available when shunt trip is used	12…24V, 50/60/DC		 *Left side ONLY*	140U-K-SNJ
		110…240V AC, 110…125V DC			140U-K-SND
		380…440V AC, 220…250V DC			140U-K-SNN
		480…600V, 50/60 Hz			140U-K-SNB
	Undervoltage Release (UVT) Automatically trips breaker when voltage falls between preset value, 35…70% Shunt trip is not available when undervoltage release is used	24V, 50/60 Hz		 *Left side ONLY*	140U-K-UJ
		110…127V, 50/60 Hz			140U-K-UD
		208…240V, 50/60 Hz			140U-K-UA
		380…500V, 50/60 Hz			140U-K-UB

Note: For Factory-Installed internal control modules, please see page 41

Accessories — 400 A, K-Frame, Continued

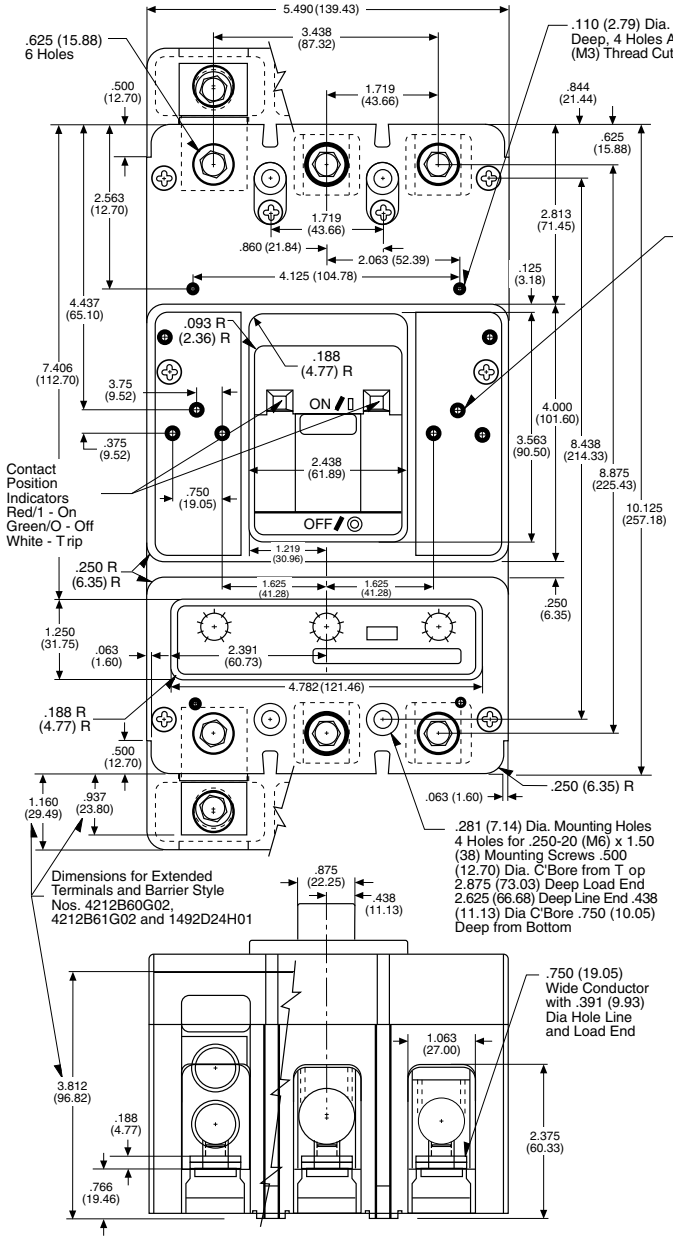
External Accessories

	Description		Cat. No.
	Terminal Shields IP20 Ingress Protection Rating		140U-K-TS
	Flex-Cable Operating Mechanism Includes handle, cable, operating, and bail mechanism Pre-assembled and adjusted UL Type 1/3/12/4/4X Flange-Mount Operating Handle Non-Metallic	4 ft (1.3 m) Cable	140U-K-FCX04
		6 ft (1.9 m) Cable	140U-K-FCX06
		10 ft (3.0 m) Cable	140U-K-FCX10
	Flex-Cable Operating Mechanism Includes handle, cable, operating, and bail mechanism Pre-assembled and adjusted UL Type 4/4X Flange-Mount Operating Handle Stainless Steel	4 ft (1.2 m) Cable	140U-K-FCS04
		6 ft (1.9 m) Cable	140U-K-FCS06
		10 ft (3.0 m) Cable	140U-K-FCS10
	Rotary, Variable-Depth Operating Mechanism UL Type 3/12/4/4X, IP 66 Rotary Handle 12 in. (30.48 cm) operating rod	Black Handle	140U-K-RVM12B
		Red/Yellow Handle	140U-K-RVM12R
	Rotary, Variable-Depth Operating Mechanism UL Type 3/12/4/4X, IP 66 Rotary Handle 21 in. (53.34 cm) operating rod	Black Handle	140U-K-RVM21B
		Red/Yellow Handle	140U-K-RVM21R
	Rotary, Variable-Depth Operating Mechanism with Internal NFPA 79 Operating Handle UL Type 3/12/4/4X, IP 66 Rotary Handle 12 in. (30.48 cm) operating rod	Black Handle	140U-K-NVM12B
		Red/Yellow Handle	140U-K-NVM12R
	Rotary, Variable-Depth Operating Mechanism with Internal NFPA 79 Operating Handle UL Type 3/12/4/4X, IP 66 Rotary Handle 21 in. (53.34 cm) operating rod	Black Handle	140U-K-NVM21B
		Red/Yellow Handle	140U-K-NVM21R
	Rotary, Direct Couple Operating Mechanism Type 1 Rotary Handle Breaker Mounted	Black Handle	140U-K-RCG
	Rotary, Direct Couple Operating Mechanism Type 1 Rotary Handle Breaker Mounted	Red/Yellow Handle	140U-K-RCR
	End Cap Kit Provides 3-phase connections for terminal or bolt-on connections Metric Hardware		140U-K-ECM
	Phase Barriers Provides additional phase clearance when special connections that extend past the circuit breaker housing are required	Qty: 2	140U-K-PB
	**Mounting Hardware** (4) M4 - 0.7 x 75 mm	1	140U-K-MHM

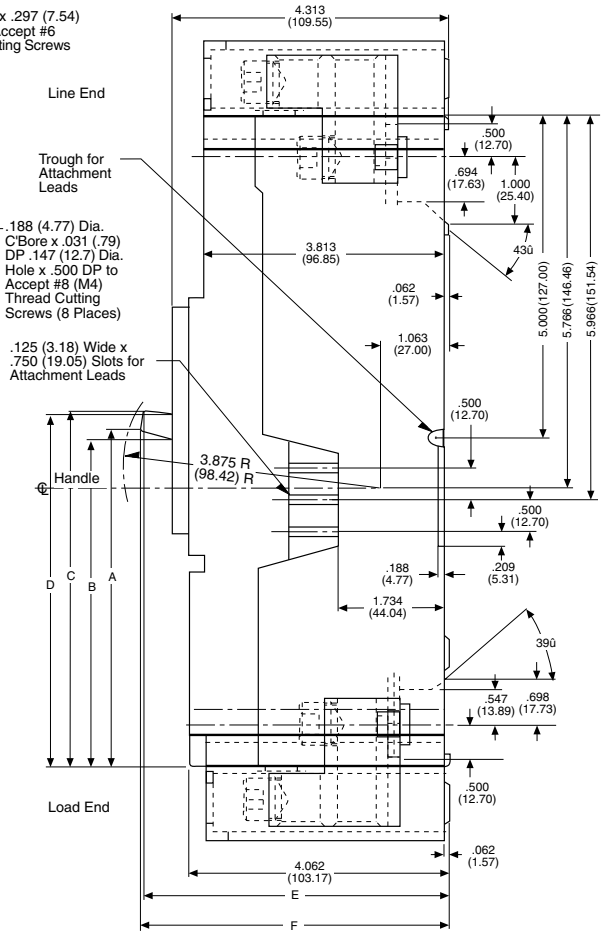
Approximate Dimensions — 400 A, K-Frame

Dimensions are in inches (millimeters). Dimensions are not intended to be used for manufacturing purposes.

Front View



Side View



Breaker Status	Dimensions						Handle Force①
	A	B	C	D	E	F	
On	5.39 (136.9)	5.20 (132.1)	5.69 (144.5)	5.61 (142.5)	4.72 (119.9)	4.77 (121.2)	30 lbs. (13.61 kgs.)
Tripped	4.77 (121.2)	4.69 (119.1)	5.08 (129.0)	5.11 (129.8)	4.89 (124.2)	4.89 (124.2)	N/A
Off	4.16 (105.7)	4.21 (106.9)	4.46 (113.3)	4.64 (117.9)	4.95 (125.7)	4.91 (124.7)	25 lbs. (11.34 kgs.)
Reset	4.07 (103.4)	4.14 (105.2)	4.57 (116.1)	4.56 (115.8)	4.95 (125.7)	4.90 (124.5)	35 lbs. (15.87 kgs.)

① All handle forces measured approximately 0.125 (3.17) from top of handle.

Product Selection — 600 A, L-Frame

- UL 489
- CSA 22.2, No. 5
- IEC 60947-2
- CE
- KEMA-KEUR

Note: Terminal box lugs must be ordered separately. See page page 27

Breaker Frames

Rated Current I_n	Breaking Capacity (50 Hz) I_{cu} /I_{cs} [kA]								Interrupting Rating (60 Hz) [kA]			Cat. No.
	220…240V		380…415V		500V		690V		240V	480V	600V	
600	85	85	45	45	30	30	20	10	65	35	25	140U-L3X3
	100	100	70	70	50	38	25	13	100	65	35	140U-L6X3

Trip Units and Rating Plugs

Thermal-Magnetic			
Rated Current I_n	Adjustment Range [A]		Cat. No.
	Thermal Trip $I_r = I_n$ (Fixed)	Magnetic Trip I_m = 5…10 x I_n	
250	250	1250…2500	140U-LTD3-D25
300	300	1500…3000	140U-LTD3-D30
350	350	1750…3500	140U-LTD3-D35
400	400	2000…4000	140U-LTD3-D40
500	500	2500…5000	140U-LTD3-D50
600	600	3000…6000	140U-LTD3-D60

Electronic				
Rated Operational Current I_n	Adjustment Range [A]		Protection Type	Cat. No.
	Thermal Trip I_r = 0.5…1.0 x I_n	Magnetic Trip I_m = 2…10 x I_n		
250	100…250	200…2500	LS	140U-LTL3-D25
			LSI	140U-LTH3-D25
			LSG	140U-LTG3-D25
			LSIG	140U-LTI3-D25
400	160…400	320…4000	LS	140U-LTL3-D40
			LSI	140U-LTH3-D40
			LSG	140U-LTG3-D40
			LSIG	140U-LTI3-D40
600	240…600	480…6000	LS	140U-LTL3-D60
			LSI	140U-LTH3-D60
			LSG	140U-LTG3-D60
			LSIG	140U-LTI3-D60

Assembled Circuit Breakers, Thermal-Magnetic Trip Units

Rated Operational Current I_n	Thermal Trip $I_r = I_n$	Breaking Capacity/Interrupting Rating [kA]❄		Cat. No.	Breaking Capacity/Interrupting Rating [kA]❄		Cat. No.
		400V	480V		400V	480V	
250	250	45	35	140U-L3D3-D25	70	65	140U-L6D3-D25
300	300	45	35	140U-L3D3-D30	70	65	140U-L6D3-D30
350	350	45	35	140U-L3D3-D35	70	65	140U-L6D3-D35
400	400	45	35	140U-L3D3-D40	70	65	140U-L6D3-D40
500	500	45	35	140U-L3D3-D50	70	65	140U-L6D3-D50
600	600	45	35	140U-L3D3-D60	70	65	140U-L6D3-D60

❄ Full ratings are found in the breaker frames table on this page

Assembled Circuit Breakers, Electronic Trip Units

Rated Operational Current I_n	Thermal Trip I_r = 0.5…1.0 x I_n	Protection Type	Breaking Capacity/ Interrupting Rating [kA]❄ 400V	480V	Cat. No.	Breaking Capacity/ Interrupting Rating [kA]❄ 400V	480V	Cat. No.
250	100…250	LS	45	35	140U-L3L3-D25	70	65	140U-L6L3-D25
		LSI	45	35	140U-L3H3-D25	70	65	140U-L6H3-D25
		LSG	45	35	140U-L3G3-D25	70	65	140U-L6G3-D25
		LSIG	45	35	140U-L3I3-D25	70	65	140U-L6I3-D25
400	160…400	LS	45	35	140U-L3L3-D40	70	65	140U-L6L3-D40
		LSI	45	35	140U-L3H3-D40	70	65	140U-L6H3-D40
		LSG	45	35	140U-L3G3-D40	70	65	140U-L6G3-D40
		LSIG	45	35	140U-L3I3-D40	70	65	140U-L6I3-D40
600	240…600	LS	45	35	140U-L3L3-D60	70	65	140U-L6L3-D60
		LSI	45	35	140U-L3H3-D60	70	65	140U-L6H3-D60
		LSG	45	35	140U-L3G3-D60	70	65	140U-L6G3-D60
		LSIG	45	35	140U-L3I3-D60	70	65	140U-L6I3-D60

❄ Full ratings are found in the breaker frames table on page 26

Molded Case Switch — UL 1087

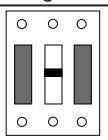
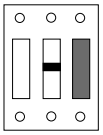
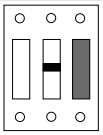
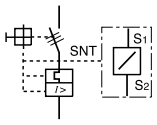
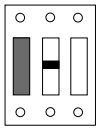
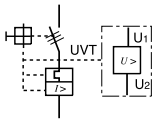
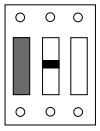
Rated Current I_n	Magnetic Trip I_m = 10 x I_n	Breaking Capacity (50 Hz) I_{cu} /I_{cs} [kA] 220…240V		380…415V		500V		690V		Interrupting Rating (60 Hz) [kA] 240V	480V	600V	Cat. No.
600	6000	100	100	70	70	50	38	25	13	100	65	35	140U-L6S3-D60

Terminal Lugs

	Description		Cat. No.
	Terminal Lugs Aluminum Lug Aluminum or Copper Wire (1) 500…750 MCM (1) 240…380 mm²	Qty: 3 (includes shield)	140U-L-TL6A1
	Terminal Lugs Copper Lug Copper Wire only (1) 500…750 MCM (1) 240…380 mm²	Qty: 3 (includes shield)	140U-L-TL6C1
	Terminal Lugs Aluminum Lug Aluminum or Copper Wire (2) 2…500 MCM (2) 35…240 mm²	Qty: 3 (includes shield)	140U-L-TL6A2
	Terminal Lugs Copper Lug Copper Wire only (2) 2…500 MCM (2) 35…240 mm²	Qty: 3 (includes shield)	140U-L-TL6C2
	Terminal Lugs Aluminum Lug Aluminum or Copper Wire (1) 2…500 MCM (1) 35…240 mm²	Qty: 1	140U-L-TL4A1
	Terminal Lugs Copper Lug Copper Wire only (1) 2…500 MCM (1) 35…240 mm²	Qty: 1	140U-L-TL4C1

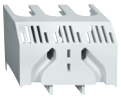
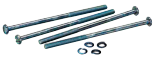
Accessories — 600 A, L-Frame

Internal Control Modules — Field Installed

	Description		Diagram	Mounting Location	Cat. No.
	Auxiliary Contact (AX) Electrically indicates "ON/OFF" status of breakers	(1) 1a-1b			140U-H-EA1
		(2) 1a-1b		*Left AND Right side*	140U-H-EA2
	Alarm Contact (AL) Electrically indicates when the breaker is in the "TRIPPED" state	(1) 1M (make)-1B (break)		 *Right side ONLY*	140U-J-ER1
	Auxiliary/Alarm Contact (AX/AL) Combination Combination of auxiliary contact and alarm contact	(1) 1a-1b (1) 1M (make)-1B (break)		 *Right side ONLY*	140U-J-EA1R1
	Shunt Trip (SNT) Provides remote tripping of the circuit breaker Undervoltage trip not available when shunt trip is used	24…60V, 50/60/DC		 *Left side ONLY*	140U-H-SNJ
		110…240V, 50/60/DC			140U-H-SND
		380…440V AC, 220…250V DC			140U-H-SNN
		380…600V, 50/60 Hz			140U-H-SNB
	Undervoltage Release (UVT) Automatically trips breaker when voltage falls between preset value, 35…70% Shunt trip is not available when undervoltage release is used	24V, 50/60 Hz		 *Left side ONLY*	140U-H-UJ
		110…127V, 50/60 Hz			140U-H-UD
		208…240V, 50/60 Hz			140U-H-UA
		380…500V, 50/60 Hz			140U-H-UB
		525…600V, 50/60 Hz			140U-H-UC

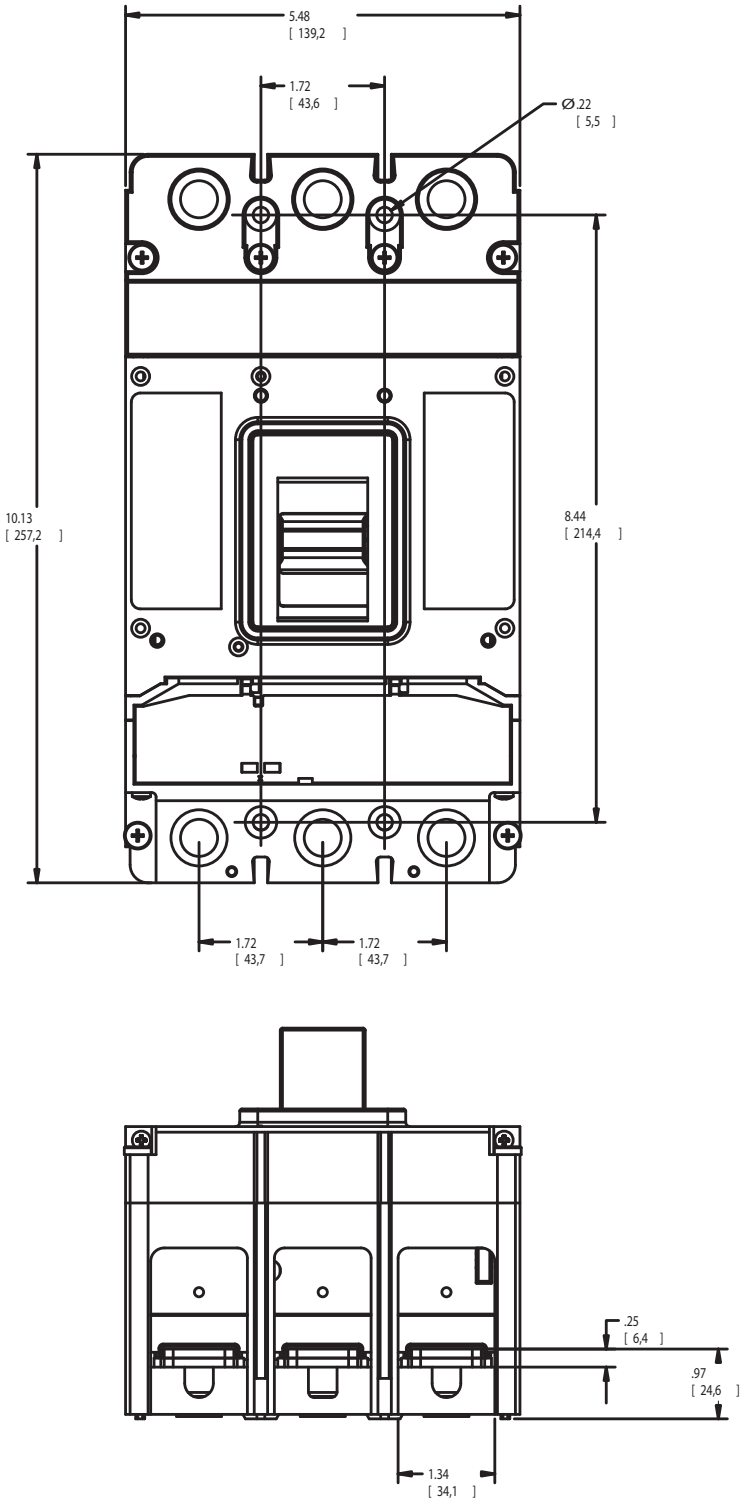
Note: For Factory-Installed internal control modules, please see page 41

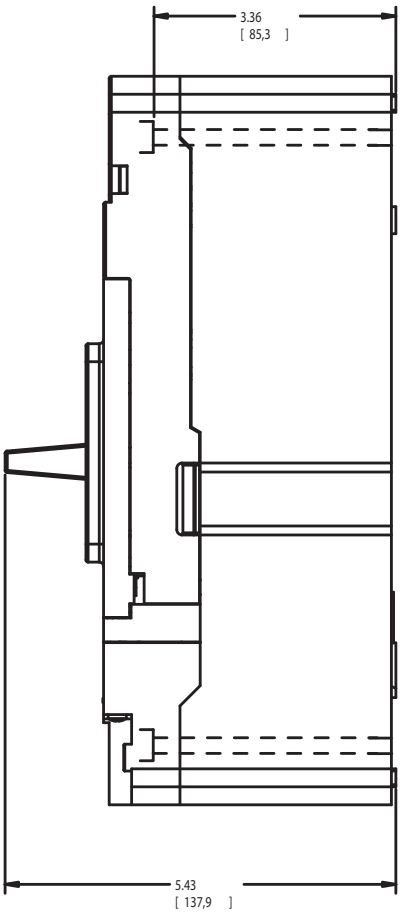
External Accessories

	Description			Cat. No.
	**Terminal Shields** IP20 Ingress Protection Rating			140U-L-TS
	Flex-Cable Operating Mechanism Includes handle, cable, operating, and bail mechanism Pre-assembled and adjusted UL Type 1/3/12/4/4X Flange-Mount Operating Handle Non-Metallic		4 ft (1.3 m) Cable	140U-L-FCX04
			6 ft (1.9 m) Cable	140U-L-FCX06
			10 ft (3.0 m) Cable	140U-L-FCX10
	Flex-Cable Operating Mechanism Includes handle, cable, operating, and bail mechanism Pre-assembled and adjusted UL Type 4/4X Flange-Mount Operating Handle Stainless Steel		4 ft (1.2 m) Cable	140U-L-FCS04
			6 ft (1.9 m) Cable	140U-L-FCS06
			10 ft (3.0 m) Cable	140U-L-FCS10
	Rotary, Variable-Depth Operating Mechanism UL Type 3/12/4/4X, IP 66 Rotary Handle 12 in. (30.48 cm) operating rod		Black Handle	140U-L-RVM12B
			Red/Yellow Handle	140U-L-RVM12R
	Rotary, Variable-Depth Operating Mechanism UL Type 3/12/4/4X, IP 66 Rotary Handle 21 in. (53.34 cm) operating rod		Black Handle	140U-L-RVM21B
			Red/Yellow Handle	140U-L-RVM21R
	Rotary, Variable-Depth Operating Mechanism with Internal NFPA79 Operating Handle UL Type 3/12/4/4X, IP 66 Rotary Handle 12 in. (30.48 cm) operating rod		Black Handle	140U-L-NVM12B
			Red/Yellow Handle	140U-L-NVM12R
	Rotary, Variable-Depth Operating Mechanism with Internal NFPA79 Operating Handle UL Type 3/12/4/4X, IP 66 Rotary Handle 21 in. (53.34 cm) operating rod		Black Handle	140U-L-NVM21B
			Red/Yellow Handle	140U-L-NVM21R
	Rotary, Direct Couple Operating Mechanism Breaker Mounted		Black Handle	140U-L-RMX
	End Cap Kit Provides 3-phase connections for terminal or bolt-on connections Metric Hardware Provided		Qty: 1	140U-L-ECM
	Phase Barriers Provides additional phase clearance when special connections that extend past the circuit breaker housing are required		Qty: 2	140U-K-PB
	Ground Fault Leakage Module Current pickup settings are selectable from 0.03…30 A with time delays up to1.0 s. Time delays are also selectable from Instantaneous…1.0 s for 0.10 A settings and above. A current pickup setting of 0.03 A defaults to an Instantaneous time setting regardless of the time dial's position. Two alarm contacts come as standard: a 50% pretrip and a 100% after trip contact, both based only on earth leakage current levels.	400 A	For use with L-Frame 3-pole MCCBs up to 400 A	140U-L-GFP4003
		600 A	For use with L-Frame 3-pole MCCBs up to 600 A	140U-L-GFP6003
	Motor Operator Remotely opens, closes, and resets the circuit breaker 110…240V AC		For use with 3- or 4-Pole MCCBs, 110…240V AC/DC	140U-L-EOPD
			For use with 3- or 4-Pole MCCBs, 24V DC	140U-L-EOPZ
	**Mounting Hardware** (4) M5 - 0.8 x 100 mm		For use with 3- or 4-Pole MCCBs	140U-L-MHM

Approximate Dimensions — 600 A, L-Frame

Dimensions are in inches (millimeters). Dimensions are not intended to be used for manufacturing purposes.





Product Selection — 800 A, M-Frame

- UL 489
- CSA 22.2, No. 5
- IEC 60947-2
- CE
- KEMA-KEUR

Note: Terminal box lugs must be ordered separately. See [S-328878]

Breaker Frames

Rated Current I_n	Breaking Capacity (50 Hz) I_{cu} /I_{cs} [kA]								Interrupting Rating (60 Hz) [kA]			Cat. No.
	220…240V		380…415V		500V		690V		240V	480V	600V	
800	65	65	50	50	50	25	20	10	65	50	25	140U-M5X3
	100	100	70	70	70	50	25	13	100	65	35	140U-M6X3

Trip Units and Rating Plugs

Thermal-Magnetic

Rated Current I_n	Adjustment Range [A]		Cat. No.
	Thermal Trip $I_r = I_n$	Magnetic Trip I_m = 5…10 x I_n	
300	300	1500…3000	140U-MTD3-D30
350	350	1750…3500	140U-MTD3-D35
400	400	2000…4000	140U-MTD3-D40
450	450	2250…4500	140U-MTD3-D45
500	500	2500…5000	140U-MTD3-D50
600	600	3000…6000	140U-MTD3-D60
700	700	3500…7000	140U-MTD3-D70
800	800	4000…8000	140U-MTD3-D80

Electronic

Rated Operational Current I_n	Adjustment Range [A]		Protection Type	Cat. No.
	Thermal Trip I_r = 0.5…1.0 x I_n	Magnetic Trip I_m = 2…8 x I_n		
800A	400…800*	800…6400	400…800 A LS Electronic Trip Unit	140U-MTL3-D80
			400…800 A LSI Electronic Trip Unit	140U-MTH3-D80
			400…800 A LSG Electronic Trip Unit	140U-MTG3-D80

Rating Plugs

Thermal Trip I_n [A]	Cat. No.	Thermal Trip I_n [A]	Cat. No.
400	140U-MRP3-D40	700	140U-MRP3-D70
500	140U-MRP3-D50	800	140U-MRP3-D80
600	140U-MRP3-D60		

Assembled Circuit Breakers, Thermal-Magnetic Trip Units

Rated Operational Current I_n	Thermal Trip $I_r = I_n$	Breaking Capacity/Interrupting Rating [kA]❄		Cat. No.	Breaking Capacity/Interrupting Rating [kA]❄		Cat. No.
		400V	480V		400V	480V	
300	300	50	50	140U-M5D3-D30	70	65	140U-M6D3-D30
350	350	50	50	140U-M5D3-D35	70	65	140U-M6D3-D35
400	400	50	50	140U-M5D3-D40	70	65	140U-M6D3-D40
450	450	50	50	140U-M5D3-D45	70	65	140U-M6D3-D45
500	500	50	50	140U-M5D3-D50	70	65	140U-M6D3-D50
600	600	50	50	140U-M5D3-D60	70	65	140U-M6D3-D60
700	700	50	50	140U-M5D3-D70	70	65	140U-M6D3-D70
800	800	50	50	140U-M5D3-D80	70	65	140U-M6D3-D80

❄ Full ratings are found in the breaker frames table on this page

Product Selection — 800 A, M-Frame, Continued

Assembled Circuit Breakers, Electronic Trip Units

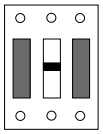
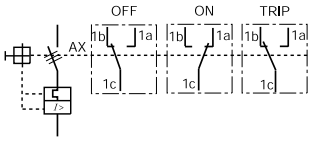
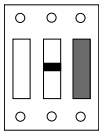
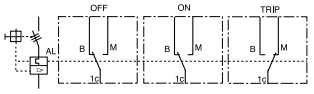
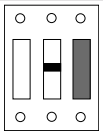
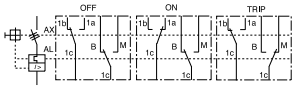
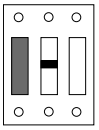
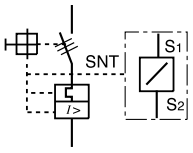
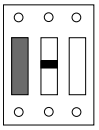
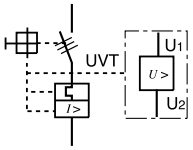
Rated Operational Current I_n	Thermal Trip I_r = 0.5…1.0 x I_n	Protection Type	Breaking Capacity/ Interrupting Rating [kA]❄ 400V	480V	Cat. No.	Breaking Capacity/ Interrupting Rating [kA]❄ 400V	480V	Cat. No.
800	200…800✶	LS	50	50	140U-M5L3-D80	70	65	140U-M6L3-D80
		LSI	50	50	140U-M5H3-D80	70	65	140U-M6H3-D80
		LSG	50	50	140U-M5G3-D80	70	65	140U-M6G3-D80

<ENSpace/>
✶ Select proper rating plug to cover thermal trip requirement.
❄ Full ratings are found in the breaker frames table on page 31

Molded Case Switch — UL 1087

Rated Current I_n	Magnetic Trip [A] I_m = 10 x I_n	Breaking Capacity (50 Hz) I_{cu} /I_{cs} [kA] 220…240V		380…415V		500V		690V		Interrupting Rating (60 Hz) [kA] 240V	480V	600V	Cat. No.
800	8000	100	100	70	70	70	50	25	13	100	65	35	140U-M6S3-D80

Internal Control Modules — Field Installed

	Description		Mounting Location	Diagram	Cat. No.
	Auxiliary Contact (AX) Electrically indicates "ON/OFF" status of breakers	(1) 1a-1b			140U-M-EA1
		(2) 1a-1b	*Left AND Right Side*		140U-M-EA2
	Alarm Contact (AL) Electrically indicates when the breaker is in the "TRIPPED" state	(1) 1M (make)-1B (break)	 *Right Side Only*		140U-M-ER1
	Auxiliary/Alarm Contact (AX/AL) Combination Combination of auxiliary contact and alarm contact	(1) 1a-1b (1) 1M (make)-1B (break)	 *Right Side Only*		140U-M-EA1R1
	Shunt Trip (SNT) Provides remote tripping of the circuit breaker Undervoltage trip not available when shunt trip is used	12…24V, 50/60/DC	 *Left Side Only*		140U-M-SNJ
		110…240V AC, 110…125V DC			140U-M-SND
		380…440V AC, 220…250V DC			140U-M-SNN
		480…600V, 50/60 Hz			140U-M-SNB
	Undervoltage Release (UVT) Automatically trips breaker when voltage falls between preset value, 35…70% Shunt trip is not available when undervoltage release is used	24V, 50/60 Hz	 —		140U-M-UJ
		110…127V, 50/60 Hz			140U-M-UD
		208…240V, 50/60 Hz			140U-M-UA
		380…500V, 50/60 Hz			140U-M-UB

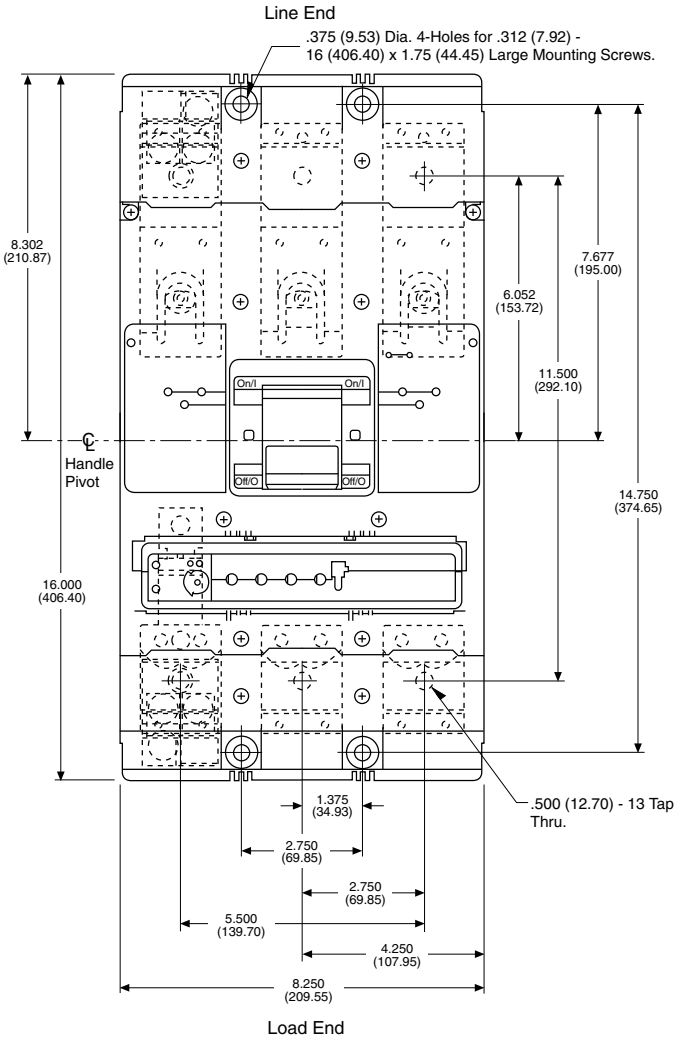
Note: For Factory-Installed internal control modules, please see page 41

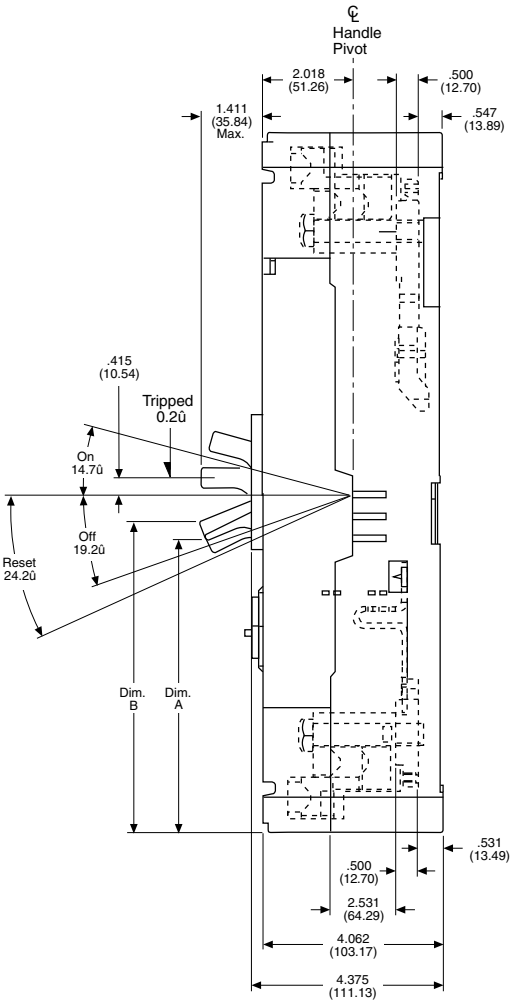
Accessories — 800 A, M-Frame, Continued

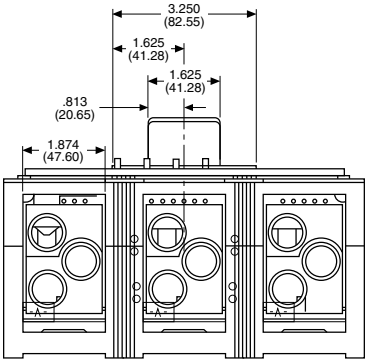
External Accessories

	Description			Cat. No.
	Flex-Cable Operating Mechanism Includes handle, cable, operating, and bail mechanism Pre-assembled and adjusted UL Type 1/3/12/4/4X Flange-Mount Operating Handle Non-Metallic		4 ft (1.3 m) Cable	140U-M-FCX04
			6 ft (1.8 m) Cable	140U-M-FCX06
			10 ft (3.0 m) Cable	140U-M-FCX10
	Flex-Cable Operating Mechanism Includes handle, cable, operating, and bail mechanism Pre-assembled and adjusted UL Type 4/4X Flange-Mount Operating Handle Stainless Steel		4 ft (1.3 m) Cable	140U-M-FCS04
			6 ft (1.8 m) Cable	140U-M-FCS06
			10 ft (3.0 m) Cable	140U-M-FCS10
	Rotary, Variable-Depth Operating Mechanism UL Type 3/12/4/4X, IP 66 Rotary Handle 12 in. (30.48 cm) operating rod		Black Handle	140U-M-RVM12B
			Red/Yellow Handle	140U-M-RVM12R
	Rotary, Variable-Depth Operating Mechanism UL Type 3/12/4/4X, IP 66 Rotary Handle 21 in. (53.34 cm) operating rod		Black Handle	140U-M-RVM21B
			Red/Yellow Handle	140U-M-RVM21R
	Rotary, Variable-Depth Operating Mechanism with Internal NFPA79 Operating Handle UL Type 3/12/4/4X, IP 66 Rotary Handle 12 in. (30.48 cm) operating rod		Black Handle	140U-M-NVM12B
			Red/Yellow Handle	140U-M-NVM12R
	Rotary, Variable-Depth Operating Mechanism with Internal NFPA79 Operating Handle UL Type 3/12/4/4X, IP 66 Rotary Handle 21 in. (53.34 cm) operating rod		Black Handle	140U-M-NVM21B
			Red/Yellow Handle	140U-M-NVM21R
	Terminal Lugs	Copper lug, Cu wire Only (3) 3/0…300 MCM or (3) 95…135 mm²	Qty: 1	140U-M-TLC3
		Aluminum lug, Al or Cu wire (3) 3/0…400 MCM or (3) 95…185 mm²	Qty: 1	140U-M-TLA3
	Terminal Lugs	Aluminum lug, Al or Cu wire (2) 1…500 MCM or (2) 50…240 mm²	Qty: 1	140U-M-TLA2
		Aluminum lug, Al or Cu wire (2) 500…750 MCM or (2) 240…400 mm²	Qty: 1	140U-M-TLA2A
		Copper lug, Cu wire only (2) 2/0…500 MCM or (2) 70…240 mm²	Qty: 1	140U-M-TLC2
	Phase Barriers Provides additional phase clearance when special connections that extend past the circuit breaker housing are required		Qty: 2	140U-M-PB
	Padlock Kit Padlocking Hasp Lock-OFF only		Qty: 1	140U-M-PL
	Mounting Hardware (4) M8 - 1 x 35 mm		For use with 3- or 4-Pole MCCBs	140U-M-MHM

Dimensions are in inches (millimeters). Dimensions are not intended to be used for manufacturing purposes.







Breaker Status	Dimension A	Dimension B
On	8.72 (221.49)	9.17 (232.92)
Off	6.72 (170.69)	7.14 (181.36)
Tripped	7.86 (199.64)	8.30 (210.82)
Reset	6.44 (163.58)	6.84 (173.74)

Molded Case Circuit Breakers

Product Selection — 1200 A, N-Frame

- UL 489
- CSA 22.2, No. 5
- IEC 60947-2
- CE
- KEMA-KEUR

Note: Terminal box lugs must be ordered separately. See [S-329966]

Assembled Circuit Breakers, Electronic Trip Units

Rated Current I_n [A]	Adjustment Range I_r [A]		Protection Type	Breaking Capacity (50 Hz) I_{cu} / I_{cs} [kA]								Interrupting Rating (60 Hz) [kA]			Cat. No.
	Thermal Trip I_r = 0.5…1.0 x I_n	Magnetic Trip I_m = 2…8 x I_n		220…240V		380…415V		500V		690V		240V	480V	600V	
1200	600…1200∗	1200…10600	LS	85	85	50	50	40	20	20	10	65	50	25	140U-N5L3-E12
			LS	100	100	70	50	50	25	25	13	100	65	35	140U-N6L3-E12
1200	600…1200	1200…10600	LSI	100	100	70	50	50	25	25	13	100	65	35	140U-N6H3-E12
			LSG	100	100	70	50	50	25	25	13	100	65	35	140U-N6G3-E12
1200	600…1200∗	1200…10600	LS	200	100	100	50	65	33	35	18	200	100	50	140U-N0L3-E12
			LSI	200	100	100	50	65	33	35	18	200	100	50	140U-N0H3-E12
			LSG	200	100	100	50	65	33	35	18	200	100	50	140U-N0G3-E12

∗ Select proper rating plug to cover thermal trip equipment.

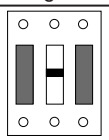
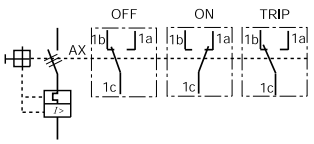
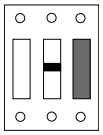
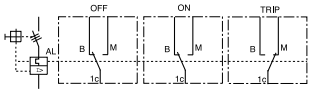
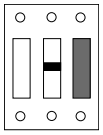
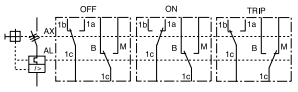
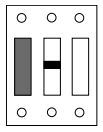
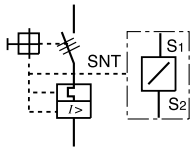
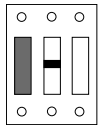
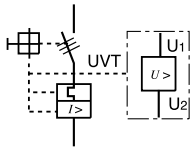
Rating Plugs

Rated Operational Current I_n	Cat. No.	Rated Operational Current I_n	Cat. No.
600	140U-NRP3-D60	900	140U-NRP3-D90
700	140U-NRP3-D70	1000	140U-NRP3-E10
800	140U-NRP3-D80	1200	140U-NRP3-E12

Molded Case Switch — UL 1087

Rated Current I_n	Magnetic Trip 10 x I_n	Breaking Capacity (50 Hz) I_{cu} / I_{cs} [kA]								Interrupting Rating (60 Hz) [kA]			Cat. No.
		220…240V		380…415V		500V		690V		240V	480V	600V	
1200	12000	100	100	70	50	50	25	25	13	100	65	35	140U-N6S3-E12

Internal Control Modules — Field Installed

	Description		Mounting Location	Diagram	Cat. No.
	Auxiliary Contact (AX) Electrically indicates "ON/OFF" status of breakers	(1) 1a-1b			140U-N-EA1
		(2) 1a-1b	*Left AND Right side*		140U-N-EA2
	Alarm Contact (AL) Electrically indicates when the breaker is in the "TRIPPED" state	(1) 1M (make)-1B (break)	 *Right side ONLY*		140U-N-ER1
	Auxiliary/Alarm Contact (AX/AL) Combination Combination of auxiliary contact and alarm contact	(1) 1a-1b (1) 1M (make)-1B (break)	 *Right side ONLY*		140U-N-EA1R1
	Shunt Trip (SNT) Provides remote tripping of the circuit breaker Undervoltage trip not available when shunt trip is used	12…24V, 50/60/DC	 *Left side ONLY*		140U-N-SNJ
		110…240V AC, 110…125V DC			140U-N-SND
		380…440V AC, 220…250V DC			140U-N-SNN
		480…600V, 50/60 Hz			140U-N-SNB
	Undervoltage Release (UVT) Automatically trips breaker when voltage falls between preset value, 35…70% Shunt trip is not available when undervoltage release is used	24V, 50/60 Hz	 *Left side ONLY*		140U-N-UJ
		110…127V, 50/60 Hz			140U-N-UD
		208…240V, 50/60 Hz			140U-N-UA
		380…500V, 50/60 Hz			140U-N-UB

Note: For Factory-Installed internal control modules, please see page 41

Accessories — 1200 A, N-Frame, Continued

External Accessories

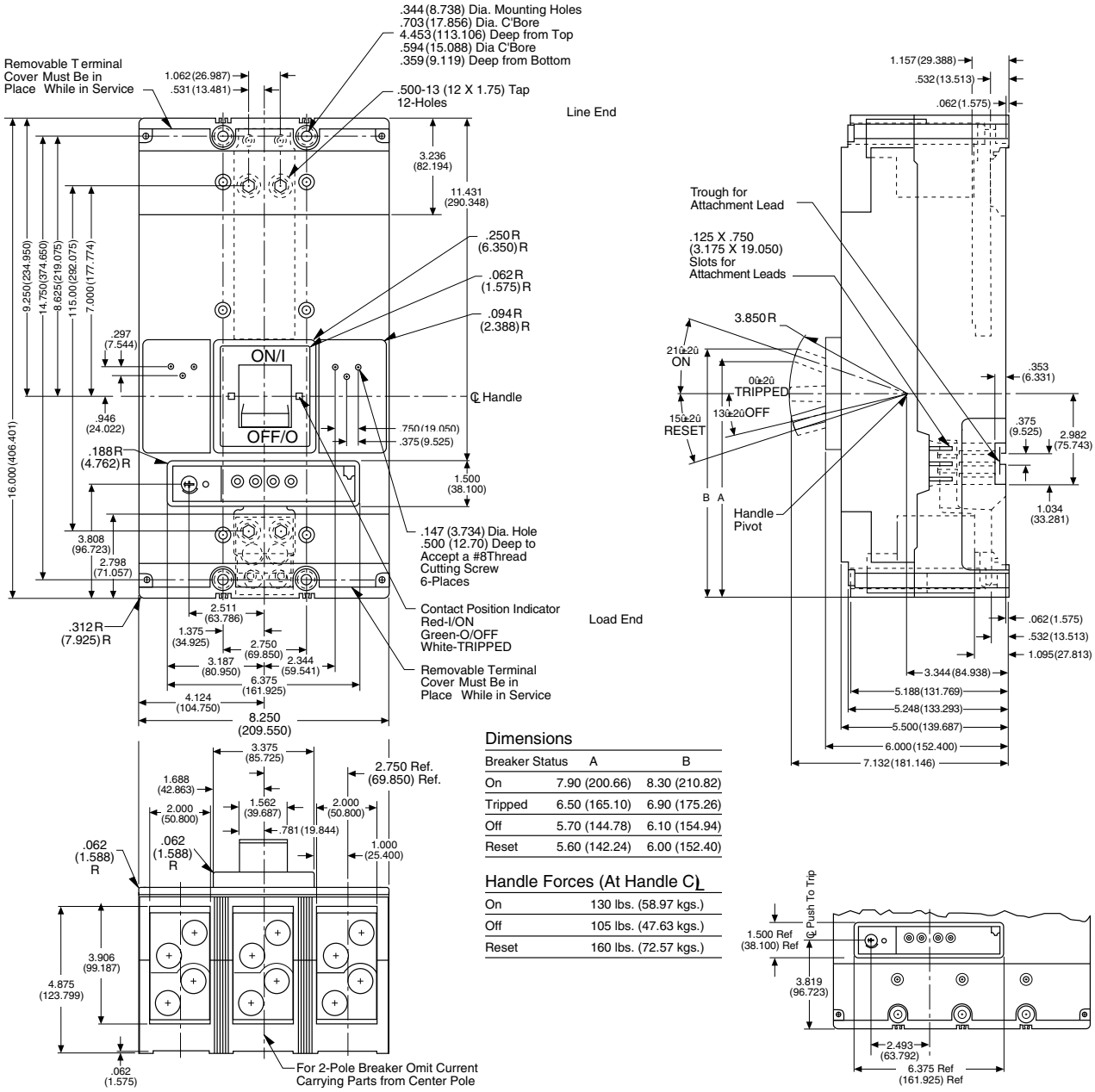
	Description		Cat. No.
	Flex-Cable Operating Mechanism NEMA Type 1/3/12/4/4X Flange-Mount Handle	4 ft. (1.2 m) Cable	140U-N-FCX04
		6 ft. (1.9 m) Cable	140U-N-FCX06
		10 ft. (3.0 m) Cable	140U-N-FCX10
	Rotary, Variable-Depth Operating Mechanism Type 1/12 Rotary Handle 12 in. (30.48 cm) operating rod	Black Handle	140U-N-RM12B
	Phase Barriers Provides additional phase clearance when special connections that extend past the circuit breaker housing are required	Qty: 2	140U-N-PB
	Padlock Kit Padlocking Hasp Lock-OFF only	Qty: 1	140U-N-PL
	Motor Operator Remotely opens, closes, and resets the circuit breaker	Qty: 1	140U-N-EOPD
	Motor Operator, 230..240V AC	Qty: 1	140U-N-EOPA
	Motor Operator Remotely opens, closes, and resets the circuit breaker	Qty: 1	140U-N-EOPZ
	Mounting Hardware (4) M8 - 1 x 35 mm	For use with 3- or 4-Pole MCCBs	140U-M-MHM

Terminal Lugs

	Description	Pkg. Quantity	Cat. No.
	Terminal Lugs Aluminum Lug Aluminum or Copper Wire (2) 1…500 MCM (2) 50…240 mm²	Qty: 1	140U-N-TLA2
	Terminal Lugs Aluminum Lug Aluminum or Copper Wire (3) 3/0…400 MCM (3) 95…185 mm²	Qty: 1	140U-N-TLA3
	Terminal Lugs Aluminum Lug Aluminum or Copper Wire (4) 4/0…500 MCM (4) 120…300 mm²	Qty: 1	140U-N-TLA4
	Terminal Lugs Aluminum Lug Aluminum or Copper Wire (3) 500…750 MCM (3) 300…400 mm²	Qty: 1	140U-N-TLA3A
	Terminal Lugs Copper Lug Copper Wire only (2) 2/0…500 MCM (2) 70…240 mm²	Qty: 1	140U-N-TLC2
	Terminal Lugs Copper Lug Copper Wire only (3) 3/0…500 MCM (3) 95…240 mm²	Qty: 1	140U-N-TLC3
	Terminal Lugs Copper Lug Copper Wire Only (4) 3/0…400 MCM (4) 95…185 mm²	Qty: 1	140U-N-TLC4

Approximate Dimensions — 1200 A, N-Frame

Dimensions are in inches (millimeters). Dimensions are not intended to be used for manufacturing purposes.



Dimensions

Breaker Status	A	B
On	7.90 (200.66)	8.30 (210.82)
Tripped	6.50 (165.10)	6.90 (175.26)
Off	5.70 (144.78)	6.10 (154.94)
Reset	5.60 (142.24)	6.00 (152.40)

Handle Forces (At Handle ℄)

On	130 lbs. (58.97 kgs.)
Off	105 lbs. (47.63 kgs.)
Reset	160 lbs. (72.57 kgs.)

Internal Control Modules — Factory Installed
For use with G-Frame Molded Case Circuit Breakers

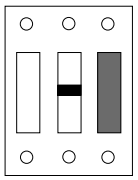
2-Pole Breaker

Mounting Location

Left side only

Right side only

(1) Auxiliary contact (AX)

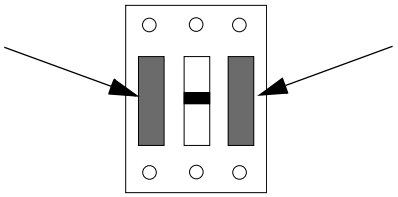


3-Pole Breaker

Mounting Location

Left side only

(1) Auxiliary contact (AX)
or
(1) Alarm contact (AL)
or
(1) Alarm contact (AL) + Auxiliary contact (AX)



Right side only

(1) Shunt Trip (SNT)
or
(1) Undervoltage Release (UVT)

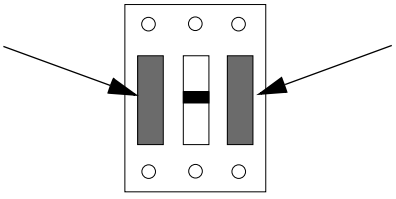
Auxiliary and Alarm Contacts	Suffix	
	2-Pole	3-Pole
(1) AX	- A	- A

Internal Control Modules — Factory Installed
For use with H-, J-, K-, L-, M-, and N-Frame Molded Case Circuit Breakers

Mounting Location

Left side only

(1) Auxiliary contact (AX)
or
(2) Auxiliary contacts (AX)
or
(1) Alarm contact (AL)
or
(1) Alarm contact (AL) + Auxiliary contact (AX)



Right side only

(1) Shunt Trip (SNT)
or
(1) Undervoltage Release (UVT)

Auxiliary and Alarm Contacts	Suffix
(1) AX	- A
(2) AX	- B
(1) AL	- D
(1) AX + (1) AL	- F

Undervoltage Release Combinations	Suffix
(1) UVT only	- G⊗
(1) AX + (1) UVT	- H⊗
(2) AX + (1) UVT	- J⊗
(1) AX + (1) AL + (1) UVT	- L⊗
(1) AL + (1) UVT	- N⊗

⊗Standard Voltage Suffix Codes∗

Voltage [V]	24	110…127	208…240	380…480
AC, 50/60 Hz	J	D	A	B
Voltage [V]	—	—	—	—
DC	—	—	—	—

Shunt Trip Combinations	Suffix
(1) SNT only	- P⊗
(1) AX + (1) SNT	- Q⊗
(2) AX + (1) SNT	- R⊗
(1) AX + (1) AL + (1) SNT	- T⊗
(1) AL + (1) SNT	- V⊗

⊗Standard Voltage Suffix Codes∗

Voltage [V]	12…24	110…240	380…600
AC, 50/60 Hz	J	D	B
Voltage [V]	12…24	110…125	—
DC	J	D	—

∗ For additional voltages, consult your local Allen-Bradley distributor.

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Variable Frequency Drive 480VAC 3-Phase, 7.5HP 12A, 5.5kW, Allen-Bradley, 22B-D012N104

Allen-Bradley

PowerFlex® 40

Adjustable Frequency AC Drive

FRN 1.xx - 6.xx

User Manual

BGMU Submittal Package, Part 2 of 2, 05/03/2010, Page 75 of 1071

Rockwell Automation

www.abpowerflex.com

Important User Information

Solid state equipment has operational characteristics differing from those of electromechanical equipment. *Safety Guidelines for the Application, Installation and Maintenance of Solid State Controls* (Publication SGI-1.1 available from your local Rockwell Automation sales office or online at **http://www.rockwellautomation.com/literature**) describes some important differences between solid state equipment and hard-wired electromechanical devices. Because of this difference, and also because of the wide variety of uses for solid state equipment, all persons responsible for applying this equipment must satisfy themselves that each intended application of this equipment is acceptable.

In no event will Rockwell Automation, Inc. be responsible or liable for indirect or consequential damages resulting from the use or application of this equipment.

The examples and diagrams in this manual are included solely for illustrative purposes. Because of the many variables and requirements associated with any particular installation, Rockwell Automation, Inc. cannot assume responsibility or liability for actual use based on the examples and diagrams.

No patent liability is assumed by Rockwell Automation, Inc. with respect to use of information, circuits, equipment, or software described in this manual.

Reproduction of the contents of this manual, in whole or in part, without written permission of Rockwell Automation, Inc. is prohibited.

Throughout this manual, when necessary we use notes to make you aware of safety considerations.

WARNING: Identifies information about practices or circumstances that can cause an explosion in a hazardous environment, which may lead to personal injury or death, property damage, or economic loss.

Important: Identifies information that is critical for successful application and understanding of the product.

ATTENTION: Identifies information about practices or circumstances that can lead to personal injury or death, property damage, or economic loss. Attentions help you:

- identify a hazard
- avoid the hazard
- recognize the consequences

Shock Hazard labels may be located on or inside the equipment (e.g., drive or motor) to alert people that dangerous voltage may be present.

Burn Hazard labels may be located on or inside the equipment (e.g., drive or motor) to alert people that surfaces may be at dangerous temperatures.

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The information below summarizes the changes to the PowerFlex 40 *User Manual* since the April 2008 release.

Manual Updates

Description of New or Updated Information	Page(s)
Description of A056 revised.	3-17
Description of A059/A062 revised.	3-19
Fault description for F3 revised.	4-3
A table row for electrical specifications added.	A-4
Graphic for the “Network Wiring” section revised.	C-1
Second last paragraph in the “Network Wiring” section revised.	C-2
Text in the “Writing (06) Logic Command Data” section revised.	C-4
Frequency source for logic command 001 of bits 14, 13, and 12 corrected.	C-4
Text in the “Writing (06) Reference” section revised.	C-5

Parameter Updates

The following parameters have been updated with firmware version 6.xx.

Parameter	Number	Description	Page
[Relay Out Sel]	A055	Function of option 20, ParamControl, changed. Option 24, MsgControl, added.	3-16
[Relay Out Sel]	A058, A061	Function of option 20, ParamControl, changed. Option 24, MsgControl, added.	3-18

The information below summarizes the changes to the PowerFlex 40 *User Manual* since the January 2007 release.

Manual Updates

Description of New or Updated Information	Page(s)
Input description and attention text for Multiple Digital Input Connection example corrected.	1-22
New method of changing speed reference for IP66, NEMA/UL Type 4X rated drives described.	2-2
Description for Up Arrow and Down Arrow keys revised.	2-4
Fault description for F3 revised.	4-3
Graphic for the “Network Wiring” section revised.	C-1
Descriptions for bits 6, 7, and 15 of register address 8192 (Logic Command) updated.	C-4
New information on reading register address 8192 added.	C-4
New information on reading register address 8193 added.	C-5
Graphic for the “Connecting an RS-485 Network” section corrected.	D-4
New method for inverting sign of PID error added.	F-6

New Parameter

The following parameter has been added with firmware version 5.xx.

Parameter	Number	Description	Page
[PID Invert Error]	A167	New	3-44

Parameter Updates

The following parameters have been updated with firmware version 5.xx.

Parameter	Number	Description	Page
[Control Source]	d012	Options 7 and 8 added.	3-5
[Start Source]	P036	Description revised for option 6.	3-10
[Relay Out Sel]	A055	Description revised for option 20.	3-16
[Relay Out Level]	A056	Description revised.	3-17
[Opto Outx Sel]	A058, A061	Description revised for option 20.	3-18
[Opto Outx Level]	A059, A062	Description revised.	3-19
[Internal Freq]	A069	Default value for IP66, NEMA/ UL Type 4X drives is 0.0 Hz. Default value for IP20 rated drives is 60.0 Hz.	3-22
[PID Trim Hi]	A130	Description revised.	3-38
[PID Trim Lo]	A131	Description revised.	3-38

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Overview

The purpose of this manual is to provide you with the basic information needed to install, start-up and troubleshoot the PowerFlex 40 Adjustable Frequency AC Drive.

For information on...	See page...
Who Should Use this Manual?	P-1
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Drive Frame Sizes	P-2
General Precautions	P-3
Catalog Number Explanation	P-4

Who Should Use this Manual?

This manual is intended for qualified personnel. You must be able to program and operate Adjustable Frequency AC Drive devices. In addition, you must have an understanding of the parameter settings and functions.

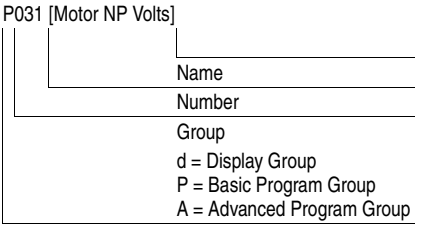
Reference Materials

The following manuals are recommended for general drive information:

Title	Publication	Available Online at ...
Wiring and Grounding Guidelines for Pulse Width Modulated (PWM) AC Drives	DRIVES-IN001...	**www.rockwellautomation.com/literature**
Preventive Maintenance of Industrial Control and Drive System Equipment	DRIVES-TD001...	
Safety Guidelines for the Application, Installation and Maintenance of Solid State Control	SGI-1.1	
A Global Reference Guide for Reading Schematic Diagrams	100-2.10	
Guarding Against Electrostatic Damage	8000-4.5.2	

Manual Conventions

- In this manual we refer to the PowerFlex 40 Adjustable Frequency AC Drive as; drive, PowerFlex 40 or PowerFlex 40 Drive.
- Parameter numbers and names are shown in this format:



- The following words are used throughout the manual to describe an action:

Word	Meaning
Can	Possible, able to do something
Cannot	Not possible, not able to do something
May	Permitted, allowed
Must	Unavoidable, you must do this
Shall	Required and necessary
Should	Recommended
Should Not	Not Recommended

Drive Frame Sizes

Similar PowerFlex 40 drive sizes are grouped into frame sizes to simplify spare parts ordering, dimensioning, etc. A cross reference of drive catalog numbers and their respective frame sizes is provided in Appendix B.

General Precautions

ATTENTION: The drive contains high voltage capacitors which take time to discharge after removal of mains supply. Before working on drive, ensure isolation of mains supply from line inputs [R, S, T (L1, L2, L3)]. Wait three minutes for capacitors to discharge to safe voltage levels. Failure to do so may result in personal injury or death.

Darkened display LEDs is not an indication that capacitors have discharged to safe voltage levels.

ATTENTION: Only qualified personnel familiar with adjustable frequency AC drives and associated machinery should plan or implement the installation, start-up and subsequent maintenance of the system. Failure to comply may result in personal injury and/or equipment damage.

ATTENTION: This drive contains ESD (Electrostatic Discharge) sensitive parts and assemblies. Static control precautions are required when installing, testing, servicing or repairing this assembly. Component damage may result if ESD control procedures are not followed. If you are not familiar with static control procedures, reference A-B publication 8000-4.5.2, “Guarding Against Electrostatic Damage” or any other applicable ESD protection handbook.

ATTENTION: An incorrectly applied or installed drive can result in component damage or a reduction in product life. Wiring or application errors, such as, undersizing the motor, incorrect or inadequate AC supply, or excessive ambient temperatures may result in malfunction of the system.

ATTENTION: The bus regulator function is extremely useful for preventing nuisance overvoltage faults resulting from aggressive decelerations, overhauling loads, and eccentric loads. However, it can also cause either of the following two conditions to occur.
1. Fast positive changes in input voltage or imbalanced input voltages can cause uncommanded positive speed changes;
2. Actual deceleration times can be longer than commanded deceleration times
However, a “Stall Fault” is generated if the drive remains in this state for 1 minute. If this condition is unacceptable, the bus regulator must be disabled (see parameter A117). In addition, installing a properly sized dynamic brake resistor will provide equal or better performance in most cases.

Catalog Number Explanation

1-3	4	5	6-8	9	10	11	12 (1)	13-14
22B	**-**	**A**	**1P5**	**N**	**1**	**1**	**4**	**AA**
Drive	Dash	Voltage Rating	Rating	Enclosure	HIM	Emission Class	Type	Optional

Code	
22B	PowerFlex 40

Code	Version
3	No Brake IGBT
4	Standard

Code	Rating
0	Not Filtered
1	Filtered

Code	Voltage	Ph.
V	120V AC	1
A	240V AC	1
B	240V AC	3
D	480V AC	3
E	600V AC	3

Code	Interface Module
1	Fixed Keypad

Code	Purpose
AA thru ZZ	Reserved for custom firmware

Code	Enclosure
N	Panel Mount - IP20, NEMA/UL Type Open
C	Panel Mount - IP66, NEMA/UL Type 4X
F	Flange Mount - IP20, NEMA/UL Type Open
H	Replacement Plate Drive - IP20, NEMA/UL Type Open - *Contact factory for ordering information.*

Output Current @ 100-120V 50/60 Hz Input

Code	Amps	kW (HP)
2P3	2.3	0.4 (0.5)
5P0	5.0	0.75 (1.0)
6P0	6.0	1.1 (1.5)

Output Current @ 200-240V 50/60 Hz Input

Code	Amps	kW (HP)
2P3	2.3	0.4 (0.5)
5P0	5.0	0.75 (1.0)
8P0	8.0	1.5 (2.0)
012	12	2.2 (3.0)
017	17.5	3.7 (5.0)
024	24	5.5 (7.5)
033	33	7.5 (10)

Output Current @ 380-480V 50/60 Hz Input

Code	Amps	kW (HP)
1P4	1.4	0.4 (0.5)
2P3	2.3	0.75 (1.0)
4P0	4.0	1.5 (2.0)
6P0	6.0	2.2 (3.0)
010	10.5	4.0 (5.0)
012	12	5.5 (7.5)
017	17	7.5 (10)
024	24	11 (15)

Output Current @ 500-600V 50/60 Hz Input

Code	Amps	kW (HP)
1P7	1.7	0.75 (1.0)
3P0	3.0	1.5 (2.0)
4P2	4.2	2.2 (3.0)
6P6	6.6	4.0 (5.0)
9P9	9.9	5.5 (7.5)
012	12.2	7.5 (10)
019	19	11 (15)

(1) Position 12 of the Catalog Number now indicates drive type. All PowerFlex 40 drives are equipped with RS485 communication.

Additional accessories, options and adapters are available. See Appendix B for details.

Installation/Wiring

This chapter provides information on mounting and wiring the PowerFlex 40 Drive.

For information on...	See page
Opening the Cover	1-1
Mounting Considerations	1-3
AC Supply Source Considerations	1-5
General Grounding Requirements	1-7

For information on...	See page
Fuses and Circuit Breakers	1-8
Power Wiring	1-10
I/O Wiring Recommendations	1-14
EMC Instructions	1-25

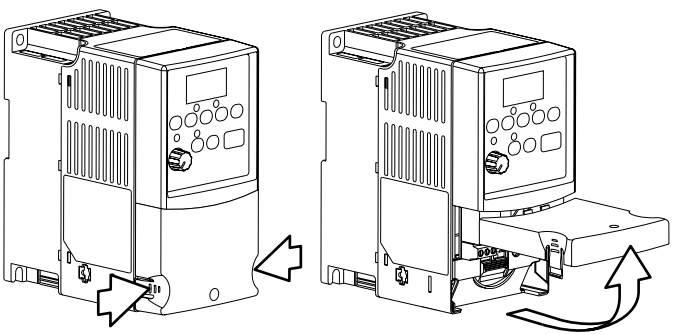
Most start-up difficulties are the result of incorrect wiring. Every precaution must be taken to assure that the wiring is done as instructed. All items must be read and understood before the actual installation begins.

ATTENTION: The following information is merely a guide for proper installation. Rockwell Automation, Inc. cannot assume responsibility for the compliance or the noncompliance to any code, national, local or otherwise for the proper installation of this drive or associated equipment. A hazard of personal injury and/or equipment damage exists if codes are ignored during installation.

Opening the Cover

IP20, NEMA/UL Type Open

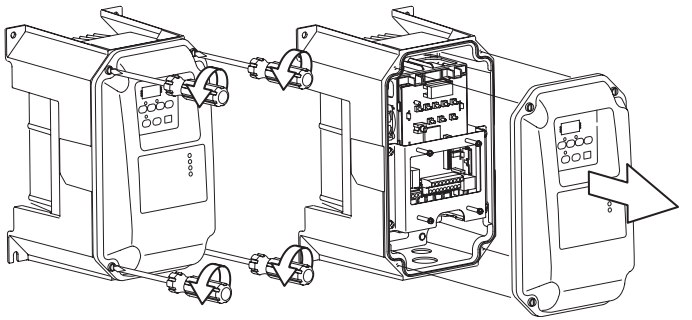
1. Press and hold in the tabs on each side of the cover.
2. Pull the cover out and up to release.



IP66, NEMA/UL Type 4X

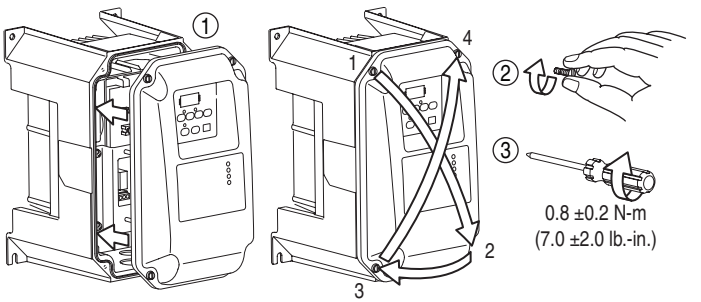
ATTENTION: To avoid an electric shock hazard, ensure isolation of mains supply from line inputs [R, S, T (L1, L2, L3)] and wait three minutes for capacitors to discharge before removing the external cover. Once the cover is removed, verify that the voltage on the bus capacitors has discharged before performing any work on the drive. Measure the DC bus voltage at the DC– and DC+ terminals on the Power Terminal Block (refer to page 1-13 for Power Terminal descriptions). The voltage must be zero.

1. Loosen the four captive cover screws.
2. Pull cover straight off chassis.



IP66, NEMA/UL Type 4X Cover Installation

1. Squarely align the cover on the chassis.
2. Lightly tighten the four captive cover screws.
3. Torque the cover screws using an alternating pattern.



Mounting Considerations

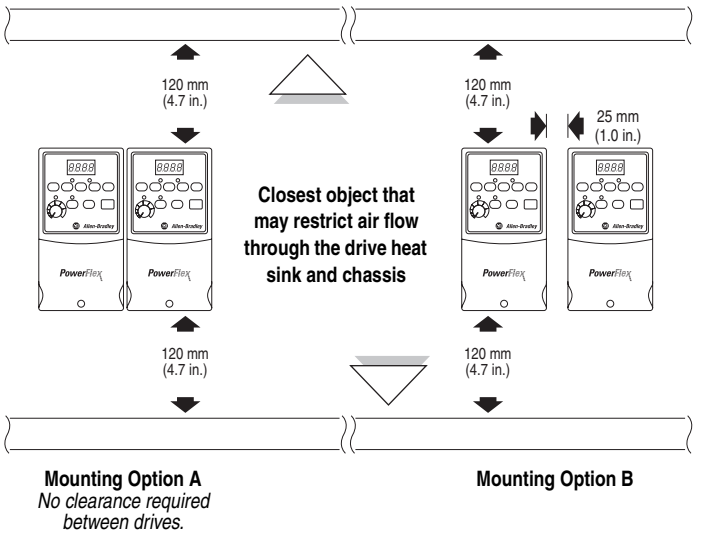
- Mount the drive upright on a flat, vertical and level surface.

Frame	Screw Size	Screw Torque	DIN Rail
B	M4 (#8-32)	1.56-1.96 N-m (14-17 lb.-in.)	35 mm
C	M5 (#10-24)	2.45-2.94 N-m (22-26 lb.-in.)	–
B (IP66, Type 4X)	M6 (#12-24)	3.95-4.75 N-m (35-42 lb.-in.)	–

- Protect the cooling fan by avoiding dust or metallic particles.
- Do not expose to a corrosive atmosphere.
- Protect from moisture and direct sunlight.

Minimum Mounting Clearances

Refer to Appendix B for mounting dimensions.



Ambient Operating Temperatures

Table 1.A Enclosure and Clearance Requirements

Ambient Temperature		Enclosure Rating	Minimum Mounting Clearances
Minimum	Maximum		
-10°C (14°F)	40°C (104°F)	IP20, NEMA/UL Type Open	Use Mounting Option A
		IP66, NEMA/UL Type 4X	Use Mounting Option A
		IP30, NEMA/UL Type 1(1)	Use Mounting Option B
	50°C (122°F)	IP20, NEMA/UL Type Open	Use Mounting Option B

(1) Rating requires installation of the PowerFlex 40 IP30, NEMA/UL Type 1 option kit.

Debris Protection

A plastic top panel is included with the drive. Install the panel to prevent debris from falling through the vents of the drive housing during installation. Remove the panel for IP20, NEMA/UL Type Open applications.

Storage

- Store within an ambient temperature range of -40° to +85°C.
- Store within a relative humidity range of 0% to 95%, non-condensing.
- Do not expose to a corrosive atmosphere.

AC Supply Source Considerations

Ungrounded Distribution Systems

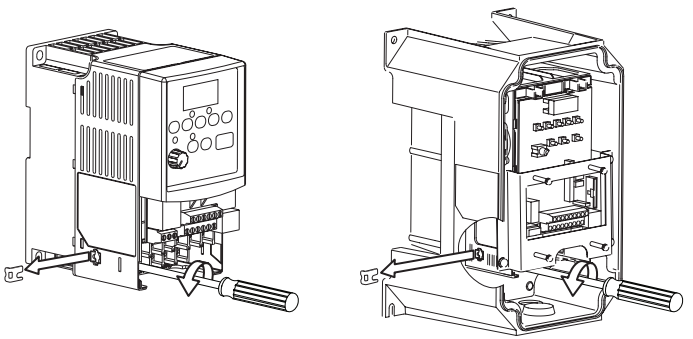
ATTENTION: PowerFlex 40 drives contain protective MOVs that are referenced to ground. These devices must be disconnected if the drive is installed on an ungrounded or resistive grounded distribution system.

Disconnecting MOVs

To prevent drive damage, the MOVs connected to ground shall be disconnected if the drive is installed on an ungrounded distribution system where the line-to-ground voltages on any phase could exceed 125% of the nominal line-to-line voltage. To disconnect these devices, remove the jumper shown in the Figures 1.1 and 1.2.

1. Turn the screw counterclockwise to loosen.
2. Pull the jumper completely out of the drive chassis.
3. Tighten the screw to keep it in place.

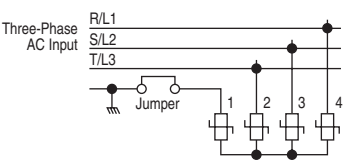
Figure 1.1 Jumper Location (Typical)



IP20, NEMA/UL Type Open **IP66, NEMA/UL Type 4X**

Important: Tighten screw after jumper removal.

Figure 1.2 Phase to Ground MOV Removal



Input Power Conditioning

The drive is suitable for direct connection to input power within the rated voltage of the drive (see Appendix A). Listed in Table 1.B are certain input power conditions which may cause component damage or reduction in product life. If any of the conditions exist, as described in Table 1.B, install one of the devices listed under the heading *Corrective Action* on the line side of the drive.

Important: Only one device per branch circuit is required. It should be mounted closest to the branch and sized to handle the total current of the branch circuit.

Table 1.B Input Power Conditions

Input Power Condition	Corrective Action
Low Line Impedance (less than 1% line reactance) Greater than 120 kVA supply transformer	• Install Line Reactor(2) • or Isolation Transformer • or Bus Inductor – 5.5 & 11 kW (7.5 & 15 HP) drives only
Line has power factor correction capacitors Line has frequent power interruptions Line has intermittent noise spikes in excess of 6000V (lightning)	• Install Line Reactor • or Isolation Transformer
Phase to ground voltage exceeds 125% of normal line to line voltage Ungrounded distribution system	• Remove MOV jumper to ground. • or Install Isolation Transformer with grounded secondary if necessary.
240V open delta configuration (stinger leg)(1)	• Install Line Reactor

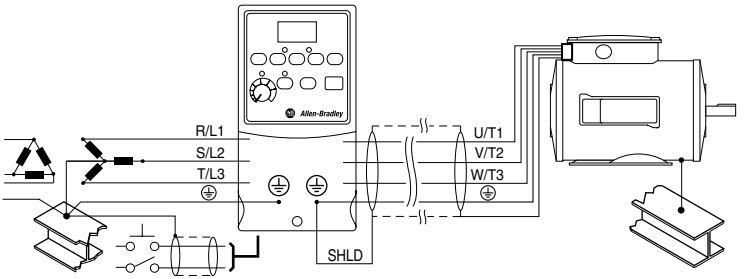
(1) For drives applied on an open delta with a middle phase grounded neutral system, the phase opposite the phase that is tapped in the middle to the neutral or earth is referred to as the “stinger leg,” “high leg,” “red leg,” etc. This leg should be identified throughout the system with red or orange tape on the wire at each connection point. The stinger leg should be connected to the center Phase B on the reactor. Refer to Table B.D for specific line reactor part numbers.

(2) Refer to Appendix B for accessory ordering information.

General Grounding Requirements

The drive Safety Ground - ⏚ (PE) must be connected to system ground. Ground impedance must conform to the requirements of national and local industrial safety regulations and/or electrical codes. The integrity of all ground connections should be periodically checked.

Figure 1.3 Typical Grounding



Ground Fault Monitoring

If a system ground fault monitor (RCD) is to be used, only Type B (adjustable) devices should be used to avoid nuisance tripping.

Safety Ground - ⏚ (PE)

This is the safety ground for the drive that is required by code. One of these points must be connected to adjacent building steel (girder, joist), a floor ground rod or bus bar. Grounding points must comply with national and local industrial safety regulations and/or electrical codes.

Motor Ground

The motor ground must be connected to one of the ground terminals on the drive.

Shield Termination - SHLD

Either of the safety ground terminals located on the power terminal block provides a grounding point for the motor cable shield. The **motor cable** shield connected to one of these terminals (drive end) should also be connected to the motor frame (motor end). Use a shield terminating or EMI clamp to connect the shield to the safety ground terminal. The conduit box option may be used with a cable clamp for a grounding point for the cable shield.

When shielded cable is used for **control and signal wiring**, the shield should be grounded at the source end only, not at the drive end.

RFI Filter Grounding

Using single phase drives with integral filter, or an external filter with any drive rating, may result in relatively high ground leakage currents. Therefore, the **filter must only be used in installations with grounded AC supply systems and be permanently installed and solidly grounded** (bonded) to the building power distribution ground. Ensure that the incoming supply neutral is solidly connected (bonded) to the same building power distribution ground. Grounding must not rely on flexible cables and should not include any form of plug or socket that would permit inadvertent disconnection. Some local codes may require redundant ground connections. The integrity of all connections should be periodically checked.

Fuses and Circuit Breakers

The PowerFlex 40 does not provide branch short circuit protection. This product should be installed with either input fuses or an input circuit breaker. National and local industrial safety regulations and/or electrical codes may determine additional requirements for these installations.

ATTENTION: To guard against personal injury and/or equipment damage caused by improper fusing or circuit breaker selection, use only the recommended line fuses/circuit breakers specified in this section.

Fusing

The PowerFlex 40 has been UL tested and approved for use with input fuses. The ratings in the table that follows are the minimum recommended values for use with each drive rating. The devices listed in this table are provided to serve as a guide.

Bulletin 140M (Self-Protected Combination Controller)/UL489 Circuit Breakers

When using Bulletin 140M or UL489 rated circuit breakers, the guidelines listed below must be followed in order to meet the NEC requirements for branch circuit protection.

- Bulletin 140M can be used in single and group motor applications.
- Bulletin 140M can be used up stream from the drive **without** the need for fuses.

Table 1.C Minimum Recommended Branch Circuit Protective Devices

Voltage Rating	**Drive Rating** *kW (HP)*	**Fuse Rating**[1] *Amps*	**140M Motor Protectors**[2] *Catalog No.*	**Recommended MCS Contactors** *Catalog No.*
120V AC – 1-Phase	0.4 (0.5) 0.75 (1.0) 1.1 (1.5)	15 35 40	140M-C2E-C16 140M-D8E-C20 140M-F8E-C32	100-C12 100-C23 100-C37
240V AC – 1-Phase	0.4 (0.5) 0.75 (1.0) 1.5 (2.0) 2.2 (3.0)	10 20 30 40	140M-C2E-B63 140M-C2E-C16 140M-D8E-C20 140M-F8E-C32	100-C09 100-C12 100-C23 100-C37
240V AC – 3-Phase	0.4 (0.5) 0.75 (1.0) 1.5 (2.0) 2.2 (3.0) 3.7 (5.0) 5.5 (7.5) 7.5 (10.0)	6 10 15 25 30 40 60	140M-C2E-B40 140M-C2E-C10 140M-C2E-C16 140M-C2E-C16 140M-F8E-C25 140M-F8E-C32 140M-G8E-C45	100-C07 100-C09 100-C12 100-C23 100-C23 100-C37 100-C60
480V AC – 3-Phase	0.4 (0.5) 0.75 (1.0) 1.5 (2.0) 2.2 (3.0) 4.0 (5.0) 5.5 (7.5) 7.5 (10.0) 11 (15)	3 6 10 15 20 25 30 50	140M-C2E-B25 140M-C2E-B40 140M-C2E-B63 140M-C2E-C10 140M-C2E-C16 140M-D8E-C20 140M-D8E-C20 140M-F8E-C32	100-C07 100-C07 100-C09 100-C09 100-C23 100-C23 100-C23 100-C43
600V AC – 3-Phase	0.75 (1.0) 1.5 (2.0) 2.2 (3.0) 4.0 (5.0) 5.5 (7.5) 7.5 (10.0) 11 (15)	6 6 10 15 20 25 40	140M-C2E-B25 140M-C2E-B40 140M-C2E-B63 140M-C2E-C10 140M-C2E-C16 140M-C2E-C16 140M-D8E-C25	100-C09 100-C09 100-C09 100-C09 100-C16 100-C23 100-C30

(1) Recommended Fuse Type: UL Class J, CC, T or Type BS88; 600V (550V) or equivalent.

(2) Refer to the Bulletin 140M Motor Protectors *Selection Guide*, publication 140M-SG001… to determine the frame and breaking capacity required for your application.

Power Wiring

ATTENTION: National Codes and standards (NEC, VDE, BSI, etc.) and local codes outline provisions for safely installing electrical equipment. Installation must comply with specifications regarding wire types, conductor sizes, branch circuit protection and disconnect devices. Failure to do so may result in personal injury and/or equipment damage.

ATTENTION: To avoid a possible shock hazard caused by induced voltages, unused wires in the conduit must be grounded at both ends. For the same reason, if a drive sharing a conduit is being serviced or installed, all drives using this conduit should be disabled. This will help minimize the possible shock hazard from “cross coupled” power leads.

Motor Cable Types Acceptable for 200-600 Volt Installations

A variety of cable types are acceptable for drive installations. For many installations, unshielded cable is adequate, provided it can be separated from sensitive circuits. As an approximate guide, allow a spacing of 0.3 meters (1 foot) for every 10 meters (32.8 feet) of length. In all cases, long parallel runs must be avoided. Do not use cable with an insulation thickness less than 15 mils (0.4 mm/0.015 in.). Do not route more than three sets of motor leads in a single conduit to minimize “cross talk”. If more than three drive/motor connections per conduit are required, shielded cable must be used.
UL installations in 50°C ambient must use 600V, 75°C or 90°C wire.
UL installations in 40°C ambient should use 600V, 75°C or 90°C wire.
Use copper wire only. Wire gauge requirements and recommendations are based on 75 degree C. Do not reduce wire gauge when using higher temperature wire.

Unshielded

THHN, THWN or similar wire is acceptable for drive installation in dry environments provided adequate free air space and/or conduit fill rates limits are provided. **Do not use THHN or similarly coated wire in wet areas**. Any wire chosen must have a minimum insulation thickness of 15 mils and should not have large variations in insulation concentricity.

Shielded/Armored Cable

Shielded cable contains all of the general benefits of multi-conductor cable with the added benefit of a copper braided shield that can contain much of the noise generated by a typical AC Drive. Strong consideration for shielded cable should be given in installations with sensitive equipment such as weigh scales, capacitive proximity switches and other devices that may be affected by electrical noise in the distribution system. Applications with large numbers of drives in a similar location, imposed EMC regulations or a high degree of communications / networking are also good candidates for shielded cable.

Shielded cable may also help reduce shaft voltage and induced bearing currents for some applications. In addition, the increased impedance of shielded cable may help extend the distance that the motor can be located from the drive without the addition of motor protective devices such as terminator networks. Refer to Reflected Wave in "Wiring and Grounding Guidelines for PWM AC Drives," publication DRIVES-IN001A-EN-P.

Consideration should be given to all of the general specifications dictated by the environment of the installation, including temperature, flexibility, moisture characteristics and chemical resistance. In addition, a braided shield should be included and be specified by the cable manufacturer as having coverage of at least 75%. An additional foil shield can greatly improve noise containment.

A good example of recommended cable is Belden® 295xx (xx determines gauge). This cable has four (4) XLPE insulated conductors with a 100% coverage foil and an 85% coverage copper braided shield (with drain wire) surrounded by a PVC jacket.

Other types of shielded cable are available, but the selection of these types may limit the allowable cable length. Particularly, some of the newer cables twist 4 conductors of THHN wire and wrap them tightly with a foil shield. This construction can greatly increase the cable charging current required and reduce the overall drive performance. Unless specified in the individual distance tables as tested with the drive, these cables are not recommended and their performance against the lead length limits supplied is not known.

Recommended Shielded Wire

Location	Rating/Type	Description
Standard (Option 1)	600V, 90°C (194°F) XHHW2/RHW-2 Anixter B209500-B209507, Belden 29501-29507, or equivalent	• Four tinned copper conductors with XLPE insulation. • Copper braid/aluminum foil combination shield and tinned copper drain wire. • PVC jacket.
Standard (Option 2)	Tray rated 600V, 90°C (194°F) RHH/RHW-2 Anixter OLF-7xxxxx or equivalent	• Three tinned copper conductors with XLPE insulation. • 5 mil single helical copper tape (25% overlap min.) with three bare copper grounds in contact with shield. • PVC jacket.
Class I & II; Division I & II	Tray rated 600V, 90°C (194°F) RHH/RHW-2 Anixter 7V-7xxxx-3G or equivalent	• Three bare copper conductors with XLPE insulation and impervious corrugated continuously welded aluminum armor. • Black sunlight resistant PVC jacket overall. • Three copper grounds on #10 AWG and smaller.

Reflected Wave Protection

The drive should be installed as close to the motor as possible. Installations with long motor cables may require the addition of external devices to limit voltage reflections at the motor (reflected wave phenomena). See Table 1.D for recommendations.

The reflected wave data applies to all frequencies 2 to 16 kHz.

For 240V ratings, reflected wave effects do not need to be considered.

Table 1.D Maximum Cable Length Recommendations

Reflected Wave		
380-480V Ratings	**Motor Insulation Rating**	**Motor Cable Only**(1)
	1000 Vp-p	15 meters (49 feet)
	1200 Vp-p	40 meters (131 feet)
	1600 Vp-p	170 meters (558 feet)

(1) Longer cable lengths can be achieved by installing devices on the output of the drive. Consult factory for recommendations.

Output Disconnect

The drive is intended to be commanded by control input signals that will start and stop the motor. A device that routinely disconnects then reapplies output power to the motor for the purpose of starting and stopping the motor should not be used. If it is necessary to disconnect power to the motor with the drive outputting power, an auxiliary contact should be used to simultaneously disable drive control run commands.

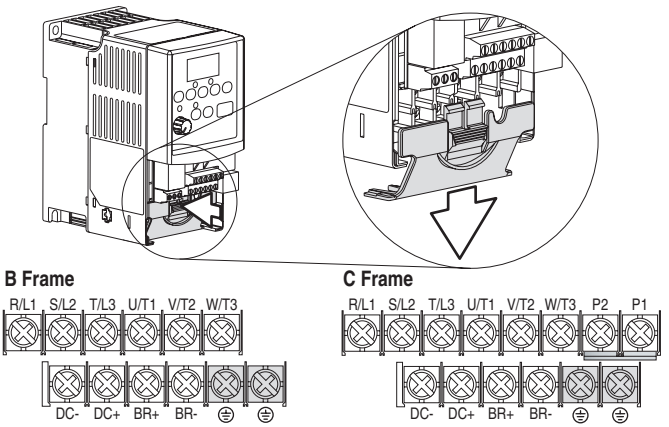
Power Terminal Block

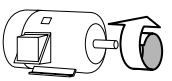
The power terminal block is covered by a finger guard. To remove:

1. Press in and hold the locking tab.
2. Slide finger guard down and out.

Replace the finger guard when wiring is complete.

Figure 1.4 Power Terminal Block (Typical)



Terminal (1)	Description
R/L1, S/L2	1-Phase Input
R/L1, S/L2, T/L3	3-Phase Input
U/T1	To Motor U/T1
V/T2	To Motor V/T2 =  Switch any two motor leads to change forward direction.
W/T3	To Motor W/T3
P2, P1	DC Bus Inductor Connection (C Frame drives only.) The C Frame drive is shipped with a jumper between Terminals P2 and P1. Remove this jumper only when a DC Bus Inductor will be connected. Drive will not power up without a jumper or inductor connected.
DC+, DC-	DC Bus Connection
BR+, BR-	Dynamic Brake Resistor Connection
⏚	Safety Ground - PE

(1) **Important:** Terminal screws may become loose during shipment. Ensure that all terminal screws are tightened to the recommended torque before applying power to the drive.

Table 1.E Power Terminal Block Specifications

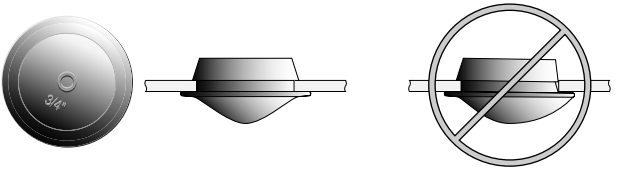
Frame	Maximum Wire Size(1)	Minimum Wire Size(1)	Torque
B	5.3 mm^2 (10 AWG)	1.3 mm^2 (16 AWG)	1.7-2.2 N-m (16-19 lb.-in.)
C	8.4 mm^2 (8 AWG)	1.3 mm^2 (16 AWG)	2.9-3.7 N-m (26-33 lb.-in.)

(1) Maximum/minimum sizes that the terminal block will accept - these are not recommendations.

IP66, NEMA/UL Type 4X Installations

Use the plugs supplied with IP66, NEMA/UL Type 4X rated drives to seal unused holes in the conduit entry plate.

Important: Completely seat the plug inner rim for the best seal.



I/O Wiring Recommendations

Motor Start/Stop Precautions

ATTENTION: A contactor or other device that routinely disconnects and reapplies the AC line to the drive to start and stop the motor can cause drive hardware damage. The drive is designed to use control input signals that will start and stop the motor. If used, the input device must not exceed one operation per minute or drive damage can occur.

ATTENTION: The drive start/stop control circuitry includes solid-state components. If hazards due to accidental contact with moving machinery or unintentional flow of liquid, gas or solids exist, an additional hardwired stop circuit may be required to remove the AC line to the drive. When the AC line is removed, there will be a loss of any inherent regenerative braking effect that might be present - the motor will coast to a stop. An auxiliary braking method may be required.

Important points to remember about I/O wiring:

- Always use copper wire.
- Wire with an insulation rating of 600V or greater is recommended.
- Control and signal wires should be separated from power wires by at least 0.3 meters (1 foot).

Important: I/O terminals labeled “Common” are not referenced to the safety ground (PE) terminal and are designed to greatly reduce common mode interference.

ATTENTION: Driving the 4-20mA analog input from a voltage source could cause component damage. Verify proper configuration prior to applying input signals.

Control Wire Types

Table 1.F Recommended Control and Signal Wire(1)

Wire Type(s)(2)	Description	Minimum Insulation Rating
Belden 8760/9460 (or equiv.)	0.8 mm^2 (18 AWG), twisted pair, 100% shield with drain.	300V 60 degrees C (140 degrees F)
Belden 8770 (or equiv.)	0.8 mm^2 (18 AWG), 3 conductor, shielded for remote pot only.	

(1) If the wires are short and contained within a cabinet which has no sensitive circuits, the use of shielded wire may not be necessary, but is always recommended.

(2) Stranded or solid wire.

I/O Terminal Block

Table 1.G I/O Terminal Block Specifications

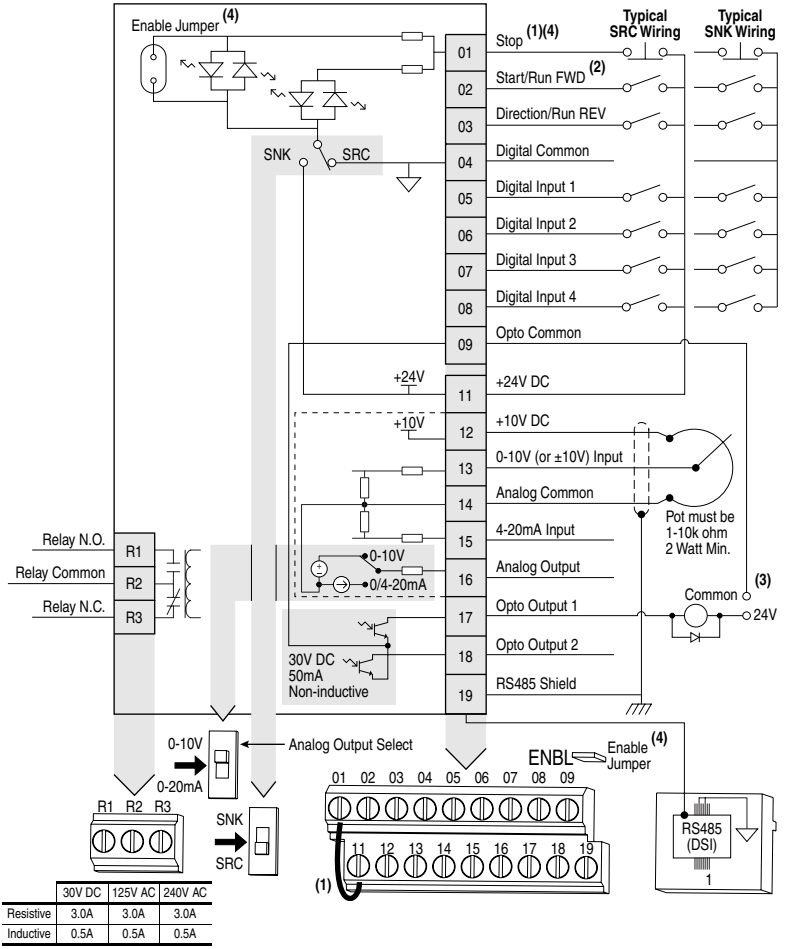
Frame	Maximum Wire Size (3)	Minimum Wire Size (3)	Torque
B & C	1.3 mm^2 (16 AWG)	0.2 mm^2 (24 AWG)	0.5-0.8 N-m (4.4-7 lb.-in.)

(3) Maximum/minimum sizes that the terminal block will accept - these are not recommendations.

Maximum Control Wire Recommendations

Do not exceed control wiring length of 30 meters (100 feet). Control signal cable length is highly dependent on electrical environment and installation practices. To improve noise immunity, the I/O terminal block Common must be connected to ground terminal/protective earth. If using the RS485 (DSI) port, I/O Terminal 16 should also be connected to ground terminal/protective earth.

Figure 1.5 Control Wiring Block Diagram



	30V DC	125V AC	240V AC
Resistive	3.0A	3.0A	3.0A
Inductive	0.5A	0.5A	0.5A

(1) **Important:** I/O Terminal 01 is always a coast to stop input except when P036 [Start Source] is set to "3-Wire" or "Momt FWD/REV" control. In three wire control, I/O Terminal 01 is controlled by P037 [Stop Mode]. All other stop sources are controlled by P037 [Stop Mode].

P036 [Start Source]	Stop	I/O Terminal 01 Stop
Keypad	Per P037	Coast
3-Wire	Per P037	Per P037(4)
2-Wire	Per P037	Coast
Momt FWD/REV	Per P037	Per P037(4)
RS485 Port	Per P037	Coast

Important: The drive is shipped with a jumper installed between I/O Terminals 01 and 11. Remove this jumper when using I/O Terminal 01 as a stop or enable input.

(2) Two wire control shown. For three wire control use a momentary input on I/O Terminal 02 to command a start. Use a maintained input for I/O Terminal 03 to change direction.

(3) When using an opto output with an inductive load such as a relay, install a recovery diode parallel to the relay as shown, to prevent damage to the output.

(4) When the ENBL enable jumper is removed, I/O Terminal 01 will always act as a hardware enable, causing a coast to stop without software interpretation.

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Table 1.H Control I/O Terminal Designations

No.	Signal	Default	Description	Param.
R1	Relay N.O.	Fault	Normally open contact for output relay.	A055
R2	Relay Common	–	Common for output relay.	
R3	Relay N.C.	Fault	Normally closed contact for output relay.	A055

Analog Output Select DIP Switch	0-10V	Sets analog output to either voltage or current. Setting must match A065 [Analog Out Sel].
Sink/Source DIP Switch	Source (SRC)	Inputs can be wired as Sink (SNK) or Source (SRC) via DIP Switch setting.

01	Stop (1)	Coast	The factory installed jumper or a normally closed input must be present for the drive to start.	P036 (1)
02	Start/Run FWD	Not Active	Command comes from the integral keypad by default.	P036, P037
03	Direction/Run REV	Not Active	To disable reverse operation, see A095 [Reverse Disable].	P036, P037, A095
04	Digital Common	–	For digital inputs. Electronically isolated with digital inputs from analog I/O and opto outputs.	
05	Digital Input 1	Preset Freq	Program with A051 [Digital In1 Sel].	A051
06	Digital Input 2	Preset Freq	Program with A052 [Digital In2 Sel].	A052
07	Digital Input 3	Local	Program with A053 [Digital In3 Sel].	A053
08	Digital Input 4	Jog Forward	Program with A054 [Digital In4 Sel].	A054
09	Opto Common	–	For opto-coupled outputs. Electronically isolated with opto outputs from analog I/O and digital inputs.	
11	+24V DC	–	Referenced to Digital Common. Drive supplied power for digital inputs. Maximum output current is 100mA.	
12	+10V DC	–	Referenced to Analog Common. Drive supplied power for 0-10V external potentiometer. Maximum output current is 15mA.	P038
13	±10V In (2)	Not Active	For external 0-10V (unipolar) or ±10V (bipolar) input supply (input impedance = 100k ohm) or potentiometer wiper.	P038, A051-A054, A123, A132
14	Analog Common	–	For 0-10V In or 4-20mA In. Electronically isolated with analog inputs and outputs from digital I/O and opto outputs.	
15	4-20mA In (2)	Not Active	For external 4-20mA input supply (input impedance = 250 ohm).	P038, A051-A054, A132
16	Analog Output	OutFreq 0-10	The default analog output is 0-10V. To covert to a current value, change the Analog Output Select DIP Switch to 0-20mA. Program with A065 [Analog Out Sel]. Max analog value can be scaled with A066 [Analog Out High]. Maximum Load: 4-20mA = 525 ohm (10.5V) 0-10V = 1k ohm (10mA)	A065, A066
17	Opto Output 1	MotorRunning	Program with A058 [Opto Out1 Sel]	A058, A059, A064
18	Opto Output 2	At Frequency	Program with A061 [Opto Out2 Sel]	A061, A062, A064
19	RS485 (DSI) Shield	–	Terminal should be connected to safety ground - PE when using the RS485 (DSI) communications port.	

(1) See Footnotes (1) and (4) on page 1-16.

(2) 0-10V In and 4-20mA In are distinct input channels and may be connected simultaneously. Inputs may be used independently for speed control or jointly when operating in PID mode.

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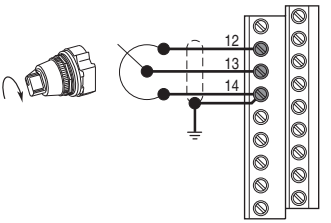
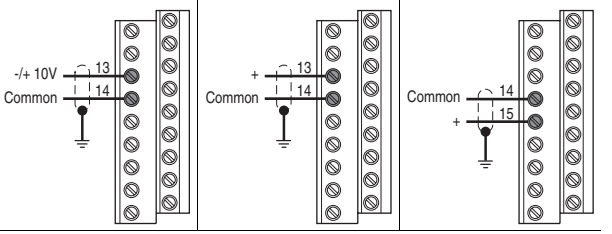
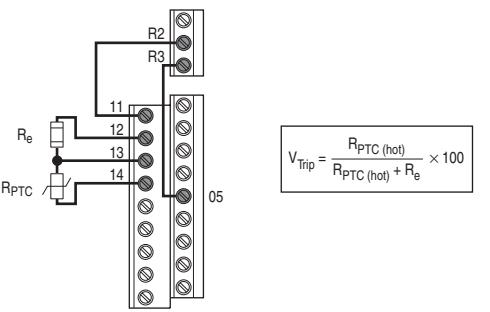
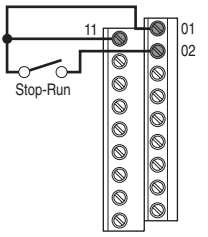
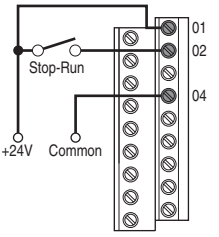
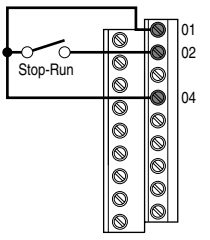
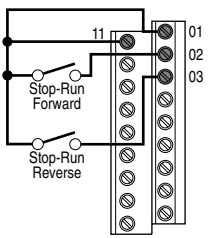
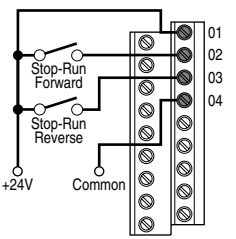
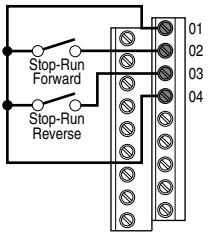
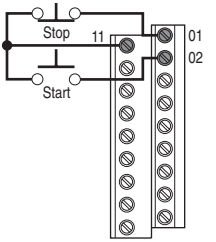
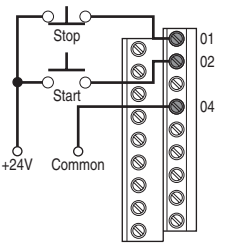
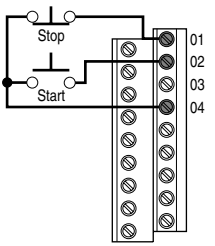
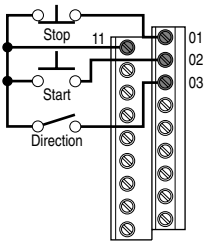
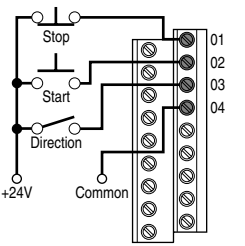
I/O Wiring Examples

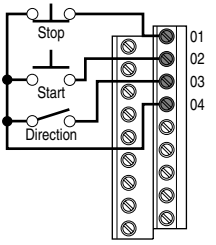
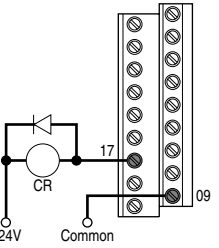
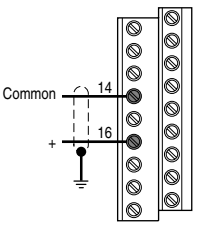
<table>
<tr><th>Input/Output</th><th colspan="3">Connection Example</th></tr>
<tr><td>Potentiometer
1-10k Ohm Pot. Recommended
(2 Watt minimum)</td><td colspan="3">P038 [Speed Reference] = 2 “0-10V Input”
 
</td></tr>
<tr><td rowspan="2">Analog Input
0 to +10V, 100k ohm impedance
4-20 mA, 250 ohm impedance</td><td>Bipolar
P038 [Speed Reference] = 2 “0-10V Input” and A123 [10V Bipolar Enbl] = 1 “Bi-Polar In”</td><td>Unipolar (Voltage)
P038 [Speed Reference] = 2 “0-10V Input”</td><td>Unipolar (Current)
P038 [Speed Reference] = 3 “4-20mA Input”</td></tr>
<tr><td> 
</td></tr>
<tr><td>Analog Input, PTC
For Drive Fault</td><td colspan="3">Wire the PTC and External Resistor (typically matched to the PTC Hot Resistance) to I/O Terminals 12, 13, 14.
Wire R2/R3 Relay Output (SRC) to I/O Terminals 5 & 11.
A051 [Digital In1 Sel] = 3 “Aux Fault”
A055 [Relay Out Sel] = 10 “Above Anlg V”
A056 [Relay Out Level] = % Voltage Trip
 
</td></tr>
</table>

<table>
<tr><th>Input/Output</th><th colspan="2">Connection Example</th></tr>
<tr><td rowspan="2">2 Wire SRC Control - Non-Reversing
P036 [Start Source] = 2, 3 or 4
Input must be active for the drive to run. When input is opened, the drive will stop as specified by P037 [Stop Mode].
If desired, a User Supplied 24V DC power source can be used. Refer to the “External Supply (SRC)” example.</td><td>Internal Supply (SRC)
 
</td><td>External Supply (SRC)
 

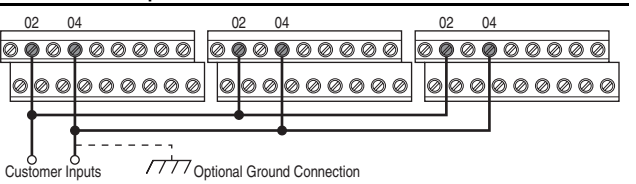
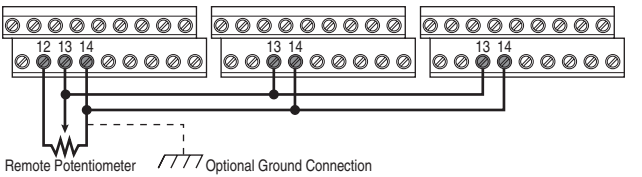
Each digital input draws 6 mA.</td></tr>
<tr><td colspan="2">2 Wire SNK Control - Non-Reversing
Internal Supply (SNK)
 
</td></tr>
<tr><td rowspan="2">2 Wire SRC Control - Run FWD/Run REV
P036 [Start Source] = 2, 3 or 4
Input must be active for the drive to run. When input is opened, the drive will stop as specified by P037 [Stop Mode].
If both Run Forward and Run Reverse inputs are closed at the same time, an undetermined state could occur.</td><td>Internal Supply (SRC)
 
</td><td>External Supply (SRC)
 

Each digital input draws 6 mA.</td></tr>
</table>

Input/Output	Connection Example	
2 Wire SNK Control - Run FWD/Run REV	Internal Supply (SNK) 	
3 Wire SRC Control - Non-Reversing P036 [Start Source] = 1 A momentary input will start the drive. A stop input to I/O Terminal 01 will stop the drive as specified by P037 [Stop Mode].	Internal Supply (SRC) 	External Supply (SRC)  Each digital input draws 6 mA.
3 Wire SNK Control - Non-Reversing	Internal Supply (SNK) 	
3 Wire SRC Control - Reversing P036 [Start Source] = 1 A momentary input will start the drive. A stop input to I/O Terminal 01 will stop the drive as specified by P037 [Stop Mode]. I/O Terminal 03 determines direction.	Internal Supply (SRC) 	External Supply (SRC)  Each digital input draws 6 mA.

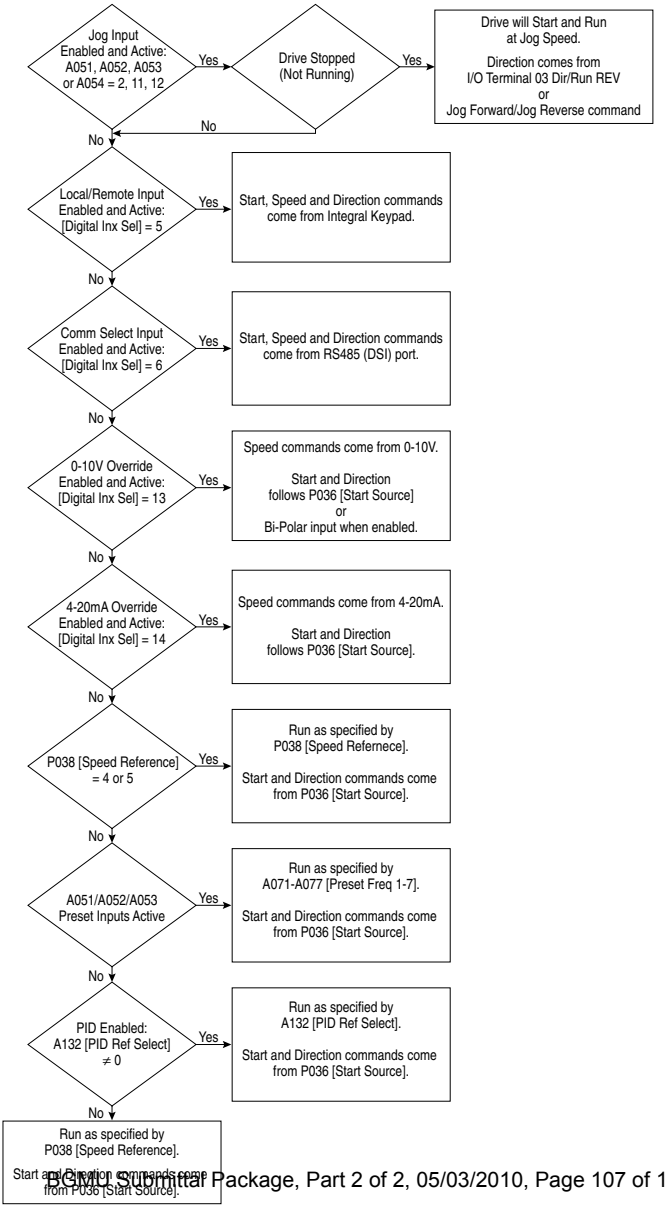
Input/Output	Connection Example
3 Wire SNK Control - Reversing	Internal Supply (SNK) 
Opto Output (1 & 2) A058 [Opto Out1 Sel] determines Opto-Output 1 (I/O Terminal 17) operation. A061 [Opto Out2 Sel] determines Opto-Output 2 (I/O Terminal 18) operation. When using Opto-Output with an inductive load such as a relay, install a recovery diode parallel to the relay as shown, to prevent damage to the output.	Opto-Output 1  Each Opto-Output is rated 30V DC 50 mA (Non-inductive).
Analog Output A065 [Analog Out Sel] determines analog output type and drive conditions. 0-10V, 1k ohm minimum 0-20mA/4-20mA, 525 ohm maximum	A065 [Analog Out Sel] = 0 through 14 The Analog Output Select DIP Switch must be set to match the analog output signal mode set in A065 [Analog Out Sel]. 

Typical Multiple Drive Connection Examples

Input/Output	Connection Example
Multiple Digital Input Connections Customer Inputs can be wired per External Supply (SRC) examples on 1-19 and 1-20.	 When connecting a single input such as Run, Stop, Reverse or Preset Speeds to multiple drives, it is important to connect I/O Terminal 04 common together for all drives. If they are to be tied into another common (such as earth ground or separate apparatus ground) only one point of the daisy chain of I/O Terminal 04 should be connected. **ATTENTION:** Digital inputs on multiple drives should **not** be tied together when using SNK (Internal Supply) mode. In SNK mode, if power is removed from one drive, inadvertent operation of other drives that share the same I/O Common connection may occur.
Multiple Analog Connections	 When connecting a single potentiometer to multiple drives it is important to connect I/O Terminal 14 common together for all drives. I/O Terminal 14 common and I/O Terminal 13 (potentiometer wiper) should be daisy-chained to each drive. All drives must be powered up for the analog signal to be read correctly.

Start and Speed Reference Control

The drive speed command can be obtained from a number of different sources. The source is normally determined by P038 [Speed Reference]. However, when A051 - A054 [Digital Inx Sel] is set to option 2, 4, 5, 6, 11, 12, 13, 14, 15 and the digital input is active, or if A132 is not set to option 0, the speed reference commanded by P038 [Speed Reference] will be overridden. See the chart below for the override priority.



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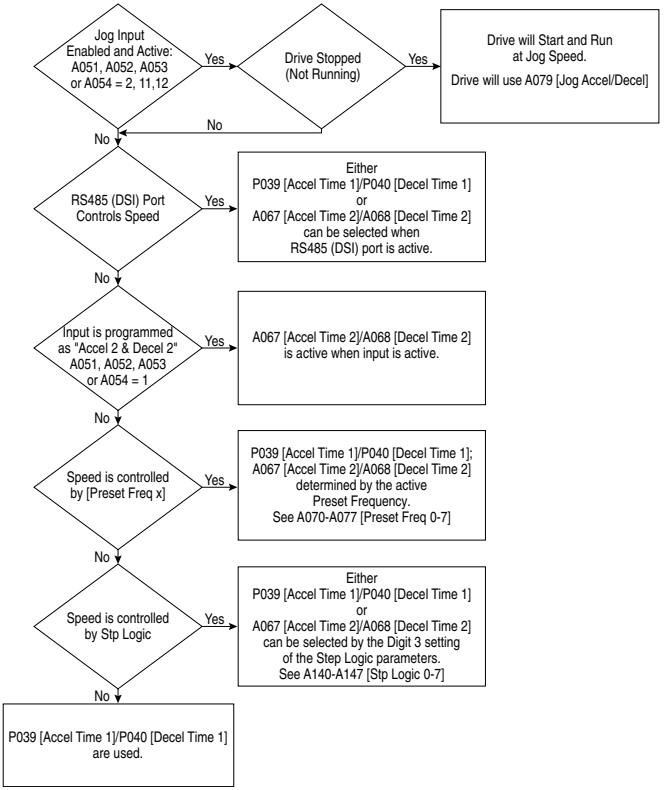
Accel/Decel Selection

The Accel/Decel rate can be obtained by a variety of methods. The default rate is determined by P039 [Accel Time 1] and P040 [Decel Time 1]. Alternative Accel/Decel rates can be made through digital inputs, RS485 (DSI) communications and/or parameters. See the chart below for the override priority.



EMC Instructions

CE Conformity

Conformity with the Low Voltage (LV) Directive and Electromagnetic Compatibility (EMC) Directive has been demonstrated using harmonized European Norm (EN) standards published in the Official Journal of the European Communities. PowerFlex Drives comply with the EN standards listed below when installed according to the User Manual.

CE Declarations of Conformity are available online at: **http://www.ab.com/certification/ce/docs**.

Low Voltage Directive (73/23/EEC)

- EN50178 Electronic equipment for use in power installations

EMC Directive (89/336/EEC)

- EN61800-3 Adjustable speed electrical power drive systems Part 3: EMC product standard including specific test methods.

General Notes

- If the plastic top panel is removed or the optional conduit box is not installed, the drive must be installed in an enclosure with side openings less than 12.5 mm (0.5 in.) and top openings less than 1.0 mm (0.04 in.) to maintain compliance with the LV Directive.
- The motor cable should be kept as short as possible in order to avoid electromagnetic emission as well as capacitive currents.
- Use of line filters in ungrounded systems is not recommended.
- Conformity of the drive with CE EMC requirements does not guarantee an entire machine installation complies with CE EMC requirements. Many factors can influence total machine/installation compliance.

Essential Requirements for CE Compliance

Conditions 1-3 listed below **must be** satisfied for PowerFlex drives to meet the requirements of **EN61800-3**.

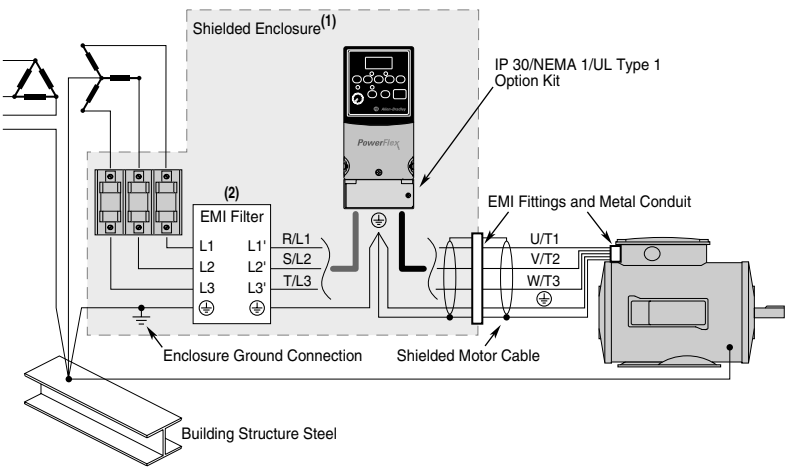
1. Grounding as described in Figure 1.6. Refer to page 1-8 for additional grounding recommendations.
2. Output power, control (I/O) and signal wiring must be braided, shielded cable with a coverage of 75% or better, metal conduit or equivalent attenuation.
3. Allowable cable length in Table 1.I is not exceeded.

Table 1.I Allowable Cable Length

Filter Type	EN61800-3 First Environment Restricted Distribution or Second Environment (2)	EN61800-3 First Environment Unrestricted Distribution (3)
Integral	10 meters (33 feet)	1 meter (3 feet)
External - S Type(1)	10 meters (33 feet)	1 meter (3 feet)
External - L Type(1)	100 meters (328 feet)	5 meters (16 feet)

(1) Refer to Appendix B for details on optional external filters.
(2) Equivalent to EN55011 Class A.
(3) Equivalent to EN55011 Class B.

Figure 1.6 Connections and Grounding



(1) First Environment Unrestricted Distribution installations require a shielded enclosure. Keep wire length as short as possible between the enclosure entry point and the EMI filter.
(2) Integral EMI filters are available on 240V, 1-Phase drives.

EN61000-3-2

- 0.75 kW (1 HP) 240V 1-Phase and 3-Phase drives and 0.37 kW (0.5 HP) 240V 1-Phase drives are suitable for installation on a private low voltage power network. Installations on a public low voltage power network may require additional external harmonic mitigation.
- Other drive ratings meet the current harmonic requirements of EN61000-3-2 without additional external mitigation.

Notes:

Start Up

This chapter describes how to start up the PowerFlex 40 Drive. To simplify drive setup, the most commonly programmed parameters are organized in a single Basic Program Group.

Important: Read the *General Precautions* section before proceeding.

ATTENTION: Power must be applied to the drive to perform the following start-up procedures. Some of the voltages present are at incoming line potential. To avoid electric shock hazard or damage to equipment, only qualified service personnel should perform the following procedure. Thoroughly read and understand the procedure before beginning. If an event does not occur while performing this procedure, **Do Not Proceed**. **Remove All Power** including user supplied control voltages. User supplied voltages may exist even when main AC power is not applied to the drive. Correct the malfunction before continuing.

Prepare For Drive Start-Up

Before Applying Power to the Drive

❑ **1.** Confirm that all inputs are connected to the correct terminals and are secure.

❑ **2.** Verify that AC line power at the disconnect device is within the rated value of the drive.

❑ **3.** Verify that any digital control power is 24 volts.

❑ **4.** Verify that the Sink (SNK)/Source (SRC) Setup DIP Switch is set to match your control wiring scheme. See Figure 1.5 on page 1-16 for location.

Important: The default control scheme is Source (SRC). The Stop terminal is jumpered (I/O Terminals 01 and 11) to allow starting from the keypad. If the control scheme is changed to Sink (SNK), the jumper must be removed from I/O Terminals 01 and 11 and installed between I/O Terminals 01 and 04.

❑ **5.** Verify that the Stop input is present or the drive will not start.

Important: If I/O Terminal 01 is used as a stop input, the jumper between I/O Terminals 01 and 11 must be removed.

Applying Power to the Drive

❑ **6.** Apply AC power and control voltages to the drive.

❑ **7.** Familiarize yourself with the integral keypad features (see page 2-4) before setting any Program Group parameters.

If a fault appears on power up, refer to Fault Descriptions on page 4-3 for an explanation of the fault code.

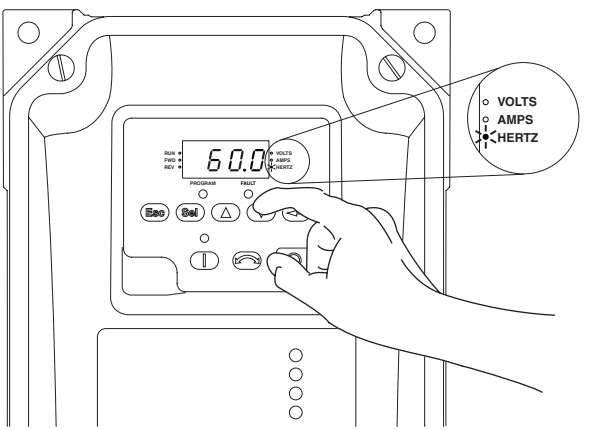
Start, Stop, Direction and Speed Control

Factory default parameter values allow the drive to be controlled from the integral keypad. No programming is required to start, stop, change direction and control speed directly from the integral keypad.

Important: To disable reverse operation, see A095 [Reverse Disable].

Changing the Speed Reference of an IP66, NEMA/UL Type 4X rated drive

When a Display Group parameter, for example, d001 [Output Freq] is displayed, and P038 [Speed Ref] is set to A069 [Internal Freq], you can change the internal frequency using the Up Arrow and Down Arrow keys.



When the internal frequency is being adjusted, its value is displayed and the Hertz LED flashes. Any changes are saved immediately. The display then returns to the Display Group parameter previously shown.

TIP: By default, the speed reference of an IP66, NEMA/UL Type 4X rated drive is set to the internal frequency, A069 [Internal Freq].

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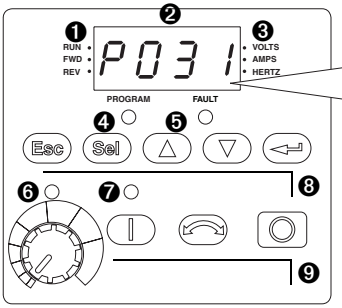
TIP: You can also change the speed reference by editing the parameter A069 [Internal Freq] in program mode. For details on how to enter the program mode, see Viewing and Editing Parameters on page 2-5.

Note: The default value of A069 [Internal Freq] is 0 Hz. For IP20 rated PowerFlex 40 drives, the default value of this parameter is 60 Hz.

Variable Torque Fan/Pump Applications

For improved motor tuning performance when using a premium efficient motor on a variable torque load, set A084 [Boost Select] to option 2 “35.0, VT”.

Integral Keypad



Menu	Description
d	**Display Group (View Only)** Consists of commonly viewed drive operating conditions.
P	**Basic Program Group** Consists of most commonly used programmable functions.
A	**Advanced Program Group** Consists of remaining programmable functions.
F	**Fault Designator** Consists of list of codes for specific fault conditions. Displayed only when fault is present.

No.	LED	LED State	Description
❶	Run/Direction Status	Steady Red	Indicates drive is running and commanded motor direction.
		Flashing Red	Drive has been commanded to change direction. Indicates actual motor direction while decelerating to zero.
❷	Alphanumeric Display	Steady Red	Indicates parameter number, parameter value, or fault code.
		Flashing Red	Single digit flashing indicates that digit can be edited. All digits flashing indicates a fault condition.
❸	Displayed Units	Steady Red	Indicates the units of the parameter value being displayed.
❹	Program Status	Steady Red	Indicates parameter value can be changed.
❺	Fault Status	Flashing Red	Indicates drive is faulted.
❻	Pot Status	Steady Green	Indicates potentiometer on Integral Keypad is active.(1)
❼	Start Key Status	Steady Green	Indicates Start key on Integral Keypad is active. The Reverse key is also active unless disabled by A095 [Reverse Disable].

No.	Key	Name	Description
❽	Esc	Escape	Back one step in programming menu. Cancel a change to a parameter value and exit Program Mode.
	Sel	Select	Advance one step in programming menu. Select a digit when viewing parameter value.
	△ ▽	Up Arrow Down Arrow	Scroll through groups and parameters. Increase/decrease the value of a flashing digit. Used to adjust internal frequency of IP66, NEMA/UL Type 4X rated drives *only* when a Display Group parameter is shown and P038 [Speed Reference] is set to internal frequency, A069 [Internal Freq].
	↵	Enter	Advance one step in programming menu. Save a change to a parameter value.
❾		Potentiometer(1)	Used to control speed of drive. Default is active. Controlled by parameter P038 [Speed Reference].
		Start	Used to start the drive. Default is active. Controlled by parameter P036 [Start Source].
		Reverse	Used to reverse direction of the drive. Default is active. Controlled by parameters P036 [Start Source] and A095 [Reverse Disable].
		Stop	Used to stop the drive or clear a fault. This key is always active. Controlled by parameter P037 [Stop Mode].

(1) IP66, NEMA/UL Type 4X rated drives are not equipped with a potentiometer.

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Viewing and Editing Parameters

The last user-selected Display Group parameter is saved when power is removed and is displayed by default when power is reapplied.
The following is an example of basic integral keypad and display functions. This example provides basic navigation instructions and illustrates how to program the first Program Group parameter.

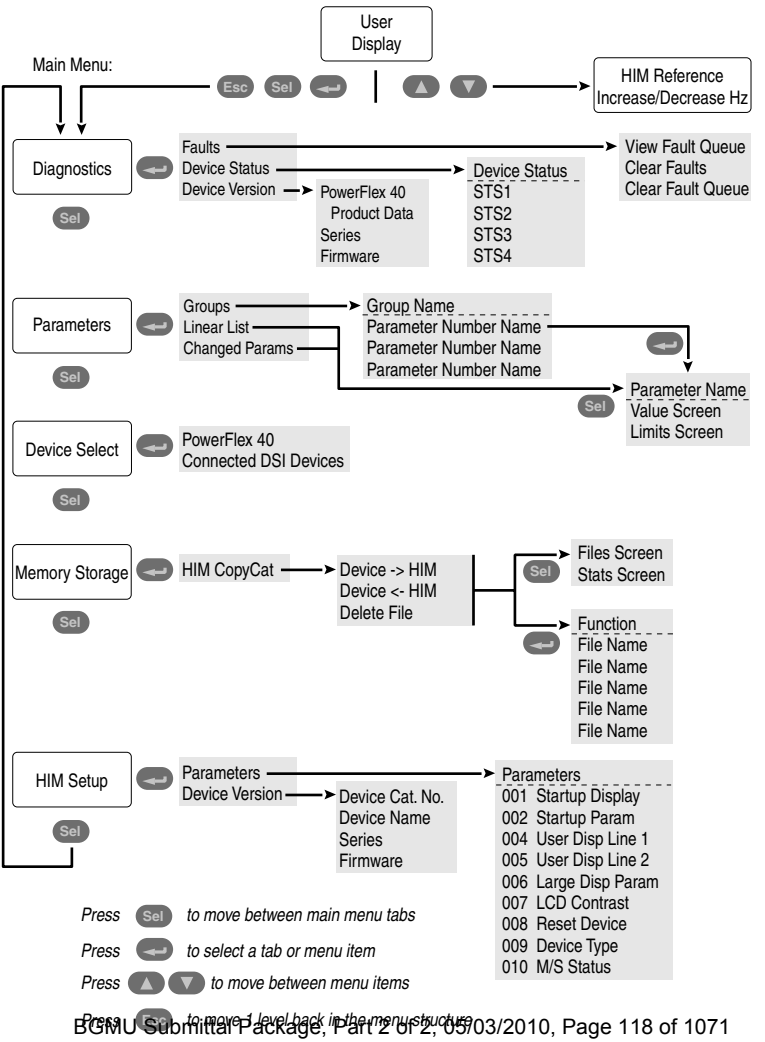
Step	Key(s)	Example Displays
1. When power is applied, the last user-selected Display Group parameter number is briefly displayed with flashing characters. The display then defaults to that parameter's current value. (Example shows the value of d001 [Output Freq] with the drive stopped.)		
2. Press Esc once to display the Display Group parameter number shown on power-up. The parameter number will flash.	Esc	
3. Press Esc again to enter the group menu. The group menu letter will flash.	Esc	
4. Press the Up Arrow or Down Arrow to scroll through the group menu (d, P and A).	▲ or ▼	
5. Press Enter or Sel to enter a group. The right digit of the last viewed parameter in that group will flash.	↵ or Sel	
6. Press the Up Arrow or Down Arrow to scroll through the parameters that are in the group.	▲ or ▼	
7. Press Enter or Sel to view the value of a parameter. If you do not want to edit the value, press Esc to return to the parameter number.	↵ or Sel	
8. Press Enter or Sel to enter program mode to edit the parameter value. The right digit will flash and the Program LED will illuminate if the parameter can be edited.	↵ or Sel	
9. Press the Up Arrow or Down Arrow to change the parameter value. If desired, press Sel to move from digit to digit or bit to bit. The digit or bit that you can change will flash.	▲ or ▼	
10. Press Esc to cancel a change. The digit will stop flashing, the previous value is restored and the Program LED will turn off. Or Press Enter to save a change. The digit will stop flashing and the Program LED will turn off.	Esc ↵	
11. Press Esc to return to the parameter list. Continue to press Esc to back out of the programming menu. If pressing Esc does not change the display, then d001 [Output Frequency] is displayed. Press Enter or Sel to enter the group menu.	Esc	

The Basic Program Group (page 3-9) contains the most commonly changed parameters.

Remote HIM Menu Structure

The Menu Structure below can be accessed through the following Human Interface Module options:

HIM Option	Catalog Number
Remote Panel Mount Small, LCD Display	22-HIM-C2S
Remote Handheld, LCD Display	22-HIM-A3



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Diagnostics Menu

When a fault trips the drive, use this menu to access detailed data about the drive.

Option	Description
Faults	View fault queue or fault information, clear faults or clear fault queue.
Device Status	View status information about the drive or peripheral.
Device Version	View the firmware version and hardware series of components.

Parameters Menu

Use this menu to access drive parameters. Parameters can be displayed in groups, in a linear list, or only those changed from their defaults.

Device Select Menu

Use this menu to access the drive or peripheral that the drive is to access.

Memory Storage Menu

Drive data can be saved to, or recalled from HIM sets.
HIM sets are files stored in permanent nonvolatile HIM memory.

Option	Description
HIM Copycat Device -> HIM Device <- HIM	Save data to a HIM set or load data from a HIM set to active drive memory. A maximum of 5 HIM set can be stored.
Delete File	Delete a HIM set.

HIM Setup Menu

The HIM and drive have features that you can customize.

Option	Description
Parameters	Access parameters in HIM to set display options.
Device Version	View HIM version, hardware series and firmware version

Notes:

Programming and Parameters

Chapter 3 provides a complete listing and description of the PowerFlex 40 parameters. Parameters are programmed (viewed/edited) using the integral keypad. As an alternative, programming can also be performed using DriveExplorer™ or DriveExecutive™ software, a personal computer and a serial converter module. Refer to Appendix B for catalog numbers.

For information on...	See page...
About Parameters	3-1
Parameter Organization	3-2
Basic Program Group	3-9
Advanced Program Group	3-14
Parameter Cross Reference – by Name	3-45

About Parameters

To configure a drive to operate in a specific way, drive parameters may have to be set. Three types of parameters exist:

- **ENUM**
  ENUM parameters allow a selection from 2 or more items. Each item is represented by a number.
- **Numeric Parameters**
  These parameters have a single numerical value (i.e. 0.1 Volts).
- **Bit Parameters**
  Bit parameters have four individual bits associated with features or conditions. If the bit is 0, the feature is off or the condition is false. If the bit is 1, the feature is on or the condition is true.

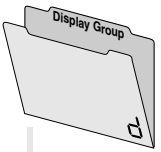
Some parameters are marked as follows.

= Stop drive before changing this parameter.

= 32 bit parameter. Parameters marked 32 bit will have two parameter numbers when using RS485 communications and programming software.

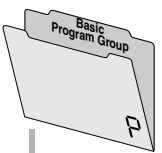
Parameter Organization

Refer to page 3-45 for an alphabetical listing of parameters.



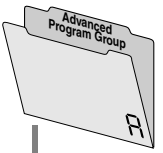
See page 3-3

Output Freq	d001
Commanded Freq	d002
Output Current	d003
Output Voltage	d004
DC Bus Voltage	d005
Drive Status	d006
Fault 1 Code	d007
Fault 2 Code	d008
Fault 3 Code	d009
Process Display	d010
Control Source	d012
Contrl In Status	d013
Dig In Status	d014
Comm Status	d015
Control SW Ver	d016
Drive Type	d017
Elapsed Run Time	d018
Testpoint Data	d019
Analog In 0-10V	d020
Analog In 4-20mA	d021
Output Power	d022
Output Power Fctr	d023
Drive Temp	d024
Counter Status	d025
Timer Status	d026
Stp Logic Status	d028
Torque Current	d029



See page 3-9

Motor NP Volts	P031
Motor NP Hertz	P032
Motor OL Current	P033
Minimum Freq	P034
Maximum Freq	P035
Start Source	P036
Stop Mode	P037
Speed Reference	P038
Accel Time 1	P039
Decel Time 1	P040
Reset To Defalts	P041
Voltage Class	P042
Motor OL Ret	P043



See page 3-14

Digital In1 Sel	A051
Digital In2 Sel	A052
Digital In3 Sel	A053
Digital In4 Sel	A054
Relay Out Sel	A055
Relay Out Level	A056
Opto Out1 Sel	A058
Opto Out1 Level	A059
Opto Out2 Sel	A061
Opto Out2 Level	A062
Opto Out Logic	A064
Analog Out Sel	A065
Analog Out High	A066
Accel Time 2	A067
Decel Time 2	A068
Internal Freq	A069
Preset Freq 0	A070
Preset Freq 1	A071
Preset Freq 2	A072
Preset Freq 3	A073
Preset Freq 4	A074
Preset Freq 5	A075
Preset Freq 6	A076
Preset Freq 7	A077
Jog Frequency	A078
Jog Accel/Decel	A079
DC Brake Time	A080
DC Brake Level	A081
DB Resistor Sel	A082
S Curve %	A083
Boost Select	A084
Start Boost	A085
Break Voltage	A086
Break Frequency	A087
Maximum Voltage	A088
Current Limit 1	A089
Motor OL Select	A090
PWM Frequency	A091
Auto Rstrt Tries	A092
Auto Rstrt Delay	A093
Start At PowerUp	A094
Reverse Disable	A095
Flying Start En	A096
Compensation	A097
SW Current Trip	A098
Process Factor	A099
Fault Clear	A100
Program Lock	A101
Testpoint Sel	A102
Comm Data Rate	A103
Comm Node Addr	A104
Comm Loss Action	A105

See page 3-14

Comm Loss Time	A106
Comm Format	A107
Language	A108
Anlg Out Setpt	A109
Anlg In 0-10V Lo	A110
Anlg In 0-10V Hi	A111
Anlg In4-20mA Lo	A112
Anlg In4-20mA Hi	A113
Slip Hertz @ FLA	A114
Process Time Lo	A115
Process Time Hi	A116
Bus Reg Mode	A117
Current Limit 2	A118
Skip Frequency	A119
Skip Freq Band	A120
Stall Fault Time	A121
Analog In Loss	A122
10V Bipolar Enbl	A123
Var PWM Disable	A124
Torque Perf Mode	A125
Motor NP FLA	A126
Autotune	A127
IR Voltage Drop	A128
Flux Current Ref	A129
PID Trim Hi	A130
PID Trim Lo	A131
PID Ref Sel	A132
PID Feedback Sel	A133
PID Prop Gain	A134
PID Integ Time	A135
PID Diff Rate	A136
PID Setpoint	A137
PID Deadband	A138
PID Preload	A139
Stp Logic 0	A140
Stp Logic 1	A141
Stp Logic 2	A142
Stp Logic 3	A143
Stp Logic 4	A144
Stp Logic 5	A145
Stp Logic 6	A146
Stp Logic 7	A147
Stp Logic Time 0	A150
Stp Logic Time 1	A151
Stp Logic Time 2	A152
Stp Logic Time 3	A153
Stp Logic Time 4	A154
Stp Logic Time 5	A155
Stp Logic Time 6	A156
Stp Logic Time 7	A157
EM Brk Off Delay	A160
EM Brk On Delay	A161
MOP Reset Sel	A162
DB Threshold	A163
Comm Write Mode	A164
Anlg Loss Delay	A165
Analog In Filter	A166
PID Invert Error	A167

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Display Group

d001 [Output Freq]

Related Parameter(s): d002, d010, P034, P035, P038

Output frequency present at T1, T2 & T3 (U, V & W).

Values	Default:	Read Only
	Min/Max:	0.0/P035 [Maximum Freq]
	Display:	0.1 Hz

d002 [Commanded Freq]

Related Parameter(s): d001, d013, P034, P035, P038

Value of the active frequency command. Displays the commanded frequency even if the drive is not running.

Important: The frequency command can come from a number of sources. Refer to Start and Speed Reference Control on page 1-23 for details.

Values	Default:	Read Only
	Min/Max:	0.0/P035 [Maximum Freq]
	Display:	0.1 Hz

d003 [Output Current]

The output current present at T1, T2 & T3 (U, V & W).

Values	Default:	Read Only
	Min/Max:	0.00/(Drive Rated Amps × 2)
	Display:	0.01 Amps

d004 [Output Voltage]

Related Parameter(s): P031, A084, A088

Output voltage present at terminals T1, T2 & T3 (U, V & W).

Values	Default:	Read Only
	Min/Max:	0/Drive Rated Volts
	Display:	1 VAC

d005 [DC Bus Voltage]

Present DC bus voltage level.

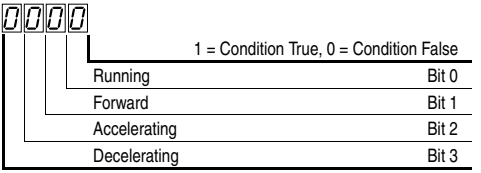
Values	Default:	Read Only
	Min/Max:	Based on Drive Rating
	Display:	1 VDC

Display Group *(continued)*

d006 [Drive Status]

Related Parameter(s): A095

Present operating condition of the drive.



Values	Default:	Read Only
	Min/Max:	0/1
	Display:	1

d007 [Fault 1 Code]
d008 [Fault 2 Code]
d009 [Fault 3 Code]

A code that represents a drive fault. The codes will appear in these parameters in the order they occur (d007 [Fault 1 Code] = the most recent fault). Repetitive faults will only be recorded once.

Refer to Chapter 4 for fault code descriptions.

Values	Default:	Read Only
	Min/Max:	F2/F122
	Display:	F1

d010 [Process Display]

Related Parameter(s): d001, A099

32 bit parameter.

The output frequency scaled by A099 [Process Factor].

Output Freq x Process Factor = Process Display

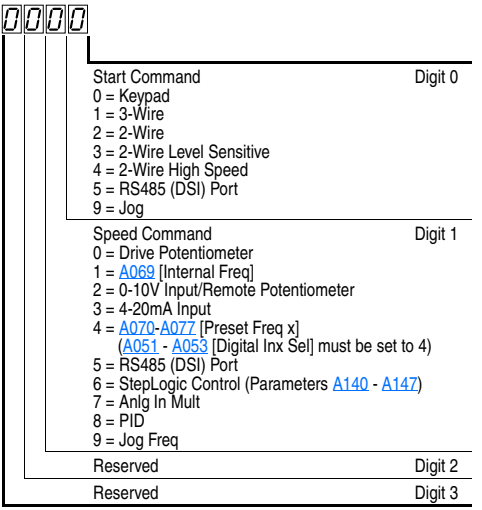
Values	Default:	Read Only
	Min/Max:	0.00/9999
	Display:	0.01 – 1

Display Group *(continued)*

d012 [Control Source]

Related Parameter(s): P036, P038, A051-A054

Displays the active source of the Start Command and Speed Command which are normally defined by the settings of P036 [Start Source] and P038 [Speed Reference] but may be overridden by digital inputs. Refer to the flowcharts on pages 1-23 and 1-24 for details.



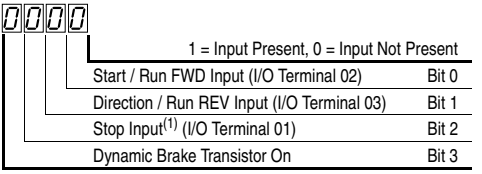
Values	Default:	Read Only
	Min/Max:	0/9
	Display:	1

d013 [Contrl In Status]

Related Parameter(s): d002, P034, P035

Status of the control terminal block control inputs.

Important: Actual control commands may come from a source other than the control terminal block.



(1) The stop input must be present in order to start the drive.
When this bit is a 1 the drive can be started.
When this bit is a 0 the drive will stop.

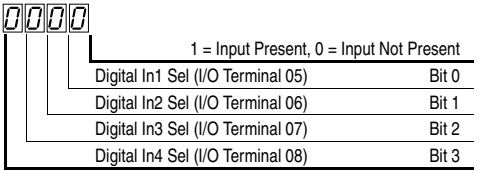
Values	Default:	Read Only
	Min/Max:	0/1
	Display:	1

Display Group *(continued)*

d014 [Dig In Status]

Related Parameter(s): A051-A054

Status of the control terminal block digital inputs.

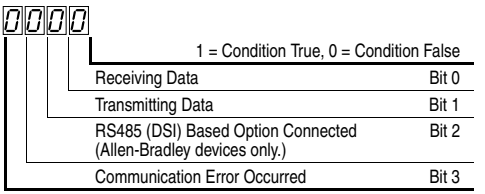


Values	Default:	Read Only
	Min/Max:	0/1
	Display:	1

d015 [Comm Status]

Related Parameter(s): A103-A107

Status of the communications ports.



Values	Default:	Read Only
	Min/Max:	0/1
	Display:	1

d016 [Control SW Ver]

Main Control Board software version.

Values	Default:	Read Only
	Min/Max:	1.00/99.99
	Display:	0.01

d017 [Drive Type]

Used by Rockwell Automation field service personnel.

Values	Default:	Read Only
	Min/Max:	1001/9999
	Display:	1

Display Group *(continued)*

d018 [Elapsed Run Time]

Accumulated time drive is outputting power. Time is displayed in 10 hour increments.

Values	Default:	Read Only
	Min/Max:	0/9999 Hrs
	Display:	1 = 10 Hrs

d019 [Testpoint Data]

Related Parameter(s): A102

The present value of the function selected in A102 [Testpoint Sel].

Values	Default:	Read Only
	Min/Max:	0/FFFF
	Display:	1 Hex

d020 [Analog In 0-10V]

Related Parameter(s): A110, A111

The present value of the voltage at I/O Terminal 13 (100.0% = 10 volts).

Values	Default:	Read Only
	Min/Max:	0.0/100.0%
	Display:	0.1%

d021 [Analog In 4-20mA]

Related Parameter(s): A112, A113

The present value of the current at I/O Terminal 15 (0.0% = 4mA, 100.0% = 20mA).

Values	Default:	Read Only
	Min/Max:	0.0/100.0%
	Display:	0.1%

d022 [Output Power]

Output power present at T1, T2 & T3 (U, V & W).

Values	Default:	Read Only
	Min/Max:	0.00/(Drive Rated Power × 2)
	Display:	0.01 kW

d023 [Output Powr Fctr]

The angle in electrical degrees between motor voltage and motor current.

Values	Default:	Read Only
	Min/Max:	0.0/180.0 deg
	Display:	0.1 deg

Display Group *(continued)*

d024 [Drive Temp]

Present operating temperature of the drive power section.

Values	Default:	Read Only
	Min/Max:	0/120 degC
	Display:	1 degC

d025 [Counter Status]

The current value of the counter when counter is enabled.

Values	Default:	Read only
	Min/Max:	0/9999
	Display:	1

d026 [Timer Status]

32 32 bit parameter.

The current value of the timer when timer is enabled.

Values	Default:	Read Only
	Min/Max:	0.0/9999 Secs
	Display:	0.1 Secs

d028 [Stp Logic Status]

When P038 [Speed Reference] is set to 6 “Stp Logic”, this parameter will display the current step of the StepLogic profile as defined by parameters A140-A147 [Stp Logic x].

Values	Default:	Read Only
	Min/Max:	0/7
	Display:	1

d029 [Torque Current]

The current value of the motor torque current.

Values	Default:	Read Only
	Min/Max:	0.00/(Drive Rated Amps × 2)
	Display:	0.01 Amps

Basic Program Group

P031 [Motor NP Volts]

Related Parameter(s): d004, A084, A085, A086, A087

Stop drive before changing this parameter.

Set to the motor nameplate rated volts.

Values	Default:	Based on Drive Rating
	Min/Max:	20/Drive Rated Volts
	Display:	1 VAC

P032 [Motor NP Hertz]

Related Parameter(s): A084, A085, A086, A087, A090

Stop drive before changing this parameter.

Set to the motor nameplate rated frequency.

Values	Default:	60 Hz
	Min/Max:	15/400 Hz
	Display:	1 Hz

P033 [Motor OL Current]

Related Parameter(s): A055, A058, A061, A089, A090, A098, A114, A118

Set to the maximum allowable motor current.

The drive will fault on an F7 Motor Overload if the value of this parameter is exceeded by 150% for 60 seconds.

Values	Default:	Based on Drive Rating
	Min/Max:	0.0/(Drive Rated Amps × 2)
	Display:	0.1 Amps

P034 [Minimum Freq]

Related Parameter(s): d001, d002, d013, P035, A085, A086, A087, A110, A112

Sets the lowest frequency the drive will output continuously.

Values	Default:	0.0 Hz
	Min/Max:	0.0/400.0 Hz
	Display:	0.1 Hz

P035 [Maximum Freq]

Related Parameter(s): d001, d002, d013, P034, A065, A078, A085, A086, A087, A111, A113

Stop drive before changing this parameter.

Sets the highest frequency the drive will output.

Values	Default:	60 Hz
	Min/Max:	0/400 Hz
	Display:	1 Hz

Basic Program Group *(continued)*

P036 [Start Source]

Related Parameter(s): d012, P037

Stop drive before changing this parameter.

Sets the control scheme used to start the drive.

Refer to Start and Speed Reference Control on page 1-23 for details about how other drive settings can override the setting of this parameter.

Important: For all settings except option 3, the drive must receive a leading edge from the start input for the drive to start after a stop input, loss of power or fault condition.

Options	**0**	"Keypad" (Default)	• Integral keypad controls drive operation. • I/O Terminal 1 "Stop" = coast to stop. • When active, the Reverse key is also active unless disabled by A095 [Reverse Disable].
	1	"3-Wire"	I/O Terminal 1 "Stop" = stop according to the value set in P037 [Stop Mode].
	2	"2-Wire"	I/O Terminal 1 "Stop" = coast to stop.
	3	"2-W Lvl Sens"	Drive will restart after a "Stop" command when: • Stop is removed and • Start is held active

ATTENTION: Hazard of injury exists due to unintended operation. When P036 [Start Source] is set to option 3, and the Run input is maintained, the Run inputs do not need to be toggled after a Stop input for the drive to run again. A Stop function is provided only when the Stop input is active (open).

	4	"2-W Hi Speed"	**Important:** There is greater potential voltage on the output terminals when using this option. • Outputs are kept in a ready-to-run state. The drive will respond to a "Start" command within 10 ms. • I/O Terminal 1 "Stop" = coast to stop.
	5	"Comm Port"	• Remote communications. Refer to Appendix C for details. • I/O Terminal 1 "Stop" = coast to stop.
	6	"Momt FWD/REV"	• Drive will start after a momentary input from either the Run FWD Input (I/O Terminal 02) or the Run REV Input (I/O Terminal 03). • I/O Terminal 1 "Stop" = coast to stop.

Basic Program Group *(continued)*

P037 [Stop Mode]

Related Parameter(s): P036, A080, A081, A082, A105, A160

Active stop mode for all stop sources [e.g. keypad, run forward (I/O Terminal 02), run reverse (I/O Terminal 03), RS485 port] except as noted below.

Important: I/O Terminal 01 is always a coast to stop input except when P036 [Start Source] is set for "3-Wire" control. When in three wire control, I/O Terminal 01 is controlled by P037 [Stop Mode].

Hardware Enable Circuitry

By default, I/O Terminal 01 is a coast to stop input. The status of the input is interpreted by drive software. If the application requires the drive to be disabled without software interpretation, a "dedicated" hardware enable configuration can be utilized. This is accomplished by removing the ENBL enable jumper on the control board. In this case, the drive will always coast to a stop regardless of the settings of P036 [Start Source] and P037 [Stop Mode].

Options	**0**	"Ramp, CF"(1) (Default)	Ramp to Stop. "Stop" command clears active fault.
	1	"Coast, CF"(1)	Coast to Stop. "Stop" command clears active fault.
	2	"DC Brake, CF"(1)	DC Injection Braking Stop. "Stop" command clears active fault.
	3	"DCBrkAuto,CF"(1)	DC Injection Braking Stop with Auto Shutoff. • Standard DC Injection Braking for value set in A080 [DC Brake Time]. OR • Drive shuts off if the drive detects that the motor is stopped. "Stop" command clears active fault.
	4	"Ramp"	Ramp to Stop.
	5	"Coast"	Coast to Stop.
	6	"DC Brake"	DC Injection Braking Stop.
	7	"DC BrakeAuto"	DC Injection Braking Stop with Auto Shutoff. • Standard DC Injection Braking for value set in A080 [DC Brake Time]. OR • Drive shuts off if current limit is exceeded.
	8	"Ramp+EM B,CF"	Ramp to Stop with EM Brake Control. "Stop" Command clears active fault.
	9	"Ramp+EM Brk"	Ramp to Stop with EM Brake Control.

(1) Stop input also clears active fault.

Basic Program Group *(continued)*

P038 [Speed Reference] Related Parameter(s): d001, d002, d012, d020, d021, P039, P040, A051-A054, A069, A070-A077, A110-A113, A123, A132, A140-A147, A150-A157

Sets the source of the speed reference to the drive.

The drive speed command can be obtained from a number of different sources. The source is normally determined by P038 [Speed Reference]. However, when A051 - A054 [Digital Inx Sel] is set to option 2, 4, 5, 6, 11, 12, 13, 14, 15 and the digital input is active, or if A132 [PID Ref Sel] is not set to option 0, the speed reference commanded by P038 [Speed Reference] will be overridden. Refer to the flowchart on page 1-23 for more information on speed reference control priority.

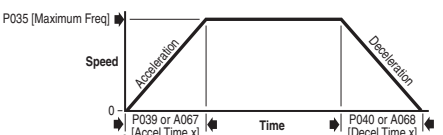
Options	**0**	"Drive Pot" (Default)	Frequency command from the potentiometer on the integral keypad. **Important:** This option is not available with IP66, NEMA/UL Type 4X rated drives. Internal frequency command comes from A069 [Internal Freq].
	1	"InternalFreq" (IP66, NEMA/UL Type 4X Default)	Internal frequency command from A069 [Internal Freq]. Must be set when using MOP function.
	2	"0-10V Input"	External frequency command from the 0-10V or ±10V analog input or remote potentiometer.
	3	"4-20mA Input"	External frequency command from the 4-20mA analog input.
	4	"Preset Freq"	External frequency command as defined by A070 - A077 [Preset Freq x] when A051 - A054 [Digital Inx Sel] are programmed as "Preset Frequencies" and the digital inputs are active.
	5	"Comm Port"	External frequency command from the communications port. Refer to Appendix C for details.
	6	"Stp Logic"	External frequency command as defined by A070 - A077 [Preset Freq x] and A140 - A147 [Stp Logic x].
	7	"Anlg In Mult"	External frequency command as defined by the product of the analog inputs (shown in d020 [Analog In 0-10V] and d021 [Analog In 4-20mA]). [Analog In 0-10V] × [Analog In 4-20mA] = Speed Command Example: 100% × 50% = 50%

P039 [Accel Time 1] Related Parameter(s): P038, P040, A051-A054, A067, A070-A077, A140-A147

Sets the rate of acceleration for all speed increases.

$$\frac{\text{Maximum Freq}}{\text{Accel Time}} = \text{Accel Rate}$$

Values	Default:	10.0 Secs
	Min/Max:	0.0/600.0 Secs
	Display:	0.1 Secs



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Basic Program Group *(continued)*

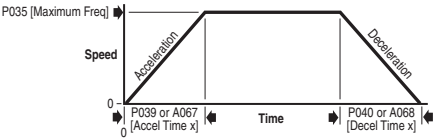
P040 [Decel Time 1]

Related Parameter(s): P038, P039, A051-A054, A068, A070-A077, A140-A147

Sets the rate of deceleration for all speed decreases.

$$\frac{\text{Maximum Freq}}{\text{Decel Time}} = \text{Decel Rate}$$

Values	Default:	10.0 Secs
	Min/Max:	0.1/600.0 Secs
	Display:	0.1 Secs



P041 [Reset To Defalts]

Stop drive before changing this parameter.

Resets all parameter values to factory defaults.

Options	**0**	"Ready/Idle" (Default)	
	1	"Factory Rset"	• After the reset function is complete, this parameter will set itself back to "0". • Causes an F48 Params Defaulted fault.

P042 [Voltage Class]

Stop drive before changing this parameter.

Sets the voltage class of 600V drives.

Options	**2**	"Low Voltage"	480V
	3	"High Voltage" (Default)	600V

P043 [Motor OL Ret]

Related Parameter(s): P033

Enables/disables the Motor Overload Retention function. When Enabled, the value held in the motor overload counter is saved at power-down and restored at power-up. A change to this parameter setting resets the counter.

Options	**0**	"Disabled" (Default)
	1	"Enabled"

Advanced Program Group

A051 [Digital In1 Sel]
(I/O Terminal 05)
A052 [Digital In2 Sel]
(I/O Terminal 06)
A053 [Digital In3 Sel]
(I/O Terminal 07)
A054 [Digital In4 Sel]
(I/O Terminal 08)

Related Parameter(s): d012, d014, P038, P039, P040, A067, A068, A070-A077, A078, A079, A118, A140-A147

Stop drive before changing this parameter.

Selects the function for the digital inputs. Refer to the flowchart on page 1-23 for more information on speed reference control priority.

Options	**0**	"Not Used"	Terminal has no function but can be read over network communications via d014 [Dig In Status].
	1	"Acc & Dec 2"	• When active, A067 [Accel Time 2] and A068 [Decel Time 2] are used for all ramp rates except Jog. • Can only be tied to one input. Refer to the flowchart on page 1-24 for more information on Accel/Decel selection.
	2	"Jog"	• When input is present, drive accelerates according to the value set in A079 [Jog Accel/Decel] and ramps to the value set in A078 [Jog Frequency]. • When input is removed, drive ramps to a stop according to the value set in A079 [Jog Accel/Decel]. • A valid "Start" command will override this input.
	3	"Aux Fault"	When enabled, an F2 Auxiliary Input fault will occur when the input is removed.
	4	"Preset Freq" (A051 & A052 Default)	Refer to A070 - A077 [Preset Freq x]. **Important:** Digital Inputs have priority for frequency control when programmed as Preset Speed and are active. Refer to the flowchart on page 1-23 for more information on speed reference control priority.
	5	"Local" (A053 Default)	When active, sets integral keypad as start source and potentiometer on the integral keypad as speed source. **Important:** Speed source for IP66, NEMA/UL Type 4X rated drives comes from A069 [Internal Freq].
	6	"Comm Port"	• When active, sets communications device as default start/speed command source. • Can only be tied to one input.
	7	"Clear Fault"	When active, clears an active fault.
	8	"RampStop,CF"	Causes drive to immediately ramp to a stop regardless of how P037 [Stop Mode] is set.
	9	"CoastStop,CF"	Causes drive to immediately coast to a stop regardless of how P037 [Stop Mode] is set.
	10	"DCInjStop,CF"	Causes drive to immediately begin a DC Injection stop regardless of how P037 [Stop Mode] is set.
	11	"Jog Forward" (A054 Default)	Drive accelerates to A078 [Jog Frequency] according to A079 [Jog Accel/Decel] and ramps to stop when input becomes inactive. A valid start will override this command.
	12	"Jog Reverse"	Drive accelerates to A078 [Jog Frequency] according to A079 [Jog Accel/Decel] and ramps to stop when input becomes inactive. A valid start will override this command.

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A051 - A054 Options (Cont.)	**13** "10V In Ctrl"	Selects 0-10V or ±10V control as the frequency reference. Start source is not changed.
	14 "20mA In Ctrl"	Selects 4-20mA control as the frequency reference. Start source is not changed.
	15 "PID Disable"	Disables PID function. Drive uses the next valid non-PID speed reference.
	16 "MOP Up"	Increases the value of A069 [Internal Freq] at the current Accel rate if P038 [Speed Reference] is set to 1 "InternalFreq". For IP20 rated drives, the default for A069 is 60.0 Hz. For IP66, NEMA/UL Type 4X drives, the default for A069 is 0.0 Hz.
	17 "MOP Down"	Decreases the value of A069 [Internal Freq] at the current Decel rate if P038 [Speed Reference] is set to 1 "InternalFreq". For IP20 rated drives, the default for A069 is 60.0 Hz. For IP66, NEMA/UL Type 4X drives, the default for A069 is 0.0 Hz.
	18 "Timer Start"	Clears and starts the timer function. May be used to control the relay or opto outputs.
	19 "Counter In"	Starts the counter function. May be used to control the relay or opto outputs.
	20 "Reset Timer"	Clears the active timer.
	21 "Reset Countr"	Clears the active counter.
	22 "Rset Tim&Cnt"	Clears the active timer and counter.
	23 "Logic In1"	Logic function input number 1. May be used to control the relay or opto outputs (see parameters A055, A058, A061 Options 11-14). May be used in conjunction with StepLogic parameters A140 - A147 [Stp Logic x].
	24 "Logic In2"	Logic function input number 2. May be used to control the relay or opto outputs (see parameters A055, A058, A061 Options 11-14). May be used in conjunction with StepLogic parameters A140 - A147 [Stp Logic x].
	25 "Current Lmt2"	When active, A118 [Current Limit 2] determines the drive current limit level.
	26 "Anlg Invert"	Inverts the scaling of the analog input levels set in A110 [Anlg In 0-10V Lo] and A111 [Anlg In 0-10V Hi] or A112 [Anlg In4-20mA Lo] and A113 [Anlg In4-20mA Hi].
	27 "EM Brk Rlse"	If EM brake function is enabled, this input releases the brake.

ATTENTION: If a hazard of injury due to movement of equipment or material exists, an auxiliary mechanical braking device must be used.

Advanced Program Group *(continued)*

A055 [Relay Out Sel]

Related Parameter(s): P033, A056, A092, A140-A147, A150-A157, A160, A161

Sets the condition that changes the state of the output relay contacts.

Options			
	0	"Ready/Fault" (Default)	Relay changes state when power is applied. This indicates that the drive is ready for operation. Relay returns drive to shelf state when power is removed or a fault occurs.
	1	"At Frequency"	Drive reaches commanded frequency.
	2	"MotorRunning"	Motor is receiving power from the drive.
	3	"Reverse"	Drive is commanded to run in reverse direction.
	4	"Motor Overld"	Motor overload condition exists.
	5	"Ramp Reg"	Ramp regulator is modifying the programmed accel/decel times to avoid an overcurrent or overvoltage fault from occurring.
	6	"Above Freq"	• Drive exceeds the frequency (Hz) value set in A056 [Relay Out Level]. • Use A056 to set threshold.
	7	"Above Cur"	• Drive exceeds the current (% Amps) value set in A056 [Relay Out Level]. • Use A056 to set threshold. **Important:** Value for A056 [Relay Out Level] must be entered in percent of drive rated output current.
	8	"Above DCVolt"	• Drive exceeds the DC bus voltage value set in A056 [Relay Out Level]. • Use A056 to set threshold.
	9	"Retries Exst"	Value set in A092 [Auto Rstrt Tries] is exceeded.
	10	"Above Anlg V"	• Analog input voltage (I/O Terminal 13) exceeds the value set in A056 [Relay Out Level]. • Do not use if A123 [10V Bipolar Enbl] is set to 1 "Bi-Polar In". • This parameter setting can also be used to indicate a PTC trip point when the input (I/O Terminal 13) is wired to a PTC and external resistor. • Use A056 to set threshold.
	11	"Logic In 1"	An input is programmed as "Logic In 1" and is active.
	12	"Logic In 2"	An input is programmed as "Logic In 2" and is active.
	13	"Logic 1 & 2"	Both Logic inputs are programmed and active.
	14	"Logic 1 or 2"	One or both Logic inputs are programmed and one or both is active.
	15	"StpLogic Out"	Drive enters StepLogic step with Digit 3 of Command Word (A140 - A147) set to enable StepLogic output.
	16	"Timer Out"	• Timer has reached value set in A056 [Relay Out Level]. • Use A056 to set threshold.
	17	"Counter Out"	• Counter has reached value set in A056 [Relay Out Level]. • Use A056 to set threshold.
	18	"Above PF Ang"	• Power Factor angle has exceeded the value set in A056 [Relay Out Level]. • Use A056 to set threshold.

A055 Options (Cont.)	**19** "Anlg In Loss"	Analog input loss has occurred. Program A122 [Analog In Loss] for desired action when input loss occurs.
	20 "ParamControl"	Prior to FRN 4.01, this option enables the output to be controlled over network communications by writing to A056 [Relay Out Level]. (0 = Off, 1 = On.) With FRN 4.01 and later, the logic command word bit 15 has full control of A056. See Writing (06) Logic Command Data on page C-4.
	21 "NonRec Fault"	• Value set in A092 [Auto Rstrt Tries] is exceeded. • A092 [Auto Rstrt Tries] in not enabled. • A Non-resettable fault has occurred.
	22 "EM Brk Cntrl"	EM brake is energized. Program A160 [EM Brk Off Delay] and A161 [EM Brk On Delay] for desired action.
	23 "Above Fcmd"	The current commanded frequency exceeds the value set in A056 [Relay Out Level].
	24 "MsgControl"	With FRN 4.01 and later, this option enables the output to be controlled over network communications by writing to A056 [Relay Out Level]. (0 = Off, 1 = On.)

A056 [Relay Out Level]

Related Parameter(s): A055

32 bit parameter.

Sets the trip point for the digital output relay if the value of A055 [Relay Out Sel] is 6, 7, 8, 10, 16, 17, 18 or 20.

With FRN 4.01 and later, when the value of A055 is set to 20, the logic command word bit 15 has full control of A056.

A055 Setting	A056 Min/Max
6	0/400 Hz
7	0/180%
8	0/815 Volts
10	0/100%
16	0.1/9999 Secs
17	1/9999 Counts
18	1/180 degs
20	0/1
23	0/400 Hz

Values	Default:	0.0
	Min/Max:	0.0/9999
	Display:	0.1

Advanced Program Group *(continued)*

A058 [Opto Out1 Sel]
A061 [Opto Out2 Sel]

Related Parameter(s): P033, A059, A062, A092, A122, A123, A160, A161, A140-A147, A150-A157

Determines the operation of the programmable opto outputs.

Options	**0**	"Ready/Fault"	Opto outputs are active when power is applied. This indicates that the drive is ready for operation. Opto outputs are inactive when power is removed or a fault occurs.
	1	"At Frequency" (A061 Default)	Drive reaches commanded frequency.
	2	"MotorRunning" (A058 Default)	Motor is receiving power from the drive.
	3	"Reverse"	Drive is commanded to run in reverse direction.
	4	"Motor Overld"	Motor overload condition exists.
	5	"Ramp Reg"	Ramp regulator is modifying the programmed accel/decel times to avoid an overcurrent or overvoltage fault from occurring.
	6	"Above Freq"	• Drive exceeds the frequency (Hz) value set in A059 or A062 [Opto Outx Level]. • Use A059 or A062 to set threshold.
	7	"Above Cur"	• Drive exceeds the current (% Amps) value set in A059 or A062 [Opto Outx Level]. • Use A059 or A062 to set threshold. **Important:** Value for A059 or A062 [Opto Outx Level] must be entered in percent of drive rated output current.
	8	"Above DCVolt"	• Drive exceeds the DC bus voltage value set in A059 or A062 [Opto Outx Level]. • Use A059 or A062 to set threshold.
	9	"Retries Exst"	Value set in A092 [Auto Rstrt Tries] is exceeded.
	10	"Above Anlg V"	• Analog input voltage (I/O Terminal 13) exceeds the value set in A059 or A062 [Opto Outx Level]. • Do not use if A123 [10V Bipolar Enbl] is set to 1 "Bi-Polar In". • This parameter setting can also be used to indicate a PTC trip point when the input (I/O Terminal 13) is wired to a PTC and external resistor. • Use A059 or A062 to set threshold.
	11	"Logic In 1"	An input is programmed as "Logic In 1" and is active.
	12	"Logic In 2"	An input is programmed as "Logic In 2" and is active.
	13	"Logic 1 & 2"	Both Logic inputs are programmed and active.
	14	"Logic 1 or 2"	One or both Logic inputs are programmed and one or both is active.
	15	"StpLogic Out"	Drive enters StepLogic step with Digit 3 of Command Word (A140 - A147) set to enable StepLogic output.
	16	"Timer Out"	• Timer has reached value set in A059 or A062 [Opto Outx Level]. • Use A059 or A062 to set threshold.
	17	"Counter Out"	• Counter has reached value set in A059 or A062 [Opto Outx Level]. • Use A059 or A062 to set threshold.

A058, A061 Options (Cont.)	**18** "Above PF Ang"	• Power Factor angle has exceeded the value set in A059 or A062 [Opto Outx Level]. • Use A059 or A062 to set threshold.
	19 "Anlg In Loss"	Analog input loss has occurred. Program A122 [Analog In Loss] for desired action when input loss occurs.
	20 "ParamControl"	Prior to FRN 4.01, this option enables the output to be controlled over network communications by writing to A059 or A062 [Opto Outx Level]. (0 = Off, 1 = On.) With FRN 4.01 and later: Setting this option for A058 means the logic command word bit 6 has full control of A059. Setting this option for A059 means the logic command word bit 7 has full control of A062. See Writing (06) Logic Command Data on page C-4.
	21 "NonRec Fault"	• Value set in A092 [Auto Rstrt Tries] is exceeded. • A092 [Auto Rstrt Tries] in not enabled. • A Non-resettable fault has occurred.
	22 "EM Brk Cntrl"	EM brake is energized. Program A160 [EM Brk Off Delay] and A161 [EM Brk On Delay] for desired action.
	23 "Above Fcmd"	The current commanded frequency exceeds the value set in A059 or A062 [Opto Outx Level].
	24 "MsgControl"	With FRN 4.01 and later: Enables the output to be controlled over the network communications by writing to A059 or A062 [Opto Outx Level]. (0 = Off, 1 = On.)

A059 [Opto Out1 Level]
A062 [Opto Out2 Level]

Related Parameter(s): A058, A061

32 bit parameter.

Determines the on/off point for the opto outputs when A058 or A061 [Opto Outx Sel] is set to option 6, 7, 8, 10, 16, 17, 18 or 20.

With FRN 4.01 and later, when the value of A058 is set to 20, the logic command word bit 6 has full control of A059 and when the value of A061 is set to 20, bit 7 has full control of A062.

A058 & A061 Setting	A059 & A062 Min/Max
6	0/400 Hz
7	0/180%
8	0/815 Volts
10	0/100%
16	0.1/9999 Secs
17	1/9999 Counts
18	1/180 degs
20	0/1
23	0/400 Hz

Values	Default:	0.0
	Min/Max:	0.0/9999
	Display:	0.1

Advanced Program Group *(continued)*

A064 [Opto Out Logic]

Determines the logic (Normally Open/NO or Normally Closed/NC) of the opto outputs.

A064 Option	Opto Out1 Logic	Opto Out2 Logic
0	NO (Normally Open)	NO (Normally Open)
1	NC (Normally Closed)	NO (Normally Open)
2	NO (Normally Open)	NC (Normally Closed)
3	NC (Normally Closed)	NC (Normally Closed)

Values	Default:	0
	Min/Max:	0/3
	Display:	1

A065 [Analog Out Sel]

Related Parameter(s): P035, A066

Sets the analog output signal mode (0-10V, 0-20mA, or 4-20mA). The output is used to provide a signal that is proportional to several drive conditions.

Option	Output Range	Minimum Output Value	Maximum Output Value A066 [Analog Out High]	DIP Switch Position	Related Parameter
0 “OutFreq 0-10”	0-10V	0V = 0 Hz	P035 [Maximum Freq]	0-10V	d001
1 “OutCurr 0-10”	0-10V	0V = 0 Amps	200% Drive Rated Output Current	0-10V	d003
2 “OutVolt 0-10”	0-10V	0V = 0 Volts	120% Drive Rated Output Volts	0-10V	d004
3 “OutPowr 0-10”	0-10V	0V = 0 kW	200% Drive Rated Power	0-10V	d022
4 “TstData 0-10”	0-10V	0V = 0000	65535 (Hex FFFF)	0-10V	d019
5 “OutFreq 0-20”	0-20mA	0 mA = 0 Hz	P035 [Maximum Freq]	0-20mA	d001
6 “OutCurr 0-20”	0-20mA	0 mA = 0 Amps	200% Drive Rated Output Current	0-20mA	d003
7 “OutVolt 0-20”	0-20mA	0 mA = 0 Volts	120% Drive Rated Output Volts	0-20mA	d004
8 “OutPowr 0-20”	0-20mA	0 mA = 0 kW	200% Drive Rated Power	0-20mA	d022
9 “TstData 0-20”	0-20mA	0 mA = 0000	65535 (Hex FFFF)	0-20mA	d019
10 “OutFreq 4-20”	4-20mA	4 mA = 0 Hz	P035 [Maximum Freq]	0-20mA	d001
11 “OutCurr 4-20”	4-20mA	4 mA = 0 Amps	200% Drive Rated Output Current	0-20mA	d003
12 “OutVolt 4-20”	4-20mA	4 mA = 0 Volts	120% Drive Rated Output Volts	0-20mA	d004
13 “OutPowr 4-20”	4-20mA	4 mA = 0 kW	200% Drive Rated Power	0-20mA	d022
14 “TstData 4-20”	4-20mA	4 mA = 0000	65535 (Hex FFFF)	0-20mA	d019
15 “OutTorq 0-10”	0-10V	0V = 0 Amps	200% Drive Rated FLA	0-10V	d029
16 “OutTorq 0-20”	0-20 mA	0 mA = 0 Amps	200% Drive Rated FLA	0-20 mA	d029
17 “OutTorq 4-20”	4-20 mA	4 mA = 0 Amps	200% Drive Rated FLA	0-20 mA	d029
18 “Setpnt 0-10”	0-10V	0V = 0%	100.0% Setpoint Setting	0-10V	A109
19 “Setpnt 0-20”	0-20 mA	0 mA = 0%	100.0% Setpoint Setting	0-20 mA	A109
20 “Setpnt 4-20”	4-20 mA	4 mA = 0%	100.0% Setpoint Setting	0-20 mA	A109
21 “MinFreq 0-10”	0-10V	0V = Min. Freq	P035 [Maximum Freq]	0-10V	d001
22 “MinFreq 0-20”	0-20 mA	0 mA = Min. Freq	P035 [Maximum Freq]	0-20 mA	d001
23 “MinFreq 4-20”	4-20 mA	4 mA = Min. Freq	P035 [Maximum Freq]	0-20 mA	d001

Values	Default:	0
	Min/Max:	0/23
	Display:	1

Advanced Program Group *(continued)*

A066 [Analog Out High]

Related Parameter(s): A065

Scales the Maximum Output Value for the A065 [Analog Out Sel] source setting.

Examples:

A066 Setting	A065 Setting	A065 Max. Output Value
50%	1 “OutCurr 0-10”	5V for 200% Drive Rated Output Current
90%	8 “OutPowr 0-20”	18mA for 200% Drive Rated Power

Values	Default:	100%
	Min/Max:	0/800%
	Display:	1%

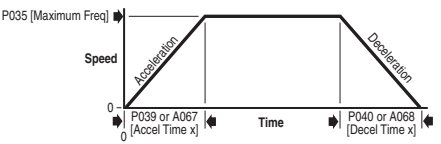
A067 [Accel Time 2]

Related Parameter(s): P039, A051-A054, A070-A077, A140-A147

When active, sets the rate of acceleration for all speed increases except jog. Refer to the flowchart on page 1-24 for details.

$$\frac{\text{Maximum Freq}}{\text{Accel Time}} = \text{Accel Rate}$$

Values	Default:	20.0 Secs
	Min/Max:	0.0/600.0 Secs
	Display:	0.1 Secs



Advanced Program Group *(continued)*

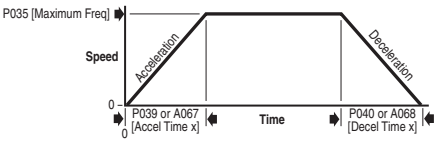
A068 [Decel Time 2]

Related Parameter(s): P040, A051-A054, A070-A077, A140-A147

When active, sets the rate of deceleration for all speed decreases except jog. Refer to the flowchart on page 1-24 for details.

$$\frac{\text{Maximum Freq}}{\text{Decel Time}} = \text{Decel Rate}$$

Values	Default:	20.0 Secs
	Min/Max:	0.1/600.0 Secs
	Display:	0.1 Secs



A069 [Internal Freq]

Related Parameter(s): P038, A162

Provides the frequency command to the drive when P038 [Speed Reference] is set to 1 “Internal Freq”. When enabled, this parameter will change the frequency command in “real time” using the integral keypad Up Arrow or Down Arrow when in program mode.

Important: Once the desired command frequency is reached, the Enter key must be pressed to store this value to EEPROM memory. If the ESC key is used before the Enter key, the frequency will return to the original value following the normal accel/decel curve.

If A051 - A054 [Digital Inx Sel] is set to 16 “MOP Up” or 17 “MOP Down” this parameter acts as the MOP frequency reference.

Values	Default:	60.0 Hz for IP20 rated drives 0.0 Hz for IP66, NEMA/UL Type 4X drives
	Min/Max:	0.0/400.0 Hz
	Display:	0.1 Hz

Advanced Program Group *(continued)*

A070 [Preset Freq 0](1)
A071 [Preset Freq 1]
A072 [Preset Freq 2]
A073 [Preset Freq 3]
A074 [Preset Freq 4]
A075 [Preset Freq 5]
A076 [Preset Freq 6]
A077 [Preset Freq 7]

Related Parameter(s): P038, P039, P040, A051-A053, A067, A068, A140-A147, A150-A157

Values	A070 Default:(1)	0.0 Hz
	A071 Default:	5.0 Hz
	A072 Default:	10.0 Hz
	A073 Default:	20.0 Hz
	A074 Default:	30.0 Hz
	A075 Default:	40.0 Hz
	A076 Default:	50.0 Hz
	A077 Default:	60.0 Hz
	Min/Max:	0.0/400.0 Hz
	Display:	0.1 Hz

Provides a fixed frequency command value when A051 - A053 [Digital Inx Sel] is set to 4 “Preset Frequencies”.

An active preset input will override speed command as shown in the flowchart on page 1-23.

(1) To activate A070 [Preset Freq 0] set P038 [Speed Reference] to option 4 “Preset Freq 0-3”.

Input State of Digital In 1 (I/O Terminal 05 when A051 = 4)	Input State of Digital In 2 (I/O Terminal 06 when A052 = 4)	Input State of Digital In 3 (I/O Terminal 07 when A053 = 4)	Frequency Source	Accel / Decel Parameter Used(2)
0	0	0	A070 [Preset Freq 0]	[Accel Time 1] / [Decel Time 1]
1	0	0	A071 [Preset Freq 1]	[Accel Time 1] / [Decel Time 1]
0	1	0	A072 [Preset Freq 2]	[Accel Time 2] / [Decel Time 2]
1	1	0	A073 [Preset Freq 3]	[Accel Time 2] / [Decel Time 2]
0	0	1	A074 [Preset Freq 4]	[Accel Time 1] / [Decel Time 1]
1	0	1	A075 [Preset Freq 5]	[Accel Time 1] / [Decel Time 1]
0	1	1	A076 [Preset Freq 6]	[Accel Time 2] / [Decel Time 2]
1	1	1	A077 [Preset Freq 7]	[Accel Time 2] / [Decel Time 2]

(2) When a Digital Input is set to “Accel 2 & Decel 2”, and the input is active, that input overrides the settings in this table.

A078 [Jog Frequency]

Related Parameter(s): P035, A051-A054, A079

Sets the output frequency when a jog command is issued.

Values	Default:	10.0 Hz
	Min/Max:	0.0/[Maximum Freq]
	Display:	0.1 Hz

Advanced Program Group *(continued)*

A079 [Jog Accel/Decel]

Related Parameter(s): A078, A051-A054

Sets the acceleration and deceleration time when a jog command is issued.

Values	Default:	10.0 Secs
	Min/Max:	0.1/600.0 Secs
	Display:	0.1 Secs

A080 [DC Brake Time]

Related Parameter(s): P037, A081

Sets the length of time that DC brake current is "injected" into the motor. Refer to parameter A081 [DC Brake Level].

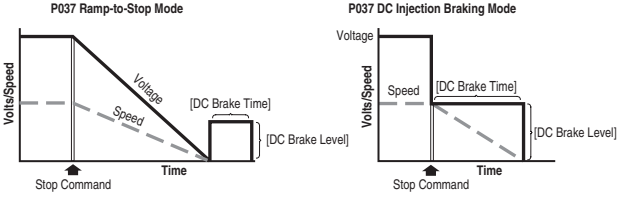
Values	Default:	0.0 Secs
	Min/Max:	0.0/99.9 Secs (A setting of 99.9 = Continuous)
	Display:	0.1 Secs

A081 [DC Brake Level]

Related Parameter(s): P037, A080

Defines the maximum DC brake current, in amps, applied to the motor when P037 [Stop Mode] is set to either "Ramp" or "DC Brake".

Values	Default:	Drive Rated Amps × 0.05
	Min/Max:	0.0/(Drive Rated Amps × 1.8)
	Display:	0.1 Amps



ATTENTION: If a hazard of injury due to movement of equipment or material exists, an auxiliary mechanical braking device must be used.

ATTENTION: This feature should not be used with synchronous or permanent magnet motors. Motors may be demagnetized during braking.

Advanced Program Group *(continued)*

A082 [DB Resistor Sel]

Related Parameter(s): P037

Stop drive before changing this parameter.

Enables/disables external dynamic braking.

Setting	Min/Max
0	"Disabled"
1	"Normal RA Res" (5% Duty Cycle) – Refer to Table B.C on page B-2.
2	"NoProtection" (100% Duty Cycle)
3-99	"x%Duty Cycle" Limited (3% – 99% of Duty Cycle)

The drive is able to provide full braking indefinitely. Braking power is limited by the external DB resistor. When this parameter is set to 1 "Normal RA Res" and an appropriate resistor is used (see selection Table B.C), the drive provides calculated resistor overload protection. However, the drive cannot protect against a brake IGBT failure.

ATTENTION: A risk of fire exists if external braking resistors are not protected. The external resistor package must be self-protected from over temperature or the protective circuit shown in Figure B.9 on page B-13, or equivalent, must be supplied.

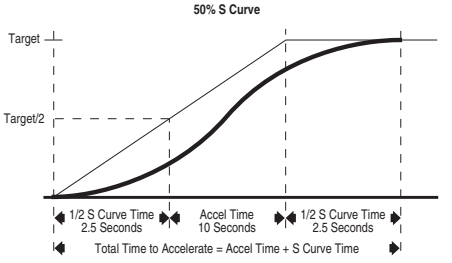
Values	Default:	0
	Min/Max:	0/99
	Display:	1

A083 [S Curve %]

Sets the percentage of acceleration or deceleration time that is applied to the ramp as S Curve. Time is added, 1/2 at the beginning and 1/2 at the end of the ramp.

Values	Default:	0% (Disabled)
	Min/Max:	0/100%
	Display:	1%

Example:
Accel Time = 10 Seconds
S Curve Setting = 50%
S Curve Time = 10 × 0.5 = 5 Seconds
Total Time = 10 + 5 = 15 Seconds



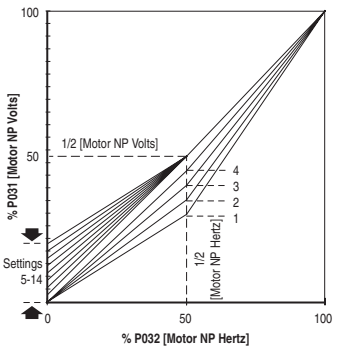
Advanced Program Group *(continued)*

A084 [Boost Select]

Related Parameter(s): d004, P031, P032, A085, A086, A087, A125

Sets the boost voltage (% of P031 [Motor NP Volts]) and redefines the Volts per Hz curve.
Active when A125 [Torque Perf Mode] = 0 "V/Hz".
Drive may add additional voltage unless Option 5 is selected.

Options			
	0	"Custom V/Hz"	
	1	"30.0, VT"	Variable Torque (Typical fan/pump curves.)
	2	"35.0, VT"	
	3	"40.0, VT"	
	4	"45.0, VT"	
	5	"0.0 no IR"	Constant Torque
	6	"0.0"	
	7	"2.5, CT" [Default for 4.0, 5.5, 7.5 & 11 kW (5.0, 7.5, 10 & 15 HP) Drives]	
	8	"5.0, CT" (Default)	
	9	"7.5, CT"	
	10	"10.0, CT"	
	11	"12.5, CT"	
	12	"15.0, CT"	
	13	"17.5, CT"	
	14	"20.0, CT"	



Advanced Program Group *(continued)*

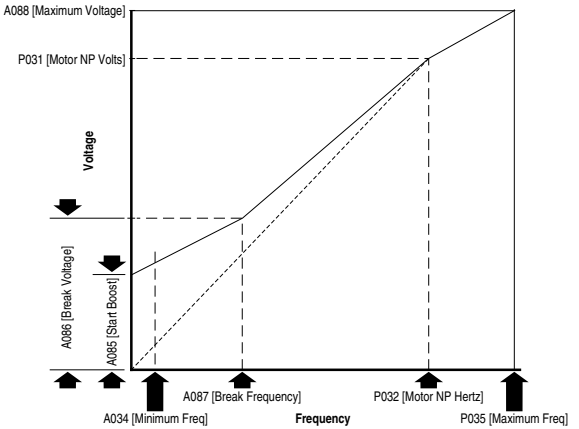
A085 [Start Boost]

Related Parameter(s): P031, P032, P034, P035, A084, A086, A087, A088, A125

Sets the boost voltage (% of P031 [Motor NP Volts]) and redefines the Volts per Hz curve when A084 [Boost Select] = 0 “Custom V/Hz” and A125 [Torque Perf Mode] = 0 “V/Hz”.

Drive may add additional voltage unless Option 5 is selected.

Values	Default:	2.5%
	Min/Max:	0.0/25.0%
	Display:	0.1%



A086 [Break Voltage]

Related Parameter(s): P031, P032, P034, P035, A084, A085, A087, A088, A125

Sets the frequency where break voltage is applied when A084 [Boost Select] = 0 “Custom V/Hz” and A125 [Torque Perf Mode] = 0 “V/Hz”

Values	Default:	25.0%
	Min/Max:	0.0/100.0%
	Display:	0.1%

A087 [Break Frequency]

Related Parameter(s): P031, P032, P034, P035, A084, A085, A086, A088, A125

Sets the frequency where break frequency is applied when A084 [Boost Select] = 0 “Custom V/Hz” and A125 [Torque Perf Mode] = 0 “V/Hz”

Values	Default:	15.0 Hz
	Min/Max:	0.0/400.0 Hz
	Display:	0.1 Hz

Advanced Program Group *(continued)*

A088 [Maximum Voltage]

Related Parameter(s): d004, A085, A086, A087

Sets the highest voltage the drive will output.

Values	Default:	Drive Rated Volts
	Min/Max:	20/Drive Rated Volts
	Display:	1 VAC

A089 [Current Limit 1]

Related Parameter(s): P033, A118

Maximum output current allowed before current limiting occurs.

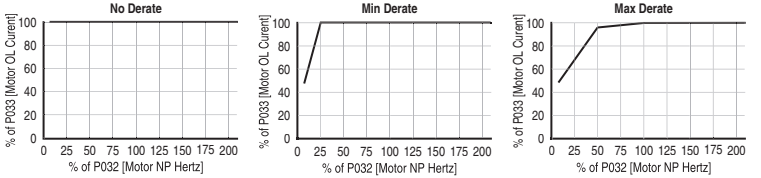
Values	Default:	Drive Rated Amps × 1.5
	Min/Max:	0.1/Drive Rated Amps × 1.8
	Display:	0.1 Amps

A090 [Motor OL Select]

Related Parameter(s): P032, P033

Drive provides Class 10 motor overload protection. Settings 0-2 select the derating factor for the I^2t overload function.

Options	**0**	"No Derate" (Default)
	1	"Min Derate"
	2	"Max Derate"



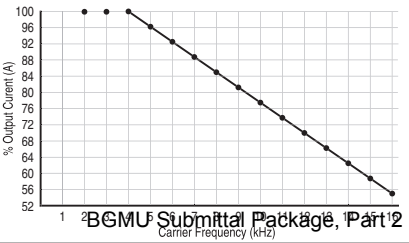
A091 [PWM Frequency]

Related Parameter(s): A124

Sets the carrier frequency for the PWM output waveform. The chart below provides derating guidelines based on the PWM frequency setting.

Important: Ignoring derating guidelines can cause reduced drive performance.

Values	Default:	4.0 kHz
	Min/Max:	2.0/16.0 kHz
	Display:	0.1 kHz



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Advanced Program Group *(continued)*

A092 [Auto Rstrt Tries]

Related Parameter(s): A055, A058, A061, A093

Sets the maximum number of times the drive attempts to reset a fault and restart.

Clear a Type 1 fault and restart the drive.

1. Set A092 [Auto Rstrt Tries] to a value other than "0".
2. Set A093 [Auto Rstrt Delay] to a value other than "0".

Clear an OverVoltage, UnderVoltage or Heatsink OvrTmp fault without restarting the drive.

1. Set A092 [Auto Rstrt Tries] to a value other than "0".
2. Set A093 [Auto Rstrt Delay] to "0".

ATTENTION: Equipment damage and/or personal injury may result if this parameter is used in an inappropriate application. Do not use this function without considering applicable local, national and international codes, standards, regulations or industry guidelines.

Values	Default:	0
	Min/Max:	0/9
	Display:	1

A093 [Auto Rstrt Delay]

Related Parameter(s): A092

Sets the time between restart attempts when A092 [Auto Rstrt Tries] is set to a value other than zero.

Values	Default:	1.0 Secs
	Min/Max:	0.0/300.0 Secs
	Display:	0.1 Secs

A094 [Start At PowerUp]

Stop drive before changing this parameter.

Enables/disables a feature that allows a Start or Run command to automatically cause the drive to resume running at commanded speed after drive input power is restored. Requires a digital input configured for Run or Start and a valid start contact.

This parameter will not function if parameter P036 [Start Source] is set to 4 "2-W High Speed".

ATTENTION: Equipment damage and/or personal injury may result if this parameter is used in an inappropriate application. Do not use this function without considering applicable local, national and international codes, standards, regulations or industry guidelines.

Options	**0**	"Disabled" (Default)
	1	"Enabled"

Advanced Program Group *(continued)*

A095 [Reverse Disable]

Related Parameter(s): d006

Stop drive before changing this parameter.

Enables/disables the function that allows the direction of motor rotation to be changed. The reverse command may come from a digital command, the keypad or a serial command. All reverse inputs including two-wire Run Reverse will be ignored with reverse disabled.

Options	**0**	"Rev Enabled" (Default)
	1	"Rev Disabled"

A096 [Flying Start En]

Sets the condition that allows the drive to reconnect to a spinning motor at actual RPM.

Options	**0**	"Disabled" (Default)
	1	"Enabled"

A097 [Compensation]

Enables/disables correction options that may improve problems with motor instability.

Options	**0**	"Disabled"	
	1	"Electrical" (Default)	Some drive/motor combinations have inherent instabilities which are exhibited as non-sinusodial motor currents. This setting attempts to correct this condition.
	2	"Mechanical"	Some motor/load combinations have mechanical resonances which can be excited by the drive current regulator. This setting slows down the current regulator response and attempts to correct this condition.
	3	"Both"	

A098 [SW Current Trip]

Related Parameter(s): P033

Enables/disables a software instantaneous (within 100 ms) current trip.

Values	Default:	0.0 (Disabled)
	Min/Max:	0.0/(Drive Rated Amps × 2)
	Display:	0.1 Amps

A099 [Process Factor]

Related Parameter(s): d010

Scales the output frequency value displayed by d010 [Process Display].

Output Freq x Process Factor = Process Display

Values	Default:	30.0
	Min/Max:	0.1/999.9
	Display:	0.1

Advanced Program Group *(continued)*

A100 [Fault Clear]

Stop drive before changing this parameter.

Resets a fault and clears the fault queue. Used primarily to clear a fault over network communications.

Options	**0**	"Ready/Idle" (Default)	
	1	"Reset Fault"	
	2	"Clear Buffer"	(Parameters d007-d009 [Fault x Code])

A101 [Program Lock]

Protects parameters against change by unauthorized personnel.

Options	**0**	"Unlocked" (Default)
	1	"Locked"

A102 [Testpoint Sel]

Related Parameter(s): d019

Used by Rockwell Automation field service personnel.

Values	Default:	400
	Min/Max:	0/FFFF
	Display:	1 Hex

A103 [Comm Data Rate]

Related Parameter(s): d015

Sets the serial port rate for the RS485 (DSI) port.

Important: Power to drive must be cycled before any changes will affect drive operation.

Options	**0**	"1200"
	1	"2400"
	2	"4800"
	3	"9600" (Default)
	4	"19.2K"
	5	"38.4K"

A104 [Comm Node Addr]

Related Parameter(s): d015

Sets the drive node address for the RS485 (DSI) port if using a network connection.

Important: Power to drive must be cycled before any changes will affect drive operation.

Values	Default:	100
	Min/Max:	1/247
	Display:	1

Advanced Program Group *(continued)*

A105 [Comm Loss Action]

Related Parameter(s): d015, P037, A106

Selects the drive's response to a loss of the communication connection or excessive communication errors.

Options	**0**	"Fault" (Default)	Drive will fault on an F81 Comm Loss and coast to stop.
	1	"Coast Stop"	Stops drive via coast to stop.
	2	"Stop"	Stops drive via P037 [Stop Mode] setting.
	3	"Continu Last"	Drive continues operating at communication commanded speed saved in RAM.

A106 [Comm Loss Time]

Related Parameter(s): d015, A105

Sets the time that the drive will remain in communication loss before implementing the option selected in A105 [Comm Loss Action].

Values	Default:	5.0 Secs
	Min/Max:	0.1/60.0 Secs
	Display:	0.1 Secs

A107 [Comm Format]

Related Parameter(s): d015

Selects the protocol (RTU only), data bits (8 data bits only), parity (None, Even, Odd), and stop bits (1 stop bit only) used by the RS485 port on the drive.

Refer to Appendix C for details on using the drive communication features.

Important: Power to drive must be cycled before any changes will affect drive operation.

Options	**0**	"RTU 8-N-1" (Default)
	1	"RTU 8-E-1"
	2	"RTU 8-O-1"
	3	"RTU 8-N-2"
	4	"RTU 8-E-2"
	5	"RTU 8-O-2"

A108 [Language]

Selects the language displayed by the remote communications option.

Options	**1**	"English" (Default)
	2	"Français"
	3	"Español"
	4	"Italiano"
	5	"Deutsch"
	6	"Reserved"
	7	"Português"
	8	"Reserved"
	9	"Reserved"
	10	"Nederlands"

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Advanced Program Group *(continued)*

A109 [Anlg Out Setpt]

Related Parameter(s): A065

When A065 [Analog Out Sel] is set to option 18, 19 or 20, this parameter sets the percentage of analog output desired.

Values	Default:	0.0%
	Min/Max:	0.0/100.0%
	Display:	0.1%

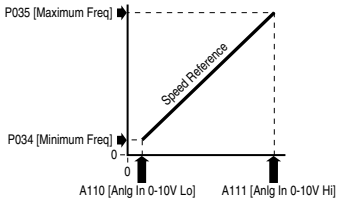
A110 [Anlg In 0-10V Lo]

Related Parameter(s): d020, P034, P038, A122

Sets the analog input level that corresponds to P034 [Minimum Freq] if a 0-10V input is used by P038 [Speed Reference].

Analog inversion can be accomplished by setting this value larger than A111 [Anlg In 0-10V Hi].

Values	Default:	0.0%
	Min/Max:	0.0/100.0%
	Display:	0.1%



A111 [Anlg In 0-10V Hi]

Related Parameter(s): d020, P035, P038, A122, A123

Sets the analog input level that corresponds to P035 [Maximum Freq] if a 0-10V input is used by P038 [Speed Reference].

Analog inversion can be accomplished by setting this value smaller than A110 [Anlg In 0-10V Lo].

Values	Default:	100.0%
	Min/Max:	0.0/100.0%
	Display:	0.1%

A112 [Anlg In4-20mA Lo]

Related Parameter(s): d021, P034, P038

Sets the analog input level that corresponds to P034 [Minimum Freq] if a 4-20mA input is used by P038 [Speed Reference].

Analog inversion can be accomplished by setting this value larger than A113 [Anlg In4-20mA Hi].

Values	Default:	0.0%
	Min/Max:	0.0/100.0%
	Display:	0.1%

Advanced Program Group *(continued)*

A113 [Anlg In4-20mA Hi]

Related Parameter(s): d021, P035, P038

Sets the analog input level that corresponds to P035 [Maximum Freq] if a 4-20mA input is used by P038 [Speed Reference].

Analog inversion can be accomplished by setting this value smaller than A112 [Anlg In4-20mA Lo].

Values	Default:	100.0%
	Min/Max:	0.0/100.0%
	Display:	0.1%

A114 [Slip Hertz @ FLA]

Related Parameter(s): P033

Compensates for the inherent slip in an induction motor. This frequency is added to the commanded output frequency based on motor current.

Values	Default:	2.0 Hz
	Min/Max:	0.0/10.0 Hz
	Display:	0.1 Hz

A115 [Process Time Lo]

Related Parameter(s): d010, P034

Scales the time value when the drive is running at P034 [Minimum Freq]. When set to a value other than zero, d010 [Process Display] indicates the duration of the process.

Values	Default:	0.00
	Min/Max:	0.00/99.99
	Display:	0.01

A116 [Process Time Hi]

Related Parameter(s): d010, P035

Scales the time value when the drive is running at P035 [Maximum Freq]. When set to a value other than zero, d010 [Process Display] indicates the duration of the process.

Values	Default:	0.00
	Min/Max:	0.00/99.99
	Display:	0.01

A117 [Bus Reg Mode]

Controls the operation of the drive voltage regulation, which is normally operational at decel or when the bus voltage rises.

Refer to the Attention statement on page P-3 for important information on bus regulation.

Options	**0**	"Disabled"
	1	"Enabled" (Default)

A118 [Current Limit 2]

Related Parameter(s): P033, A051-A054, A089

Maximum output current allowed before current limiting occurs. This parameter is only active if A051 - A054 [Digital Inx Sel] is set to 25 "Current Lmt2" and is active.

Values	Default:	Drive Rated Amps × 1.5
	Min/Max:	0.1/(Drive Rated Amps × 1.8)
	Display:	0.1 Amps

Advanced Program Group *(continued)*

A119 [Skip Frequency]

Related Parameter(s): A120

Sets the frequency at which the drive will not operate.

A setting of 0 disables this parameter.

Values	Default:	0 Hz
	Min/Max:	0/400 Hz
	Display:	1 Hz

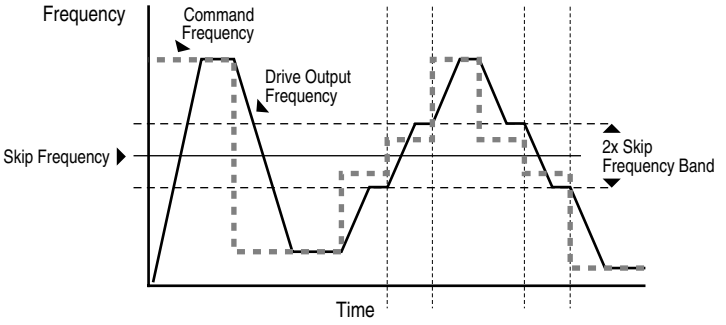
A120 [Skip Freq Band]

Related Parameter(s): A119

Determines the bandwidth around A119 [Skip Frequency]. A120 [Skip Frequency Band] is split applying 1/2 above and 1/2 below the actual skip frequency.

A setting of 0.0 disables this parameter.

Values	Default:	0.0 Hz
	Min/Max:	0.0/30.0 Hz
	Display:	0.1 Hz



A121 [Stall Fault Time]

Sets the time that the drive will remain in stall mode before a fault is issued.

Options	**0**	"60 Seconds" (Default)
	1	"120 Seconds"
	2	"240 Seconds"
	3	"360 Seconds"
	4	"480 Seconds"
	5	"Flt Disabled"

Advanced Program Group *(continued)*

A122 [Analog In Loss]

Related Parameter(s): A110, A111, A132

Selects drive action when an input signal loss is detected. Signal loss is defined as an analog signal less than 1V or 2mA. The signal loss event ends and normal operation resumes when the input signal level is greater than or equal to 1.5V or 3mA. If using a 0-10V analog input, set A110 [Anlg In 0-10V Lo] to a minimum of 20% (i.e. 2 volts).

Options	**0**	"Disabled" (Default)	
	1	"Fault (F29)"	F29 Analog Input Loss
	2	"Stop"	Uses P037 [Stop Mode]
	3	"Zero Ref"	Drive runs at zero speed reference.
	4	"Min Freq Ref"	Drive runs at minimum frequency.
	5	"Max Freq Ref"	Drive runs at maximum frequency.
	6	"Int Freq Ref"	Drive runs at internal frequency.

A123 [10V Bipolar Enbl]

Related Parameter(s): P038, A111

Enables/disables bipolar control. In bipolar mode direction is commanded by the sign of the reference.

Options	**0**	"Uni-Polar In" (Default)	0 to 10V only
	1	"Bi-Polar In"	±10V

A124 [Var PWM Disable]

Related Parameter(s): A091

Stop drive before changing this parameter.

Enables/disables a feature that varies the carrier frequency for the PWM output waveform defined by A091 [PWM Frequency].

Disabling this feature when low frequency conditions exist may result in IGBT stress and nuisance tripping.

Options	**0**	"Enabled" (Default)	
	1	"Disabled"	

A125 [Torque Perf Mode]

Related Parameter(s): A084, A085, A086, A087, A127

Stop drive before changing this parameter.

Enables/disables sensorless vector control operation.

Options	**0**	"V/Hz"	
	1	"Sensrls Vect" (Default)	

A126 [Motor NP FLA]

Related Parameter(s): A127

Set to the motor nameplate rated full load amps.

Values	Default:	Drive Rated Amps
	Min/Max:	0.1/(Drive Rated Amps × 2)
	Display:	0.1 Amps

Advanced Program Group *(continued)*

A127 [Autotune]

Related Parameter(s): A125, A126, A128, A129

Stop drive before changing this parameter.

Provides an automatic method for setting A128 [IR Voltage Drop] and A129 [Flux Current Ref], which affect sensorless vector performance. Parameter A126 [Motor NP FLA] must be set to the motor nameplate full load amps before running the Autotune procedure.

Options	**0**	"Ready/Idle" (Default)
	1	"Static Tune"
	2	"Rotate Tune"

"Ready" (0) = Parameter returns to this setting following a "Static Tune" or "Rotate Tune."

"Static Tune" (1) = A temporary command that initiates a non-rotational motor stator resistance test for the best possible automatic setting of A128 [IR Voltage Drop]. A start command is required following initiation of this setting. The parameter returns to "Ready" (0) following the test, at which time another start transition is required operate the drive in normal mode. Used when motor cannot be uncoupled from the load.

"Rotate Tune" (2) = A temporary command that initiates a "Static Tune" followed by a rotational test for the best possible automatic setting of A129 [Flux Current Ref]. A start command is required following initiation of this setting. The parameter returns to "Ready" (0) following the test, at which time another start transition is required to operate the drive in normal mode. **Important:** Used when motor is uncoupled from the load. Results may not be valid if a load is coupled to the motor during this procedure.

ATTENTION: Rotation of the motor in an undesired direction can occur during this procedure. To guard against possible injury and/or equipment damage, it is recommended that the motor be disconnected from the load before proceeding.

If the Autotune routine fails, an F80 SVC Autotune fault is displayed.

A128 [IR Voltage Drop]

Related Parameter(s): A127

Value of volts dropped across the resistance of the motor stator.

Values	Default:	Based on Drive Rating
	Min/Max:	0.0/230.0 VAC
	Display:	0.1 VAC

A129 [Flux Current Ref]

Related Parameter(s): A127

Value of amps for full motor flux.

Values	Default:	Based on Drive Rating
	Min/Max:	0.00/[Motor NP FLA]
	Display:	0.01 Amps

Advanced Program Group *(continued)*

A130 [PID Trim Hi]

Sets the maximum positive value that is added to the speed reference when PID trim is used.

Values	Default:	60.0
	Min/Max:	0.0/400.0
	Display:	0.1

A131 [PID Trim Lo]

Sets the maximum positive value that is subtracted from the PID reference when PID trim is used.

Values	Default:	0.0
	Min/Max:	0.0/400.0
	Display:	0.1

A132 [PID Ref Sel]

Related Parameter(s): P038, A122

Stop drive before changing this parameter.

Enables/disables PID mode and selects the source of the PID reference. Refer to Appendix F for details.

Options	**0**	"PID Disabled" (Default)
	1	"PID Setpoint"
	2	"0-10V Input"
	3	"4-20mA Input"
	4	"Comm Port"
	5	"Setpnt, Trim"
	6	"0-10V, Trim"
	7	"4-20mA, Trim"
	8	"Comm, Trim"

A133 [PID Feedback Sel]

Select the source of the PID feedback. Refer to Appendix F for details.

Options	**0**	"0-10V Input" (Default)	The PID will not function with a bipolar input. Negative voltages are treated as 0 volts.
	1	"4-20mA Input"	
	2	"Comm Port"	

A134 [PID Prop Gain]

Sets the value for the PID proportional component when the PID mode is enabled by A132 [PID Ref Sel].

Values	Default:	0.01
	Min/Max:	0.00/99.99
	Display:	0.01

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Advanced Program Group *(continued)*

A135 [PID Integ Time]

Sets the value for the PID integral component when the PID mode is enabled by A132 [PID Ref Sel].

Values	Default:	0.1 Secs
	Min/Max:	0.0/999.9 Secs
	Display:	0.1 Secs

A136 [PID Diff Rate]

Sets the value for the PID differential component when the PID mode is enabled by A132 [PID Ref Sel].

Values	Default:	0.01 (1/Secs)
	Min/Max:	0.00/99.99 (1/Secs)
	Display:	0.01 (1/Secs)

A137 [PID Setpoint]

Provides an internal fixed value for process setpoint when the PID mode is enabled by A132 [PID Ref Sel].

Values	Default:	0.0%
	Min/Max:	0.0/100.0%
	Display:	0.1%

A138 [PID Deadband]

Sets the lower limit of the PID output.

Values	Default:	0.0%
	Min/Max:	0.0/10.0%
	Display:	0.1%

A139 [PID Preload]

Sets the value used to preload the integral component on start or enable.

Values	Default:	0.0 Hz
	Min/Max:	0.0/400.0 Hz
	Display:	0.1 Hz

Advanced Program Group *(continued)*

A140 [Stp Logic 0]
A141 [Stp Logic 1]
A142 [Stp Logic 2]
A143 [Stp Logic 3]
A144 [Stp Logic 4]
A145 [Stp Logic 5]
A146 [Stp Logic 6]
A147 [Stp Logic 7]

Related Parameter(s): P038, P039, P040, A051-A054, A055, A058, A061, A067, A068, A070-A077, A150-A157

Stop drive before changing this parameter.

Values	Default:	00F1
	Min/Max:	0001/bAFF
	Display:	4 Digits

Parameters A140-A147 are only active if P038 [Speed Reference] is set to 6 “Stp Logic”.

These parameters can be used to create a custom profile of frequency commands. Each “step” can be based on time, status of a Logic input or a combination of time and the status of a Logic input.

Digits 0-3 for each [Stp Logic x] parameter must be programmed according to the desired profile.

A Logic input is established by setting a digital input, parameters A051 - A054 [Digital Inx Sel], to 23 “Logic In1” and/or 24 “Logic In2”.

A time interval between steps can be programmed using parameters A150 - A157 [Stp Logic Time x]. See the table below for related parameters.

The speed for any step is programmed using parameters A070 - A077 [Preset Freq x].

StepLogic Parameter (Active when P038 = 6 “Stp Logic”)	Related Preset Frequency Parameter (Can be activated independent of StepLogic Parameters)	Related StepLogic Time Parameter (Active when A140-A147 Digit 0 or 1 are set to 1, b, C, d or E)
A140 [Stp Logic 0]	A070 [Preset Freq 0]	A150 [Stp Logic Time 0]
A141 [Stp Logic 1]	A071 [Preset Freq 1]	A151 [Stp Logic Time 1]
A142 [Stp Logic 2]	A072 [Preset Freq 2]	A152 [Stp Logic Time 2]
A143 [Stp Logic 3]	A073 [Preset Freq 3]	A153 [Stp Logic Time 3]
A144 [Stp Logic 4]	A074 [Preset Freq 4]	A154 [Stp Logic Time 4]
A145 [Stp Logic 5]	A075 [Preset Freq 5]	A155 [Stp Logic Time 5]
A146 [Stp Logic 6]	A076 [Preset Freq 6]	A156 [Stp Logic Time 6]
A147 [Stp Logic 7]	A077 [Preset Freq 7]	A157 [Stp Logic Time 7]

How StepLogic Works
The StepLogic sequence begins with a valid start command. A normal sequence always begins with A140 [Stp Logic 0].

Digit 0: Logic For Next Step
This digit defines the logic for the next step. When the condition is met the program advances to the next step. Step 0 follows Step 7. Example: Digit 0 is set 3. When “Logic In2” becomes active, the program advances to the next step.

Digit 1: Logic to Jump to a Different Step
For all settings other than F, when the condition is met, the program overrides Digit 0 and jumps to the step defined by Digit 2.

Digit 2: Different Step to Jump
When the condition for Digit 1 is met, the Digit 2 setting determines the next step or to end the program.

Digit 3: Step Settings

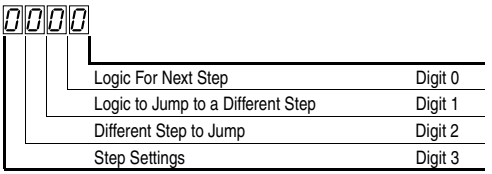
This digit defines what accel/decel profile the speed command will follow and the direction of the command for the current step. In addition, if a relay or opto output (parameters A055, A058 and A061) is set to 15 “StpLogic Out”, this parameter can control the status of that output.

Any StepLogic parameter can be programmed to control a relay or opto output, but you can not control different outputs based on the condition of different StepLogic commands.

StepLogic Settings

The logic for each function is determined by the four digits for each StepLogic parameter. The following is a listing of the available settings for each digit.

Refer to Appendix E for details.



Digit 3 Settings

Required Setting	Accel/Decel Param. Used	StepLogic Output State	Commanded Direction
0	Accel/Decel 1	Off	FWD
1	Accel/Decel 1	Off	REV
2	Accel/Decel 1	Off	No Output
3	Accel/Decel 1	On	FWD
4	Accel/Decel 1	On	REV
5	Accel/Decel 1	On	No Output
6	Accel/Decel 2	Off	FWD
7	Accel/Decel 2	Off	REV
8	Accel/Decel 2	Off	No Output
9	Accel/Decel 2	On	FWD
A	Accel/Decel 2	On	REV
b	Accel/Decel 2	On	No Output

Digit 2 Settings

0 = Jump to Step 0
1 = Jump to Step 1
2 = Jump to Step 2
3 = Jump to Step 3
4 = Jump to Step 4
5 = Jump to Step 5
6 = Jump to Step 6
7 = Jump to Step 7
8 = End Program (Normal Stop)
9 = End Program (Coast to Stop)
A = End Program and Fault (F2)

Digit 1 and Digit 0 Settings

0 = Skip Step (Jump Immediately)
1 = Step Based on [Stp Logic Time x]
2 = Step if “Logic In1” is Active
3 = Step if “Logic In2” is Active
4 = Step if “Logic In1” is Not Active
5 = Step if “Logic In2” is Not Active
6 = Step if either “Logic In1” or “Logic In2” is Active
7 = Step if both “Logic In1” and “Logic In2” is Active
8 = Step if neither “Logic In1” or “Logic In2” is Active
9 = Step if “Logic In1” is Active and “Logic In2” is Not Active
A = Step if “Logic In2” is Active and “Logic In1” is Not Active
b = Step after [Stp Logic Time x] and “Logic In1” is Active
C = Step after [Stp Logic Time x] and “Logic In2” is Active
d = Step after [Stp Logic Time x] and “Logic In1” is Not Active
E = Step after [Stp Logic Time x] and “Logic In2” is Not Active
F = Do Not Step/Ignore Digit 2 Settings

Advanced Program Group *(continued)*

A150 [Stp Logic Time 0]
A151 [Stp Logic Time 1]
A152 [Stp Logic Time 2]
A153 [Stp Logic Time 3]
A154 [Stp Logic Time 4]
A155 [Stp Logic Time 5]
A156 [Stp Logic Time 6]
A157 [Stp Logic Time 7]

Related Parameter(s): P038, A055, A058, A061, A070-A077, A140-A147

Sets the time to remain in each step if the corresponding StpLogic command word is set to “Step after Time”.

Values	Default:	30.0 Secs
	Min/Max:	0.0/999.9 Secs
	Display:	0.1 Secs

A160 [EM Brk Off Delay]

Related Parameter(s): P037

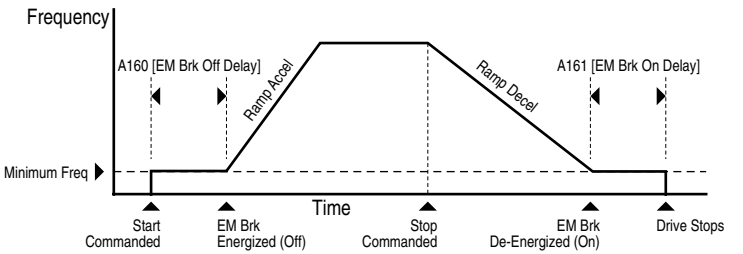
Sets the time the drive remains at minimum frequency before the relay or an opto output is energized and the drive ramps to the commanded frequency.

The relay or opto output is typically connected to a user-supplied electromechanical brake coil relay.

Set P037 [Stop Mode] to 8 “Ramp+EM B,CF” or 9 “Ramp+EM Brk” to enable the electromechanical brake option.

Set A055 [Relay Out Sel], A058 or A061 [Opto Outx Sel] to 22 “EM Brk Cntrl” to control brake operation.

Values	Default:	2.00 Secs
	Min/Max:	0.01/10.00 Secs
	Display:	0.01 Secs



Advanced Program Group *(continued)*

A161 [EM Brk On Delay]

Related Parameter(s): P037

Sets the time the drive remains at minimum frequency before the relay or an opto output is de-energizing and the drive stops.

The relay or opto output is typically connected to a user-supplied electromechanical brake coil relay.

Set P037 [Stop Mode] to 8 “Ramp+EM B,CF” or 9 “Ramp+EM Brk” to enable the electromechanical brake option.

Set A055 [Relay Out Sel], A058 or A061 [Opto Outx Sel] to 22 “EM Brk Cntrl” to control brake operation.

Values	Default:	2.00 Secs
	Min/Max:	0.01/10.00 Secs
	Display:	0.01 Secs

A162 [MOP Reset Sel]

Related Parameter(s): A069

Set the drive to save the current MOP reference command.

Options	**0**	“Zero MOP Ref”	This option clamps A069 [Internal Freq] at 0.0 Hz when the drive is not running.
	1	“Save MOP Ref” (Default)	Reference is saved in A069 [Internal Freq].

A163 [DB Threshold]

Related Parameter(s): P037, A080, A081, A082

Sets the DC bus Voltage Threshold for Dynamic Brake operation. If the DC bus voltage falls below the value set in this parameter, the Dynamic Brake will not turn on. Lower values will make the Dynamic Braking function more responsive but may result in nuisance Dynamic Brake activation.

Values	Default	100.0%
	Min/Max:	0.0/110.0%
	Display:	0.0%

ATTENTION: Equipment damage may result if this parameter is set a value that causes the dynamic braking resistor to dissipate excessive power. Parameter settings less than 100% should be carefully evaluated to ensure that the dynamic brake resistor’s wattage rating is not exceeded. In general, values less than 90% are not needed. This parameter’s setting is especially important if parameter A082 [DB Resistor Sel] is set to 2 “No Protection”.

Advanced Program Group *(continued)*

A164 [Comm Write Mode]

Determines whether parameter changes made over communication port are saved and stored in Non-Volatile Storage (NVS) or RAM only. If they are stored in RAM, the values will be lost at power-down.

Options	**0**	"Save" (Default)
	1	"RAM Only"

ATTENTION: Risk of equipment damage exists. If a controller is programmed to write parameter data to Non-Volatile Storage (NVS) frequently, the NVS will quickly exceed its life cycle and cause the drive to malfunction. Do not create a program that frequently uses configurable outputs to write parameter data to NVS unless A164 [Comm Write Mode] is set to option 1.

A165 [Anlg Loss Delay]

Related Parameter(s): A122

Sets the length of time after power-up during which the drive will not detect an analog signal loss. The drive response to an analog signal loss is set in A122 [Analog In Loss].

Values	Default:	0.0 Secs
	Min/Max:	0.0/20.0 Secs
	Display:	0.1 Secs

A166 [Analog In Filter]

Sets level of additional filtering of the analog input signals. A higher number increases filtering and decreases bandwidth. Each setting doubles the applied filtering (1 = 2x filter, 2 = 4x filter, etc...). No additional filtering is applied when set to "0".

Values	Default:	0
	Min/Max:	0/14
	Display:	1

A167 [PID Invert Error]

When set to "Inverted", changes the sign of the PID error. This causes an increase in the drive output frequency with PID Feedback greater than PID Setpoint, and a decrease in drive output frequency with PID Feedback less than PID Setpoint.

Options	**0**	"Not Inverted" (Default)
	1	"Inverted"

Parameter Cross Reference – by Name

Parameter Name	No.	Group
10V Bipolar Enbl	A123	Advanced Program
Accel Time 1	P039	Basic Program
Accel Time 2	A067	Advanced Program
Analog In 0-10V	d020	Display
Analog In 4-20mA	d021	Display
Analog In Filter	A166	Advanced Program
Analog In Loss	A122	Advanced Program
Analog Out High	A066	Advanced Program
Analog Out Sel	A065	Advanced Program
Anlg In 0-10V Hi	A111	Advanced Program
Anlg In 0-10V Lo	A110	Advanced Program
Anlg In4-20mA Hi	A113	Advanced Program
Anlg In4-20mA Lo	A112	Advanced Program
Anlg Loss Delay	A166	Advanced Program
Anlg Out Setpt	A109	Advanced Program
Auto Rstrt Delay	A093	Advanced Program
Auto Rstrt Tries	A092	Advanced Program
Autotune	A127	Advanced Program
Boost Select	A084	Advanced Program
Break Frequency	A087	Advanced Program
Break Voltage	A086	Advanced Program
Bus Reg Mode	A117	Advanced Program
Comm Data Rate	A103	Advanced Program
Comm Format	A107	Advanced Program
Comm Loss Action	A105	Advanced Program
Comm Loss Time	A106	Advanced Program
Comm Node Addr	A104	Advanced Program
Comm Status	d015	Display
Comm Write Mode	A164	Advanced Program
Commanded Freq	d002	Display
Compensation	A097	Advanced Program
Contrl In Status	d013	Display
Control Source	d012	Display
Control SW Ver	d016	Display
Counter Status	d025	Display
Current Limit x	A089, A118	Advanced Program
DB Resistor Sel	A082	Advanced Program
DB Threshold	A163	Advanced Program
DC Brake Level	A081	Advanced Program
DC Brake Time	A080	Advanced Program
DC Bus Voltage	d005	Display
Decel Time 1	P040	Basic Program
Decel Time 2	A068	Advanced Program
Dig In Status	d014	Display
Digital Inx Sel	A051-A054	Advanced Program
Drive Status	d006	Display
Drive Temp	d024	Display
Drive Type	d017	Display
Elapsed Run Time	d018	Display
EM Brk Off Delay	A160	Advanced Program
EM Brk On Delay	A161	Advanced Program
Fault Clear	A100	Advanced Program
Fault x Code	d007-d009	Display
Flux Current Ref	A129	Advanced Program
Flying Start En	A096	Advanced Program
Internal Freq	A069	Advanced Program
IR Voltage Drop	A128	Advanced Program
Jog Accel/Decel	A079	Advanced Program
Jog Frequency	A078	Advanced Program
Language	A108	Advanced Program
Maximum Freq	P035	Basic Program
Maximum Voltage	A088	Advanced Program
Minimum Freq	P034	Basic Program
MOP Reset Sel	A162	Advanced Program
Motor NP FLA	A126	Advanced Program
Motor NP Hertz	P032	Basic Program
Motor NP Volts	P031	Basic Program
Motor OL Current	P033	Basic Program
Motor OL Ret	P043	Basic Program
Motor OL Select	A090	Advanced Program
Opto Out Logic	A064	Advanced Program
Opto Outx Level	A059, A062	Advanced Program
Opto Outx Sel	A058, A061	Advanced Program
Output Current	d003	Display
Output Freq	d001	Display
Output Power	d022	Display
Output Powr Fctr	d023	Display
Output Voltage	d004	Display
PID Deadband	A138	Advanced Program
PID Diff Rate	A136	Advanced Program
PID Feedback Sel	A133	Advanced Program
PID Integ Time	A135	Advanced Program
PID Invert Error	A167	Advanced Program
PID Preload	A139	Advanced Program
PID Prop Gain	A134	Advanced Program
PID Ref Sel	A132	Advanced Program
PID Setpoint	A137	Advanced Program
PID Trim Hi	A130	Advanced Program
PID Trim Lo	A131	Advanced Program
Preset Freq x	A070-A077	Advanced Program
Process Display	d010	Display
Process Factor	A099	Advanced Program
Process Time Hi	A116	Advanced Program
Process Time Lo	A115	Advanced Program
Program Lock	A101	Advanced Program
PWM Frequency	A091	Advanced Program
Relay Out Level	A056	Advanced Program
Relay Out Sel	A055	Advanced Program
Reset To Defalts	P041	Basic Program
Reverse Disable	A095	Advanced Program
S Curve %	A083	Advanced Program
Skip Freq Band	A120	Advanced Program
Skip Frequency	A119	Advanced Program
Slip Hertz @ FLA	A114	Advanced Program
Stp Logic Status	d028	Display
Stp Logic x	A140-A147	Advanced Program
Stp Logic Time x	A150-A157	Advanced Program
Speed Reference	P038	Basic Program
Stall Fault Time	A121	Advanced Program
Start At PowerUp	A094	Advanced Program
Start Boost	A085	Advanced Program
Start Source	P036	Basic Program
Stop Mode	P037	Basic Program
SW Current Trip	A098	Advanced Program

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Parameter Name	No.	Group
Testpoint Data	d019	Display
Testpoint Sel	A102	Advanced Program
Timer Status	d026	Display
Torque Current	d029	Display
Torque Perf Mode	A125	Advanced Program
Var PWM Disable	A124	Advanced Program
Voltage Class	P042	Basic Program

Troubleshooting

Chapter 4 provides information to guide you in troubleshooting the PowerFlex 40 drive. Included is a listing and description of drive faults (with possible solutions, when applicable).

For information on...	See page...	For information on...	See page...
Drive Status	4-1	Fault Descriptions	4-3
Faults	4-1	Common Symptoms and Corrective Actions	4-5

Drive Status

The condition or state of your drive is constantly monitored. Any changes will be indicated through the integral keypad.

LED Indications

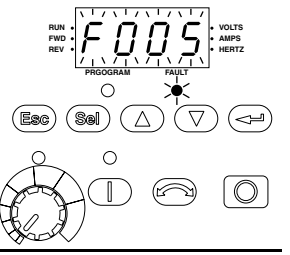
See page 2-4 for information on drive status indicators and controls.

Faults

A fault is a condition that stops the drive. There are two fault types.

Type	Fault Description	
①	Auto-Reset/Run	When this type of fault occurs, and A092 [Auto Rstrt Tries] is set to a value greater than "0," a user-configurable timer, A093 [Auto Rstrt Delay], begins. When the timer reaches zero, the drive attempts to automatically reset the fault. If the condition that caused the fault is no longer present, the fault will be reset and the drive will be restarted.
②	Non-Resetable	This type of fault may require drive or motor repair, or is caused by wiring or programing errors. The cause of the fault must be corrected before the fault can be cleared.

Fault Indication

Condition	Display
Drive is indicating a fault. The integral keypad provides visual notification of a fault condition by displaying the following. • Flashing fault number • Flashing fault indicator Press the Escape key to regain control of the integral keypad.	

Manually Clearing Faults

Step	Key(s)
1. Press Esc to acknowledge the fault. The fault information will be removed so that you can use the integral keypad. Access d007 [Fault 1 Code] to view the most recent fault information. 2. Address the condition that caused the fault. The cause must be corrected before the fault can be cleared. See Table 4.A. 3. After corrective action has been taken, clear the fault by one of these methods. • Press Stop if P037 [Stop Mode] is set to a value between “0” and “3”. • Cycle drive power. • Set A100 [Fault Clear] to “1” or “2”. • Cycle digital input if A051-A054 [Digital Inx Sel] is set to option 7 “Clear Fault”.	

Automatically Clearing Faults

Option / Step
Clear a Type 1 fault and restart the drive. 1. Set A092 [Auto Rstrt Tries] to a value other than “0”. 2. Set A093 [Auto Rstrt Delay] to a value other than “0”.
Clear an OverVoltage, UnderVoltage or Heatsink OvrTmp fault without restarting the drive. 1. Set A092 [Auto Rstrt Tries] to a value other than “0”. 2. Set A093 [Auto Rstrt Delay] to “0”.

Auto Restart (Reset/Run)

The Auto Restart feature provides the ability for the drive to automatically perform a fault reset followed by a start attempt without user or application intervention. This allows remote or “unattended” operation. Only certain faults are allowed to be reset. Certain faults (Type 2) that indicate possible drive component malfunction are not resettable.

Caution should be used when enabling this feature, since the drive will attempt to issue its own start command based on user selected programming.

Fault Descriptions

Table 4.A Fault Types, Descriptions and Actions

No.	Fault	Type(1)	Description	Action
F2	Auxiliary Input	①	Auxiliary input interlock is open.	1. Check remote wiring. 2. Verify communications programming for intentional fault.
F3	Power Loss	②	Excessive DC Bus voltage ripple.	1. Monitor the incoming line for phase loss or line imbalance. 2. Check input line fuse.
F4	UnderVoltage	①	DC bus voltage fell below the minimum value.	Monitor the incoming AC line for low voltage or line power interruption.
F5	OverVoltage	①	DC bus voltage exceeded maximum value.	Monitor the AC line for high line voltage or transient conditions. Bus overvoltage can also be caused by motor regeneration. Extend the decel time or install dynamic brake option.
F6	Motor Stalled	①	Drive is unable to accelerate motor.	Increase P039 - A067 [Accel Time x] or reduce load so drive output current does not exceed the current set by parameter A089 [Current Limit 1].
F7	Motor Overload	①	Internal electronic overload trip.	1. An excessive motor load exists. Reduce load so drive output current does not exceed the current set by parameter P033 [Motor OL Current]. 2. Verify A084 [Boost Select] setting
F8	Heatsink OvrTmp	①	Heatsink temperature exceeds a predefined value.	1. Check for blocked or dirty heat sink fins. Verify that ambient temperature has not exceeded 40° C (104° F) for IP30, NEMA UL Type 1 installations or 50°C (122°F) for IP20/Open type installations. 2. Check fan.
F12	HW OverCurrent	②	The drive output current has exceeded the hardware current limit.	Check programming. Check for excess load, improper A084 [Boost Select] setting, DC brake volts set too high or other causes of excess current.
F13	Ground Fault	②	A current path to earth ground has been detected at one or more of the drive output terminals.	Check the motor and external wiring to the drive output terminals for a grounded condition.
F29	Analog Input Loss	①	An analog input is configured to fault on signal loss. A signal loss has occurred. Configure with A122 [Analog In Loss].	1. Check parameters. 2. Check for broken/loose connections at inputs.

(1) See page 4-1 for a description of fault types.

No.	Fault	Type(1)	Description	Action
F33	Auto Rstrt Tries	②	Drive unsuccessfully attempted to reset a fault and resume running for the programmed number of A092 [Auto Rstrt Tries].	Correct the cause of the fault and manually clear.
F38	Phase U to Gnd	②	A phase to ground fault has been detected between the drive and motor in this phase.	1. Check the wiring between the drive and motor. 2. Check motor for grounded phase. 3. Replace drive if fault cannot be cleared.
F39	Phase V to Gnd			
F40	Phase W to Gnd			
F41	Phase UV Short	②	Excessive current has been detected between these two output terminals.	1. Check the motor and drive output terminal wiring for a shorted condition. 2. Replace drive if fault cannot be cleared.
F42	Phase UW Short			
F43	Phase VW Short			
F48	Params Defaulted		The drive was commanded to write default values to EEPROM.	1. Clear the fault or cycle power to the drive. 2. Program the drive parameters as needed.
F63	SW OverCurrent	①	Programmed A098 [SW Current Trip] has been exceeded.	Check load requirements and A098 [SW Current Trip] setting.
F64	Drive Overload	②	Drive rating of 150% for 1 minute or 200% for 3 seconds has been exceeded.	Reduce load or extend Accel Time.
F70	Power Unit	②	Failure has been detected in the drive power section.	1. Cycle power. 2. Replace drive if fault cannot be cleared.
F71	Net Loss		The communication network has faulted.	1. Cycle power. 2. Check communications cabling. 3. Check network adapter setting. 4. Check external network status.
F80	SVC Autotune		The autotune function was either cancelled by the user or failed.	Restart procedure.
F81	Comm Loss	②	RS485 (DSI) port stopped communicating.	1. If adapter was not intentionally disconnected, check wiring to the port. Replace wiring, port expander, adapters or complete drive as required. 2. Check connection. 3. An adapter was intentionally disconnected. 4. Turn off using A105 [Comm Loss Action].

No.	Fault	Type(1)	Description	Action
F100	Parameter Checksum	②	The checksum read from the board does not match the checksum calculated.	Set P041 [Reset To Defalts] to option 1 “Reset Defaults”.
F122	I/O Board Fail	②	Failure has been detected in the drive control and I/O section.	1. Cycle power. 2. Replace drive if fault cannot be cleared.

(1) See page 4-1 for a description of fault types.

Common Symptoms and Corrective Actions

Motor does not Start.

Cause(s)	Indication	Corrective Action
No output voltage to the motor.	None	Check the power circuit. • Check the supply voltage. • Check all fuses and disconnects. Check the motor. • Verify that the motor is connected properly. Check the control input signals. • Verify that a Start signal is present. If 2-Wire control is used, verify that either the Run Forward or Run Reverse signal is active, but not both. • Verify that I/O Terminal 01 is active. • Verify that P036 [Start Source] matches your configuration. • Verify that A095 [Reverse Disable] is not prohibiting movement.
Improper boost setting at initial start-up.	None	Set A084 [Boost Select] to option 2 “35.0, VT”.
Drive is Faulted	Flashing red status light	Clear fault. • Press Stop • Cycle power • Set A100 [Fault Clear] to option 1 “Clear Faults”. • Cycle digital input if A051 - A054 [Digital Inx Sel] is set to option 7 “Clear Fault”.

Drive does not Start from Start or Run Inputs wired to the terminal block.

Cause(s)	Indication	Corrective Action
Drive is Faulted	Flashing red status light	Clear fault. • Press Stop • Cycle power • Set A100 [Fault Clear] to option 1 “Clear Faults”. • Cycle digital input if A051 - A054 [Digital Inx Sel] is set to option 7 “Clear Fault”.
Incorrect programming. • P036 [Start Source] is set to option 0 “Keypad” or option 5 “RS485 (DSI) Port”. • A051 - A054 [Digital Inx Sel] is set to option 5 “Local” and the input is active.	None	Check parameter settings.
Incorrect input wiring. See 1-18 for wiring examples. • 2 wire control requires Run Forward, Run Reverse or Jog input. • 3 wire control requires Start and Stop inputs • Stop input is always required.	None	Wire inputs correctly and/or install jumper.
Incorrect Sink/Source DIP switch setting.	None	Set switch to match wiring scheme.

Drive does not Start from Integral Keypad.

Cause(s)	Indication	Corrective Action
Integral keypad is not enabled.	Green LED above Start key is not illuminated.	• Set parameter P036 [Start Source] to option 0 “Keypad”. • Set parameter A051 - A054 [Digital Inx Sel] to option 5 “Local” and activate the input.
I/O Terminal 01 “Stop” input is not present.	None	Wire inputs correctly and/or install jumper.

Drive does not respond to changes in speed command.

Cause(s)	Indication	Corrective Action
No value is coming from the source of the command.	The drive “Run” indicator is lit and output is 0 Hz.	• Check d012 [Control Source] for correct source. • If the source is an analog input, check wiring and use a meter to check for presence of signal. • Check d002 [Commanded Freq] to verify correct command.
Incorrect reference source is being selected via remote device or digital inputs.	None	• Check d012 [Control Source] for correct source. • Check d014 [Dig In Status] to see if inputs are selecting an alternate source. Verify settings for A051 - A054 [Digital Inx Sel]. • Check P038 [Speed Reference] for the source of the speed reference. Reprogram as necessary. • Review the Speed Reference Control chart on page 1-23.

Motor and/or drive will not accelerate to commanded speed.

Cause(s)	Indication	Corrective Action
Acceleration time is excessive.	None	Reprogram P039 [Accel Time 1] or A067 [Accel Time 2].
Excess load or short acceleration times force the drive into current limit, slowing or stopping acceleration.	None	Compare d003 [Output Current] with A089 [Current Limit 1]. Remove excess load or reprogram P039 [Accel Time 1] or A067 [Accel Time 2]. Check for improper A084 [Boost Select] setting.
Speed command source or value is not as expected.	None	Verify d002 [Commanded Freq]. Check d012 [Control Source] for the proper Speed Command.
Programming is preventing the drive output from exceeding limiting values.	None	Check P035 [Maximum Freq] to insure that speed is not limited by programming.
Torque performance does not match motor characteristics.	None	Set motor nameplate full load amps in parameter A126 [Motor NP FLA]. Perform A127 [Autotune] “Static Tune” or “Rotate Tune” procedure. Set A125 [Torque Perf Mode] to option 0 “V/Hz”.

Motor operation is unstable.

Cause(s)	Indication	Corrective Action
Motor data was incorrectly entered.	None	1. Correctly enter motor nameplate data into P031, P032 and P033. 2. Enable A097 [Compensation]. 3. Use A084 [Boost Select] to reduce boost level.

Drive will not reverse motor direction.

Cause(s)	Indication	Corrective Action
Digital input is not selected for reversing control.	None	Check [Digital Inx Sel] (See page 3-14). Choose correct input and program for reversing mode.
Digital input is incorrectly wired.	None	Check input wiring. (See page 1-17)
Motor wiring is improperly phased for reverse.	None	Switch two motor leads.
Reverse is disabled.	None	Check A095 [Reverse Disable].

Drive does not power up.

Cause(s)	Indication	Corrective Action
No input power to drive.	None	Check the power circuit. • Check the supply voltage. • Check all fuses and disconnects.
Jumper between I/O Terminals P2 and P1 not installed and/or DC Bus Inductor not connected.	None	Install jumper or connect DC Bus Inductor.

Supplemental Drive Information

For information on...	See page...
Drive, Fuse & Circuit Breaker Ratings	A-1
Specifications	A-2

Drive, Fuse & Circuit Breaker Ratings

The tables on the following pages provide drive ratings and recommended AC line input fuse and circuit breaker information. Both types of short circuit protection are acceptable for UL and IEC requirements. Sizes listed are the recommended sizes based on 40 degree C and the U.S. N.E.C. Other country, state or local codes may require different ratings.

Fusing

If fuses are chosen as the desired protection method, refer to the recommended types listed below. If available amp ratings do not match the tables provided, the closest fuse rating that exceeds the drive rating should be chosen.

- IEC – BS88 (British Standard) Parts 1 & 2 (1), EN60269-1, Parts 1 & 2, type gG or equivalent should be used.
- UL – UL Class CC, T or J must be used. (2)

Circuit Breakers

Refer to listings in the following tables for recommended circuit breakers (inverse time or instantaneous trip) and 140M Self-Protecting Motor Starters.

(1) Typical designations include, but may not be limited to the following; Parts 1 & 2: AC, AD, BC, BD, CD, DD, ED, EFS, EF, FF, FG, GF, GG, GH.

(2) Typical designations include; Type CC - KTK-R, FNQ-R
Type J - JKS, LPJ
Type T - JKS, JNL

Specifications

Drive Ratings								
Catalog Number[1]	Output Ratings		Input Ratings			Branch Circuit Protection		
	kW (HP)	*Amps*	*Voltage Range*	*kVA*	*Amps*	*Fuses*	*140M Motor Protectors*[3]	*Contactors*
100 - 120V AC (±10%) – 1-Phase Input, 0 - 230V 3-Phase Output								
22B-V2P3x104	0.4 (0.5)	2.3	90-132	1.15	9.0	15	140M-C2E-C16	100-C12
22B-V5P0x104	0.75 (1.0)	5.0	90-132	2.45	20.3	35	140M-D8E-C20	100-C23
22B-V6P0x104	1.1 (1.5)	6.0	90-132	3.0	24.0	40	140M-F8E-C32	100-C37
200 - 240V AC (±10%) – 1-Phase[2] Input, 0 - 230V 3-Phase Output								
22B-A2P3x104	0.4 (0.5)	2.3	180-264	1.15	6.0	10	140M-C2E-B63	100-C09
22B-A5P0x104	0.75 (1.0)	5.0	180-264	2.45	12.0	20	140M-C2E-C16	100-C12
22B-A8P0x104	1.5 (2.0)	8.0	180-264	4.0	18.0	30	140M-D8E-C20	100-C23
22B-A012x104	2.2 (3.0)	12.0	180-264	5.5	25.0	40	140M-F8E-C32	100-C37
200 - 240V AC (±10%) – 3-Phase Input, 0 - 230V 3-Phase Output								
22B-B2P3x104	0.4 (0.5)	2.3	180-264	1.15	2.5	6	140M-C2E-B40	100-C07
22B-B5P0x104	0.75 (1.0)	5.0	180-264	2.45	5.7	10	140M-C2E-C10	100-C09
22B-B8P0x104	1.5 (2.0)	8.0	180-264	4.0	9.5	15	140M-C2E-C16	100-C12
22B-B012x104	2.2 (3.0)	12.0	180-264	5.5	15.5	25	140M-C2E-C16	100-C23
22B-B017x104	3.7 (5.0)	17.5	180-264	8.6	21.0	30	140M-F8E-C25	100-C23
22B-B024x104	5.5 (7.5)	24.0	180-264	11.8	26.1	40	140M-F8E-C32	100-C37
22B-B033x104	7.5 (10.0)	33.0	180-264	16.3	34.6	60	140M-G8E-C45	100-C60
380 - 480V AC (±10%) – 3-Phase Input, 0 - 460V 3-Phase Output								
22B-D1P4x104	0.4 (0.5)	1.4	342-528	1.4	1.8	3	140M-C2E-B25	100-C07
22B-D2P3x104	0.75 (1.0)	2.3	342-528	2.3	3.2	6	140M-C2E-B40	100-C07
22B-D4P0x104	1.5 (2.0)	4.0	342-528	4.0	5.7	10	140M-C2E-B63	100-C09
22B-D6P0x104	2.2 (3.0)	6.0	342-528	5.9	7.5	15	140M-C2E-C10	100-C09
22B-D010x104	4.0 (5.0)	10.5	342-528	10.3	13.0	20	140M-C2E-C16	100-C23
22B-D012x104	5.5 (7.5)	12.0	342-528	11.8	14.2	25	140M-D8E-C20	100-C23
22B-D017x104	7.5 (10.0)	17.0	342-528	16.8	18.4	30	140M-D8E-C20	100-C23
22B-D024x104	11.0 (15.0)	24.0	342-528	23.4	26.0	50	140M-F8E-C32	100-C43
460 - 600V AC (±10%) – 3-Phase Input, 0 - 575V 3-Phase Output								
22B-E1P7x104	0.75 (1.0)	1.7	414-660	2.1	2.3	6	140M-C2E-B25	100-C09
22B-E3P0x104	1.5 (2.0)	3.0	414-660	3.65	3.8	6	140M-C2E-B40	100-C09
22B-E4P2x104	2.2 (3.0)	4.2	414-660	5.2	5.3	10	140M-C2E-B63	100-C09
22B-E6P6x104	4.0 (5.0)	6.6	414-660	8.1	8.3	15	140M-C2E-C10	100-C09
22B-E9P9x104	5.5 (7.5)	9.9	414-660	12.1	11.2	20	140M-C2E-C16	100-C16
22B-E012x104	7.5 (10.0)	12.2	414-660	14.9	13.7	25	140M-C2E-C16	100-C23
22B-E019x104	11.0 (15.0)	19.0	414-660	23.1	24.1	40	140M-D8E-C25	100-C30

(1) In the Catalog Numbers listed "x" represents enclosure type. Specifications are valid for all enclosure types. IP66, NEMA/UL Type 4X drive ratings are only available as Frame B drives. Refer to Table B.B.

(2) 200-240V AC - 1-Phase drives are also available with an integral EMC filter. Catalog suffix changes from N104 to N114. Filter option is not available for IP66, NEMA/UL Type 4X rated drives.

(3) Refer to the Bulletin 140M Motor Protectors *Selection Guide*, publication 140M-SG001… to determine the frame and breaking capacity required for your application.

Input/Output Ratings

Output Frequency: 0-400 Hz (Programmable)
Efficiency: 97.5% (Typical)

Approvals

UL508C c UL CSA 22.2
CE EMC Directive 89/336
LV: EN 50178, EN 60204
EMC: EN 61800-3, EN 50081-1, EN 50082-2

Digital Control Inputs (Input Current = 6mA)

SRC (Source) Mode:	SNK (Sink) Mode:
18-24V = ON	0-6V = ON
0-6V = OFF	18-24V = OFF

Analog Control Inputs

4-20mA Analog: 250 ohm input impedance
0-10V DC Analog: 100k ohm input impedance
External Pot: 1-10k ohms, 2 Watt minimum

Control Output

Programmable Output (form C relay)	*Opto Outputs*	*Analog Outputs (10 bit)*
Resistive Rating: 3.0A at 30V DC, 3.0A at 125V AC, 3.0A at 240V AC	30V DC, 50mA	0-10V, 1k ohm Min.
Inductive Rating: 0.5A at 30V DC, 0.5A at 125V AC, 0.5A at 240V AC	Non-inductive	4-20mA, 525 ohm Max.

Fuses and Circuit Breakers

Recommended Fuse Type: UL Class J, CC, T or Type BS88; 600V (550V) or equivalent.
Recommended Circuit Breakers: HMCP circuit breakers or equivalent.

Protective Features

Motor Protection: I^2t overload protection - 150% for 60 Secs, 200% for 3 Secs (Provides Class 10 protection)

Overcurrent: 200% hardware limit, 300% instantaneous fault

Over Voltage: 100-120V AC Input – Trip occurs at 405V DC bus voltage (equivalent to 150V AC incoming line)
200-240V AC Input – Trip occurs at 405V DC bus voltage (equivalent to 290V AC incoming line)
380-460V AC Input – Trip occurs at 810V DC bus voltage (equivalent to 575V AC incoming line)
460-600V AC Input – Trip occurs at 1005V DC bus voltage (equivalent to 711V AC incoming line)

Under Voltage: 100-120V AC Input – Trip occurs at 210V DC bus voltage (equivalent to 75V AC incoming line)
200-240V AC Input – Trip occurs at 210V DC bus voltage (equivalent to 150V AC incoming line)
380-480V AC Input – Trip occurs at 390V DC bus voltage (equivalent to 275V AC incoming line)
460-600V AC Input – If P042 = 3 “High Voltage” trip occurs at 487V DC bus voltage (344V AC incoming line);
If P042 = 2 “Low Voltage” trip occurs at 390V DC bus voltage (275V AC incoming line)

Control Ride Through: Minimum ride through is 0.5 Secs - typical value 2 Secs

Faultless Power Ride Through: 100 milliseconds

Dynamic Braking

Internal brake IGBT included with all ratings except when no brake is specified.
Refer to Appendix B for DB resistor ordering information.

Category	Specification	
Environment	Altitude:	1000 m (3300 ft) max. without derating
	Maximum Surrounding Air Temperature without derating:	
	IP20, NEMA/UL Type Open:	–10 to 50° C (14 to 122° F)
	IP30, NEMA/UL Type 1:	–10 to 40° C (14 to 104° F)
	Flange Mount:	Heatsink: –10 to 40° C (14 to 104° F) Drive: –10 to 50° C (14 to 122° F)
	IP66, NEMA/UL Type 4X:	–10 to 40° C (14 to 104° F)
	Cooling Method	
	Convection:	0.4 kW (0.5 HP) drives
	Fan:	All other drive ratings and 0.4 kW (0.5 HP) 1-Phase drives with Integral “S Type” EMC Filter
	Storage Temperature:	–40 to 85 degrees C (–40 to 185 degrees F)
	Atmosphere:	**Important:** Drive **must not** be installed in an area where the ambient atmosphere contains volatile or corrosive gas, vapors or dust. If the drive is not going to be installed for a period of time, it must be stored in an area where it will not be exposed to a corrosive atmosphere.
	Relative Humidity:	0 to 95% non-condensing
	Shock (operating):	15G peak for 11ms duration (±1.0ms)
	Vibration (operating):	1G peak, 5 to 2000 Hz
Control	Carrier Frequency	2-16 kHz. Drive rating based on 4 kHz.
	Frequency Accuracy	
	Digital Input:	Within ±0.05% of set output frequency.
	Analog Input:	Within 0.5% of maximum output frequency, 10-Bit resolution
	Analog Output:	±2% of full scale, 10-Bit resolution
	Speed Regulation - Open Loop with Slip Compensation:	±1% of base speed across a 60:1 speed range.
	Stop Modes:	Multiple programmable stop modes including - Ramp, Coast, DC-Brake, Ramp-to-Hold and S Curve.
	Accel/Decel:	Two independently programmable accel and decel times. Each time may be programmed from 0 - 600 seconds in 0.1 second increments.
	Intermittent Overload:	150% Overload capability for up to 1 minute 200% Overload capability for up to 3 seconds
	Electronic Motor Overload Protection:	Class 10 protection with speed sensitive response and power-down overload retention function.
Electrical	Voltage Tolerance:	100-120V ±10% 200-240V ±10% 380-480V ±10% 460-600V ±10%
	Frequency Tolerance:	48-63 Hz
	Input Phases:	Three-phase input provides full rating. Single-phase operation provides 35% rated current.
	Displacement Power Factor:	0.98 across entire speed range
	Maximum Short Circuit Rating:	100,000 Amps Symmetrical
	Actual Short Circuit Rating:	Determined by AIC Rating of installed fuse/circuit breaker
	Transistor Type:	Insulated Gate Bipolar Transistor (IGBT)

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PowerFlex 40 Estimated Watts Loss (Rated Load, Speed & PWM)

Voltage	kW (HP)	External Watts	Internal Watts	Total Watts Loss
100–120V	0.4 (0.5)	22	18	40
	0.75 (1.0)	40	20	60
	1.1 (1.5)	58	22	80
200–240V	0.4 (0.5)	22	18	40
	0.75 (1.0)	40	20	60
	1.1 (2.0)	63	22	85
	2.2 (3.0)	100	25	125
	3.7 (5.0)	150	30	180
	5.5 (7.5)	200	35	235
	7.5 (10)	265	40	305
380–480V	0.4 (0.5)	17	18	35
	0.75 (1.0)	30	20	50
	1.1 (2.0)	48	22	70
	2.2 (3.0)	75	25	100
	3.7 (5.0)	135	25	160
	5.5 (7.5)	140	35	175
	7.5 (10)	175	35	210
	11 (15)	260	40	300
460–600V	0.75 (1.0)	30	20	50
	1.5 (2.0)	48	22	70
	2.2 (3.0)	75	25	100
	4.0 (5.0)	135	25	160
	5.5 (7.5)	140	35	175
	7.5 (10)	175	35	210
	11 (15)	260	40	300

Notes:

Accessories and Dimensions

Product Selection

Table B.A Catalog Number Description

22B	-	A	1P5	N	1	1	4
Drive		Voltage Rating	Rating	Enclosure	HIM	Emission Class	Type

Table B.B PowerFlex 40 Drives

Drive Ratings				IP20, NEMA/UL Type Open		IP20 Flange Mount(1)	IP66, NEMA/UL Type 4X
Input Voltage	kW	HP	Output Current	Catalog Number	Frame Size	Catalog Number	Catalog Number
120V 50/60 Hz 1-Phase No Filter	0.4	0.5	2.3A	22B-V2P3N104	B	22B-V2P3F104	22B-V2P3C104
	0.75	1.0	5.0A	22B-V5P0N104	B	22B-V5P0F104	22B-V5P0C104
	1.1	1.5	6.0A	22B-V6P0N104	B	22B-V6P0F104	22B-V6P0C104
240V 50/60 Hz 1-Phase With Integral "S Type" EMC Filter	0.4	0.5	2.3A	22B-A2P3N114	B	–	–
	0.75	1.0	5.0A	22B-A5P0N114	B	–	–
	1.5	2.0	8.0A	22B-A8P0N114	B	–	–
	2.2	3.0	12.0A	22B-A012N114	C	–	–
240V 50/60 Hz 1-Phase No Filter	0.4	0.5	2.3A	22B-A2P3N104	B	22B-A2P3F104	22B-A2P3C104
	0.75	1.0	5.0A	22B-A5P0N104	B	22B-A5P0F104	22B-A5P0C104
	1.5	2.0	8.0A	22B-A8P0N104	B	22B-A8P0F104	22B-A8P0C104
	2.2	3.0	12.0A	22B-A012N104	C	22B-A012F104	–
240V 50/60 Hz 3-Phase No Filter	0.4	0.5	2.3A	22B-B2P3N104	B	22B-B2P3F104	22B-B2P3C104
	0.75	1.0	5.0A	22B-B5P0N104	B	22B-B5P0F104	22B-B5P0C104
	1.5	2.0	8.0A	22B-B8P0N104	B	22B-B8P0F104	22B-B8P0C104
	2.2	3.0	12.0A	22B-B012N104	B	22B-B012F104	22B-B012C104
	3.7	5.0	17.5A	22B-B017N104	B	22B-B017F104	22B-B017C104
	5.5	7.5	24.0A	22B-B024N104	C	22B-B024F104	–
	7.5	10.0	33.0A	22B-B033N104	C	22B-B033F104	–
480V 50/60 Hz 3-Phase No Filter	0.4	0.5	1.4A	22B-D1P4N104	B	22B-D1P4F104	22B-D1P4C104
	0.75	1.0	2.3A	22B-D2P3N104	B	22B-D2P3F104	22B-D2P3C104
	1.5	2.0	4.0A	22B-D4P0N104	B	22B-D4P0F104	22B-D4P0C104
	2.2	3.0	6.0A	22B-D6P0N104	B	22B-D6P0F104	22B-D6P0C104
	4.0	5.0	10.5A	22B-D010N104	B	22B-D010F104	22B-D010C104
	5.5	7.5	12.0A	22B-D012N104	C	22B-D012F104	–
	7.5	10.0	17.0A	22B-D017N104	C	22B-D017F104	–
	11.0	15.0	24.0A	22B-D024N104	C	22B-D024F104 (2)	–
600V 50/60 Hz 3-Phase No Filter	0.75	1.0	1.7A	22B-E1P7N104	B	22B-E1P7F104	22B-E1P7C104
	1.5	2.0	3.0A	22B-E3P0N104	B	22B-E3P0F104	22B-E3P0C104
	2.2	3.0	4.2A	22B-E4P2N104	B	22B-E4P2F104	22B-E4P2C104
	4.0	5.0	6.6A	22B-E6P6N104	B	22B-E6P6F104	22B-E6P6C104
	5.5	7.5	9.9A	22B-E9P9N104	C	22B-E9P9F104	–
	7.5	10.0	12.0A	22B-E012N104	C	22B-E012F104	–
	11.0	15.0	19.0A	22B-E019N104	C	22B-E019F104	–

(1) Mounting Kit (NEMA/UL Type 1) is required and must be ordered separately. See Table B.E for details.
(2) Requires use of external DC Bus Inductor or AC Line Reactor. See Table B.E for details.

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Table B.C Dynamic Brake Modules

Drive Ratings				
Input Voltage	kW	HP	Minimum Resistance Ω	Catalog Number (1) (2)
120V 50/60 Hz 1-Phase	0.4	0.5	48	AK-R2-091P500
	0.75	1.0	48	AK-R2-091P500
	1.1	1.5	48	AK-R2-091P500
240V 50/60 Hz 1-Phase	0.4	0.5	48	AK-R2-091P500
	0.75	1.0	48	AK-R2-091P500
	1.5	2.0	48	AK-R2-091P500
	2.2	3.0	32	AK-R2-047P500
240V 50/60 Hz 3-Phase	0.4	0.5	48	AK-R2-091P500
	0.75	1.0	48	AK-R2-091P500
	1.5	2.0	48	AK-R2-091P500
	2.2	3.0	32	AK-R2-047P500
	3.7	5.0	19	AK-R2-047P500
	5.5	7.5	13	AK-R2-030P1K2
	7.5	10.0	10	AK-R2-030P1K2
480V 50/60 Hz 3-Phase	0.4	0.5	97	AK-R2-360P500
	0.75	1.0	97	AK-R2-360P500
	1.5	2.0	97	AK-R2-360P500
	2.2	3.0	97	AK-R2-120P1K2
	4.0	5.0	77	AK-R2-120P1K2
	5.5	7.5	55	AK-R2-120P1K2
	7.5	10.0	39	AK-R2-120P1K2
	11.0	15.0	24	AK-R2-120P1K2 (3)
600V 50/60 Hz 3-Phase	0.75	1.0	120	AK-R2-360P500
	1.5	2.0	120	AK-R2-360P500
	2.2	3.0	82	AK-R2-120P1K2
	4.0	5.0	82	AK-R2-120P1K2
	5.5	7.5	51	AK-R2-120P1K2
	7.5	10.0	51	AK-R2-120P1K2
	11.0	15.0	51	AK-R2-120P1K2 (3)

(1) The resistors listed in this tables are rated for 5% duty cycle.

(2) Use of Rockwell resistors is always recommended. The resistors listed have been carefully selected for optimizing performance in a variety of applications. Alternative resistors may be used, however care must be taken when making a selection. Refer to the P*owerFlex Dynamic Braking Resistor Calculator*, publication PFLEX-AT001.

(3) Requires two resistors wired in parallel.

Table B.D Bulletin 1321-3R Series Line Reactors

Input Voltage	kW	HP	Fundamental Amps	Maximum Continuous Amps	Inductance mh	Watts Loss	Catalog Number (1)
240V 50/60 Hz 3-Phase	0.4	0.5	4	6	12.0	21 W	1321-3R4-D
	0.75	1.0	8	12	3.0	29 W	1321-3R8-B
	1.5	2.0	8	12	1.5	19.5 W	1321-3R8-A
	2.2	3.0	12	18	1.25	26 W	1321-3R12-A
	3.7	5.0	18	27	0.8	36 W	1321-3R18-A
	5.5	7.5	25	37.5	0.5	48 W	1321-3R25-A
	7.5	10.0	35	52.5	0.4	49 W	1321-3R35-A
480V 50/60 Hz 3-Phase	0.4	0.5	2	3	20.0	11.3 W	1321-3R2-B
	0.75	1.0	4	6	9.0	20 W	1321-3R4-C
	1.5	2.0	4	6	6.5	20 W	1321-3R4-B
	2.2	3.0	8	12	5.0	25.3 W	1321-3R8-C
	4.0	5.0	12	18	2.5	31 W	1321-3R12-B
	5.5	7.5	12	18	2.5	31 W	1321-3R12-B
	7.5	10.0	18	27	1.5	43 W	1321-3R18-B
	11.0	15.0	25	37.5	1.2	52 W	1321-3R25-B
600V 50/60 Hz 3-Phase	0.75	1.0	2	3	20.0	11.3 W	1321-3R2-B
	1.5	2.0	4	6	6.5	20 W	1321-3R4-B
	2.2	3.0	4	6	6.5	20 W	1321-3R4-B
	4.0	5.0	8	12	5.0	25.3 W	1321-3R8-C
	5.5	7.5	12	18	2.5	31 W	1321-3R12-B
	7.5	10.0	12	18	2.5	31 W	1321-3R12-B
	11.0	15.0	18	27	1.5	43 W	1321-3R18-B

(1) Catalog numbers listed are for 3% impedance open style units. NEMA Type 1 and 5% impedance reactor types are also available. Refer to publication 1321-TD001….

Table B.E DC Bus Inductors

Input Voltage	kW	HP	Amps	Inductance mh	MTE Catalog Number (2)
240V 50/60 Hz 3-Phase	5.5	7.5	32	0.85	32RB001
	7.5	10.0	40	0.5	40RB001
480V 50/60 Hz 3-Phase	5.5	7.5	18	3.75	18RB004
	7.5	10.0	25	4.0	25RB005
	11.0	15.0	32	2.68	32RB003
600V 50/60 Hz 3-Phase	5.5	7.5	12	6.0	12RB004
	7.5	10.0	18	6.0	18RB005
	11.0	15.0	25	4.0	25RB005

(2) Use MTE RB Series or equivalent inductors.

Table B.F EMC Line Filters

Drive Ratings			S Type Filter Catalog Number (1)	L Type Filter Catalog Number (4)
Input Voltage	kW	HP		
120V 50/60 Hz 1-Phase	0.4	0.5	–	22-RF018-BL
	0.75	1.0	–	22-RF018-BL
	1.1	1.5	–	22-RF018-BL
240V 50/60 Hz 1-Phase	0.4	0.5	(2)	22-RF018-BL
	0.75	1.0	(2)	22-RF018-BL
	1.5	2.0	(2)	22-RF018-BL
	2.2	3.0	(2)	22-RF025-CL
240V 50/60 Hz 3-Phase	0.4	0.5	22-RF021-BS(3)	22-RF021-BL
	0.75	1.0	22-RF021-BS(3)	22-RF021-BL
	1.5	2.0	22-RF021-BS(3)	22-RF021-BL
	2.2	3.0	22-RF021-BS(3)	22-RF021-BL
	3.7	5.0	22-RF021-BS(3)	22-RF021-BL
	5.5	7.5	22-RF034-CS	22-RF034-CL
	7.5	10.0	22-RF034-CS	22-RF034-CL
480V 50/60 Hz 3-Phase	0.4	0.5	22-RF012-BS	22-RF012-BL
	0.75	1.0	22-RF012-BS	22-RF012-BL
	1.5	2.0	22-RF012-BS	22-RF012-BL
	2.2	3.0	22-RF012-BS	22-RF012-BL
	4.0	5.0	22-RF012-BS	22-RF012-BL
	5.5	7.5	22-RF018-CS	22-RF018-CL
	7.5	10.0	22-RF018-CS	22-RF018-CL
	11.0	15.0	22-RF026-CS	22-RF026-CL
600V 50/60 Hz 3-Phase	0.75	1.0	–	22-RF8P0-BL
	1.5	2.0	–	22-RF8P0-BL
	2.2	3.0	–	22-RF8P0-BL
	4.0	5.0	–	22-RF8P0-BL
	5.5	7.5	–	22-RF015-CL
	7.5	10.0	–	22-RF015-CL
	11.0	15.0	–	22-RF024-CL

(1) This filter is suitable for use with a cable length of at least 10 meters (33 feet) for Class A and 1 meter for Class B environments.

(2) These ratings can be ordered with internal “S Type” filters. Refer to the Catalog Number explanation on page P-4 and Table B.B for details.

(3) Filter must be Series B or later.

(4) This filter is suitable for use with a cable length of at least 100 meters for Class A and 5 meters for Class B environments.

Table B.G Human Interface Module (HIM) Option Kits and Accessories

Item	Description	Catalog Number
LCD Display, Remote Panel Mount	Digital speed control CopyCat capable IP66 (NEMA Type 4X/12) indoor use only Includes 2.9 meter cable	22-HIM-C2S
LCD Display, Remote Panel Mount	Digital speed control CopyCat capable IP66 (NEMA Type 4X/12) indoor use only Includes 2.9 meter cable	22-HIM-C2
LCD Display, Remote Handheld	Digital speed control Full numeric keypad CopyCat capable IP30 (NEMA Type 1) Includes 1.0 meter cable Panel mount with optional Bezel Kit	22-HIM-A3
Bezel Kit	Panel mount for LCD Display, Remote Handheld unit, IP30 (NEMA Type 1)	22-HIM-B1
DSI HIM Cable (DSI HIM to RJ45 cable)	1.0 Meter (3.3 Feet) 2.9 Meter (9.51 Feet)	22-HIM-H10 22-HIM-H30

Table B.H IP30/NEMA 1/UL Type 1 Kit

Item	Description	Drive Frame	Catalog Number
IP30/NEMA 1/UL Type 1 Kit	Field installed kit. Converts drive to IP30/ NEMA 1/UL Type 1 enclosure. Includes conduit box with mounting screws and plastic top panel.	B	22-JBAB
		C	22-JBAC
IP30/NEMA 1/UL Type 1 Kit for Communication Option	Field installed kit. Converts drive to IP30/ NEMA 1/UL Type 1 enclosure. Includes communication option conduit box with mounting screws and plastic top panel.	B	22-JBCB
		C	22-JBCC

Table B.I Communication Option Kits and Accessories

Item	Description	Catalog Number
Communication Adapters	Embedded communication options for use with the PowerFlex 4-Class drives. Requires a Communication Adapter Cover (IP20, NEMA/UL Type 1 only. Ordered Separately) BACnet® ControlNet™ DeviceNet™ EtherNet/IP™ LonWorks® PROFIBUS™ DP	 22-COMM-B 22-COMM-C 22-COMM-D 22-COMM-E 22-COMM-L 22-COMM-P
External DSI™ Communications Kit	External mounting kit for 22-COMM communication options	22-XCOMM-DC-BASE
External Comms Power Supply	Optional 100-240V AC Power Supply for External DSI Communications Kit.	20-XCOMM-AC-PS1
Compact I/O Module	Three channel.	1769-SM2
Communication Adapter Cover	Cover that houses the DeviceNet Communication Adapter (IP20, NEMA/UL Type 1 only) B Frame Drive C Frame Drive	 22B-CCB 22B-CCC
Serial Converter Module (RS485 to RS232)	Provides serial communication via DF1 protocol for use with DriveExplorer and DriveExecutive software. Includes: DSI to RS232 serial converter (1) 1203-SFC serial cable (1) 22-RJ45CBL-C20 cable (1) DriveExplorer Lite CD (1)	22-SCM-232
DSI Cable	2.0 meter RJ45 to RJ45 cable, male to male connectors.	22-RJ45CBL-C20
Serial Cable	2.0 meter serial cable with a locking low profile connector to connect to the serial converter and a 9-pin sub-miniature D female connector to connect to a computer.	1203-SFC
Null Cable Converter	For use when connecting the serial converter to DriveExplorer on a handheld PC.	1203-SNM
Splitter Cable	RJ45 one to two port splitter cable	AK-U0-RJ45-SC1
Terminating Resistors	RJ45 120 Ohm resistors (2 pieces)	AK-U0-RJ45-TR1
Terminal Block	RJ45 Two position terminal block (5 pieces)	AK-U0-RJ45-TB2P
DriveExplorer Software (CD-ROM) Version 3.01 or later	Windows based software package that provides an intuitive means for monitoring or configuring Allen-Bradley drives and communication adapters online. Compatibility: Windows 95, 98, ME, NT 4.0 (Service Pack 3 or later), 2000, XP and CE[1]	9306-4EXP01ENE
DriveExecutive software (CD-ROM) Version 1.01 or later	Windows based software package that provides an intuitive means for monitoring or configuring Allen-Bradley drives and communication adapters online and offline. Compatibility: Windows 98, ME, NT 4.0 (Service Pack 3 or later), 2000 and XP	9303-4DTE01ENE

(1) See www.ab.com/drives/driveexplorer.htm for supported devices.

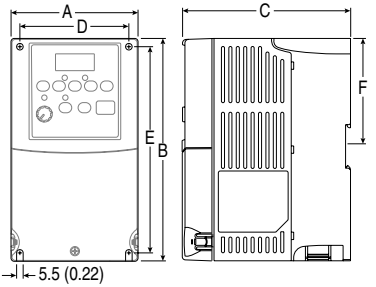
Product Dimensions

Table B.J PowerFlex 40 Frames – Ratings are in kW and (HP)

Frame	120V AC – 1-Phase	240V AC – 1-Phase	240V AC – 3-Phase	480V AC – 3-Phase	600V AC – 3-Phase
B	0.4 (0.5) 0.75 (1.0) 1.1 (1.5)	0.4 (0.5) 0.75 (1.0) 1.5 (2.0)	0.4 (0.5) 2.2 (3.0) 0.75 (1.0) 3.7 (5.0) 1.5 (2.0)	0.4 (0.5) 2.2 (3.0) 0.75 (1.0) 4.0 (5.0) 1.5 (2.0)	0.75 (1.0) 2.2 (3.0) 1.5 (2.0) 4.0 (5.0)
C(1)		2.2 (3.0)	5.5 (7.5) 7.5 (10.0)	5.5 (7.5) 11.0 (15.0) 7.5 (10.0)	5.5 (7.5) 11.0 (15.0) 7.5 (10.0)

(1) IP66, NEMA/UL Type 4X rated drives are not availble in Frame C drive ratings.

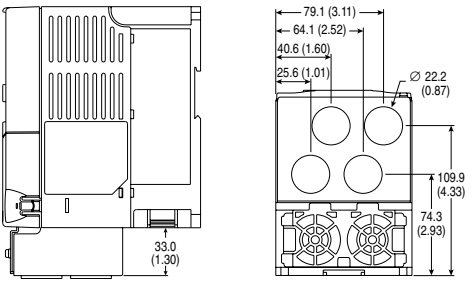
Figure B.1 IP20, NEMA/UL Type Open



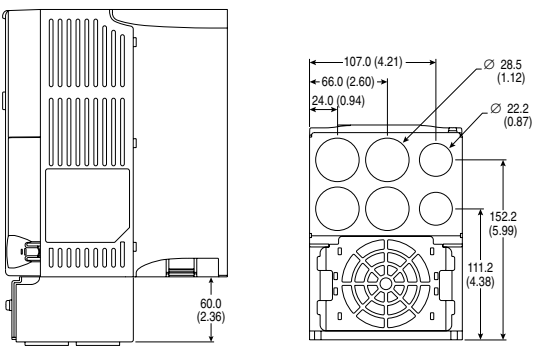
Dimensions are in millimeters and (inches).
Weights are in kilograms and (pounds).

Frame	A	B	C	D	E	F	Ship Weight
B	100 (3.94)	180 (7.09)	136 (5.35)	87 (3.43)	168 (6.61)	87.4 (3.44)	2.2 (4.9)
C	130 (5.1)	260 (10.2)	180 (7.1)	116 (4.57)	246 (9.7)	–	4.3 (9.5)

Figure B.2 IP30, NEMA/UL Type 1 Option Kit without Communication Option

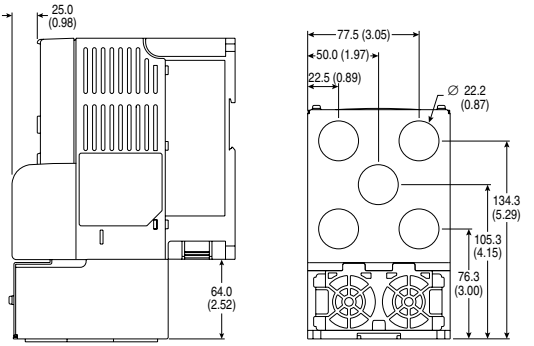


Frame B - 22-JBAB

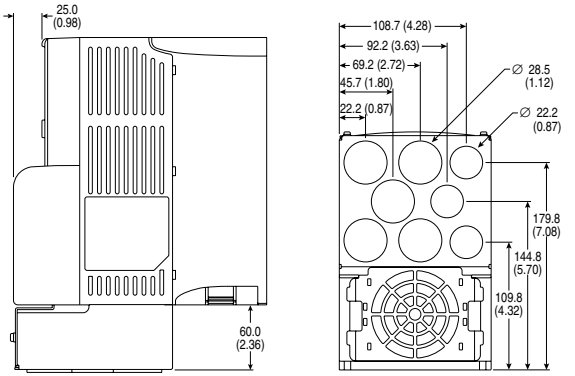


Frame C - 22-JBAC

Figure B.3 IP30, NEMA/UL Type 1 Option Kit with Communication Option – Dimensions are in millimeters and (inches)

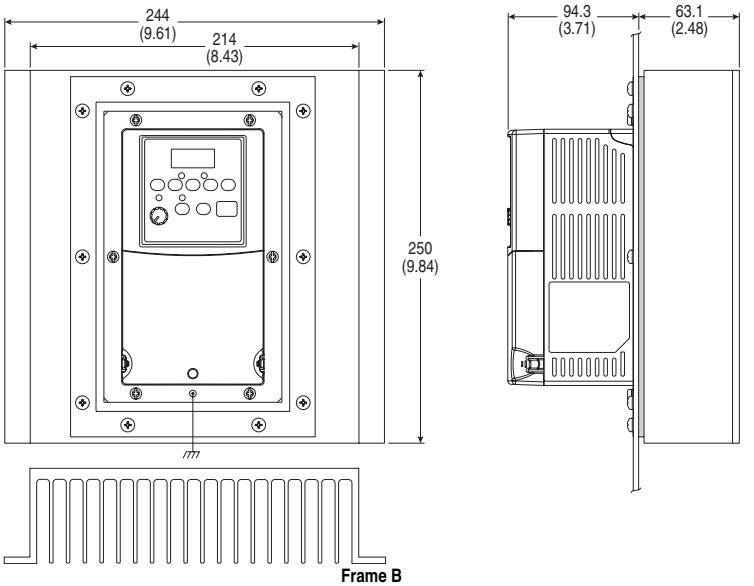


Frame B - 22-JBCB

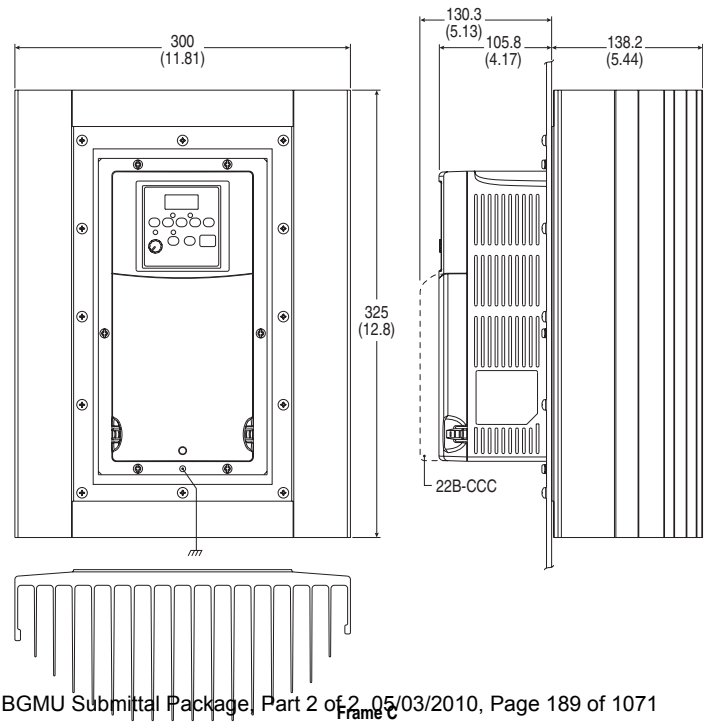


Frame C - 22-JBCC

Figure B.4 PowerFlex 40 Flange Mount Drives – Dimensions are in millimeters and (inches)



Frame B



Frame C

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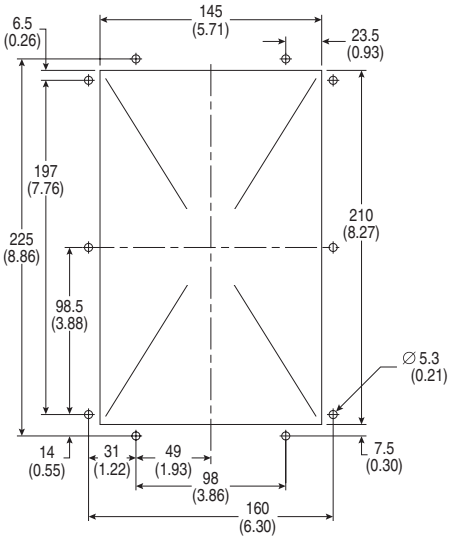
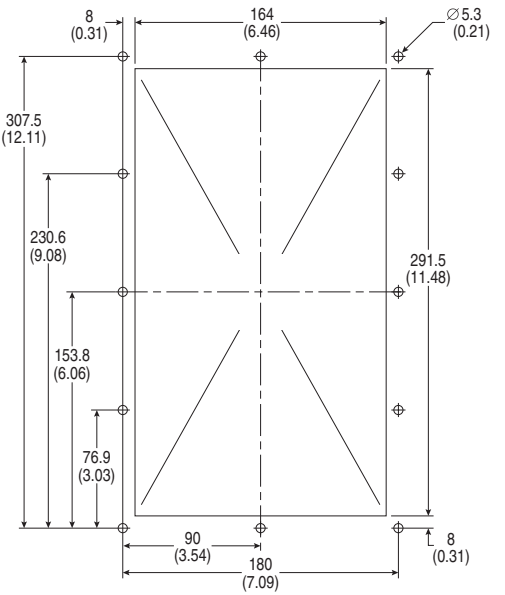
Figure B.5 PowerFlex 40 Flange Mount Cutout Dimensions – Dimensions are in millimeters and (inches)

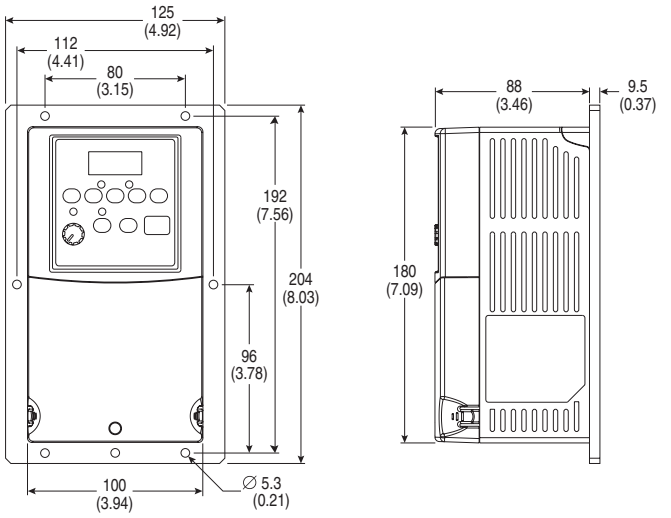


Frame B

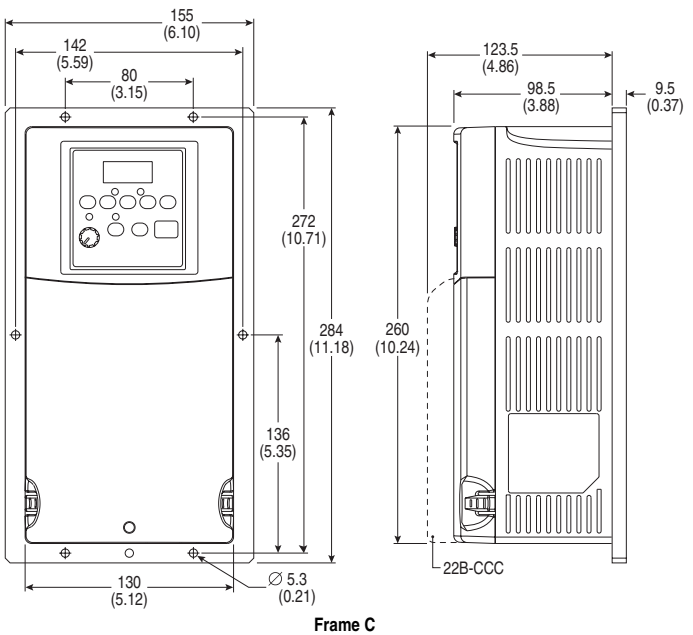


Frame C

Figure B.6 PowerFlex 40 Replacement Plate Drive Dimensions – Dimensions are in millimeters and (inches)

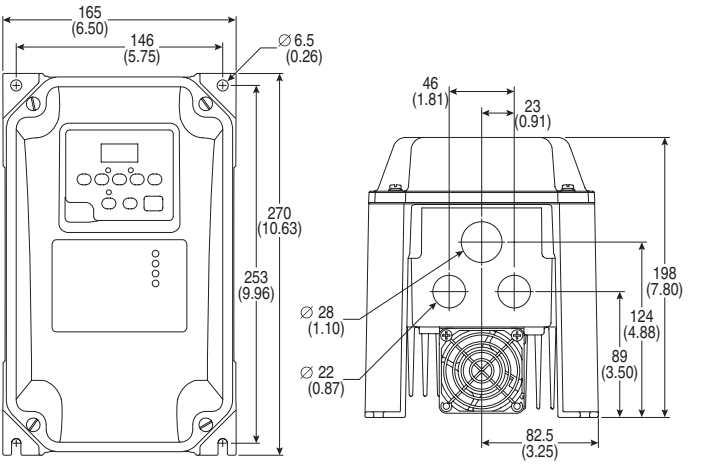


Frame B



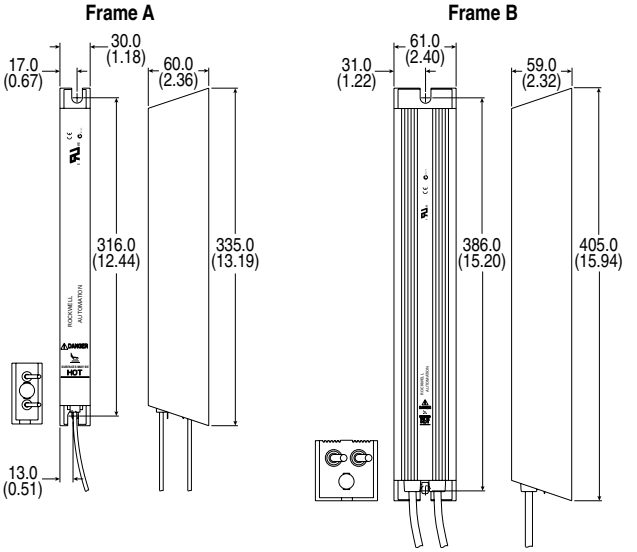
Frame C

Figure B.7 IP66, NEMA Type/UL Type 4X – Dimensions are in millimeters and (inches) Weights are in kilograms and (pounds).



Weight
5.2 (11.5)

Figure B.8 Dynamic Brake Modules – Dimensions are in millimeters and (inches). Weights are in kilograms and (pounds).



Frame	Catalog Number	Weight
A	AK-R2-091P500, AK-R2-047P500, AK-R2-360P500	1.1 (2.5)
B	AK-R2-030P1K2, AK-R2-120P1K2	2.7 (6)

Figure B.9 Recommended External Brake Resistor Circuitry

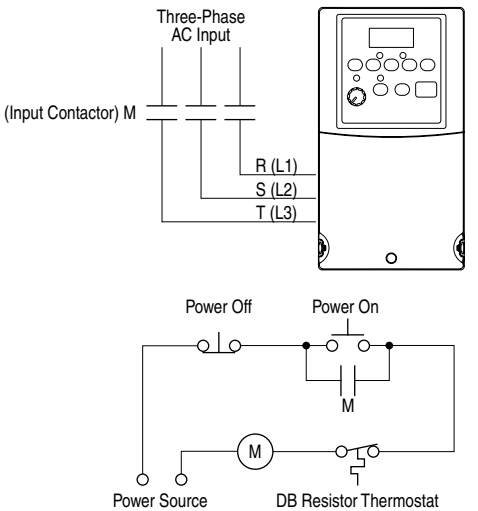
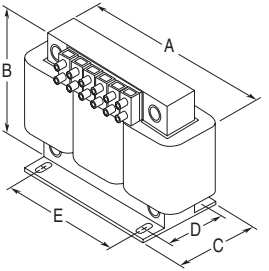


Figure B.10 Bulletin 1321-3R Series Line Reactors – Dimensions are in millimeters and (inches). Weights are in kilograms and (pounds).



Catalog Number	A	B	C	D	E	Weight
1321-3R2-A	112 (4.40)	104 (4.10)	70 (2.75)	50 (1.98)	37 (1.44)	1.8 (4)
1321-3R2-B	112 (4.40)	104 (4.10)	70 (2.75)	50 (1.98)	37 (1.44)	1.8 (4)
1321-3R4-A	112 (4.40)	104 (4.10)	76 (3.00)	50 (1.98)	37 (1.44)	1.8 (4)
1321-3R4-B	112 (4.40)	104 (4.10)	76 (3.00)	50 (1.98)	37 (1.44)	1.8 (4)
1321-3R4-C	112 (4.40)	104 (4.10)	86 (3.38)	60 (2.35)	37 (1.44)	2.3 (5)
1321-3R4-D	112 (4.40)	104 (4.10)	92 (3.62)	66 (2.60)	37 (1.44)	2.7 (6)
1321-3R8-A	152 (6.00)	127 (5.00)	76 (3.00)	53 (2.10)	51 (2.00)	3.1 (7)
1321-3R8-B	152 (6.00)	127 (5.00)	76 (3.00)	53 (2.10)	51 (2.00)	3.6 (8)
1321-3R8-C	152 (6.00)	127 (5.00)	85 (3.35)	63 (2.48)	51 (2.00)	4.9 (11)
1321-3R12-A	152 (6.00)	127 (5.00)	76 (3.00)	53 (2.10)	51 (2.00)	4.1 (9)
1321-3R12-B	152 (6.00)	127 (5.00)	76 (3.00)	53 (2.10)	51 (2.00)	4.5 (10)
1321-3R18-A	152 (6.00)	133 (5.25)	79 (3.10)	54 (2.13)	51 (2.00)	4.1 (9)
1321-3R18-B	152 (6.00)	133 (5.25)	86 (3.40)	63 (2.48)	51 (2.00)	5.4 (12)
1321-3R25-A	183 (7.20)	146 (5.76)	85 (3.35)	60 (2.35)	76 (3.00)	4.9 (11)
1321-3R35-A	193 (7.60)	146 (5.76)	91 (3.60)	66 (2.60)	76 (3.00)	6.3 (14)

Figure B.11 Frame B EMC Line Filters – Dimensions are in millimeters and (inches)
Catalog Numbers: 22-RF8P0-BL, 22-RF012-BS, -BL (Series B); 22-RF018-BS; 22-RF021-BS, -BL

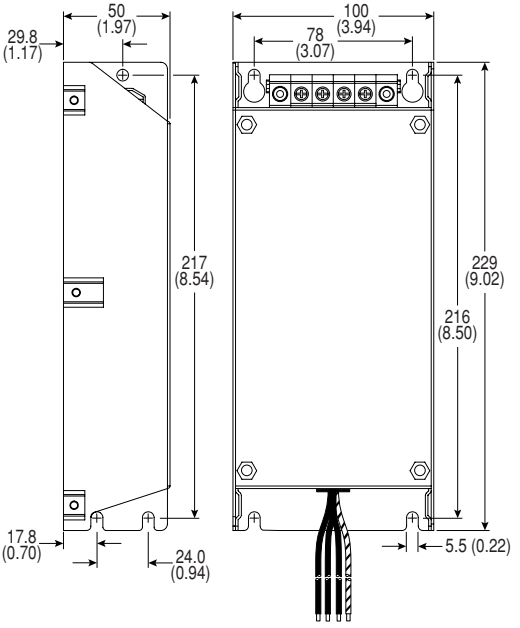


Figure B.12 Frame C EMC Line Filters – Dimensions are in millimeters and (inches)
Catalog Numbers: 22-RF018-CS, -CL; 22-RF025-CL; 22-RF026-CS, -CL; 22-RF034-CS, -CL

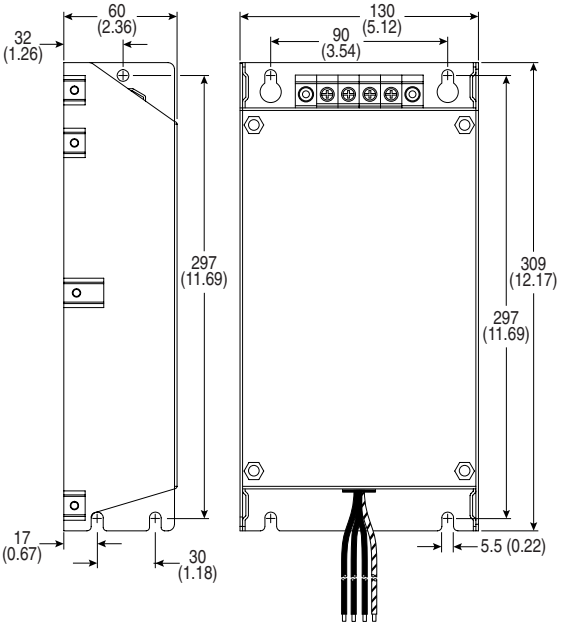
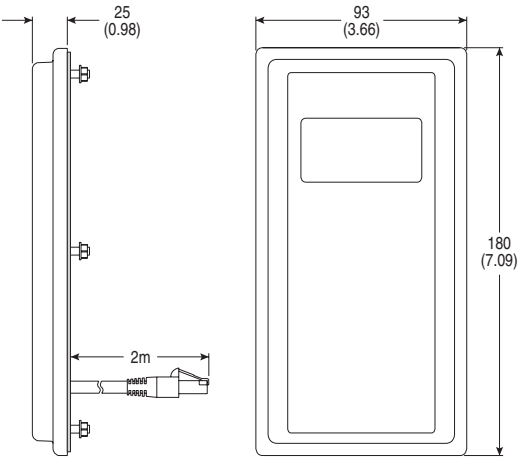


Figure B.13 Remote (Panel Mount) Small HIM – Dimensions are in millimeters and (inches) Catalog Number: 22-HIM-C2S



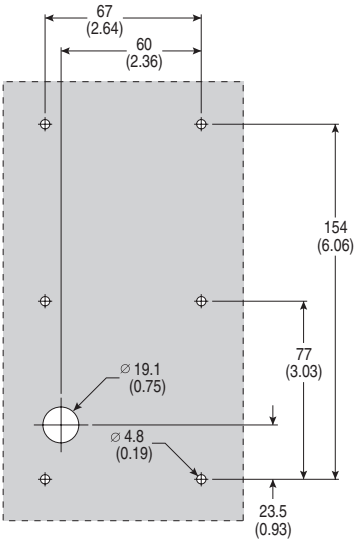
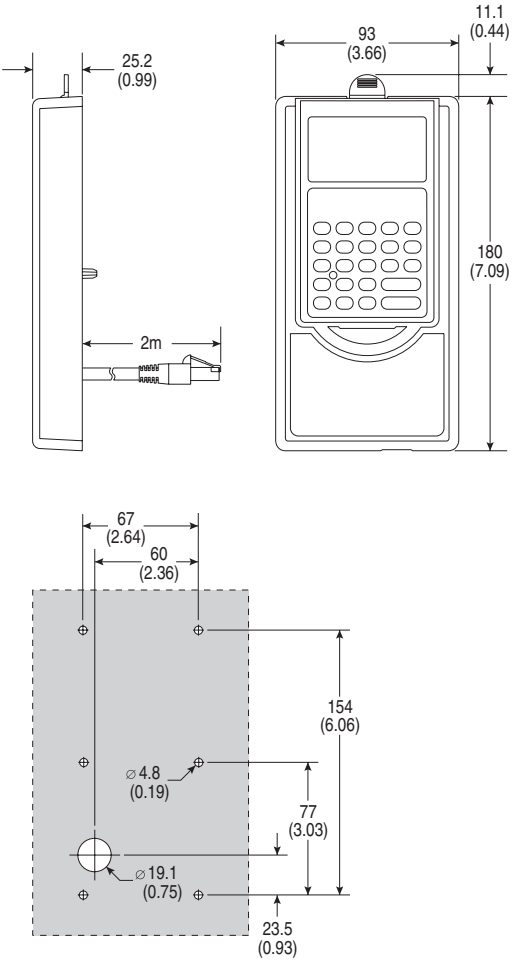
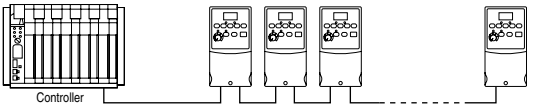


Figure B.14 NEMA Type 1 Bezel – Dimensions are in millimeters and (inches)
Catalog Number: 22-HIM-B1



RS485 (DSI) Protocol

PowerFlex 40 drives support the RS485 (DSI) protocol to allow efficient operation with Rockwell Automation peripherals. In addition, some Modbus functions are supported to allow simple networking. PowerFlex 40 drives can be multi-dropped on an RS485 network using Modbus protocol in RTU mode.

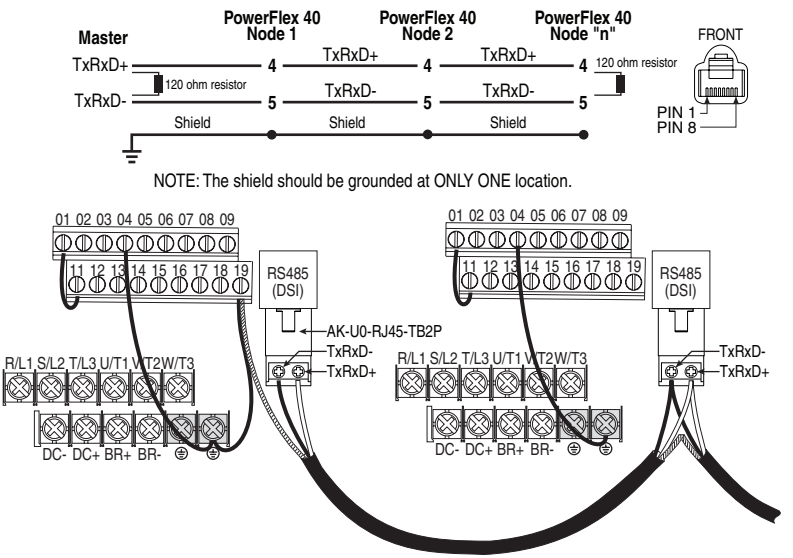


For information regarding DeviceNet or other communication protocols, refer to the appropriate user manual.

Network Wiring

Network wiring consists of a shielded 2-conductor cable that is daisy-chained from node to node.

Figure C.1 Network Wiring Diagram



Only pins 4 and 5 on the RJ45 plug should be wired. The other pins on the PowerFlex 40 RJ45 socket must not be connected because they contain power, etc. for other Rockwell Automation peripheral devices.

Wiring terminations on the master controller will vary depending on the master controller used and “TxRxD+” and “TxRxD-” are shown for illustration purposes only. Refer to the master controller’s user manual for network terminations. Note that there is no standard for the “+” and “-” wires, and consequently Modbus device manufacturers interpret them differently. If you have problems with initially establishing communications, try swapping the two network wires at the master controller.

Standard RS485 wiring practices apply.

- Termination resistors need to be applied at each end of the network cable.
- RS485 repeaters may need to be used for long cable runs, or if greater than 32 nodes are needed on the network.
- Network wiring should be separated from power wires by at least 0.3 meters (1 foot).
- Network wiring should only cross power wires at a right angle.

I/O Terminal 19 on the PowerFlex 40 is connected to the metal shield around the RJ45 connector. It is recommended to ground this terminal (there are two PE terminals on the drive). See Table 1.H for more information.

Network Common is internally tied to I/O Terminal 04 (Digital Common). Tying I/O Terminal 04 to PE ground may improve noise immunity in some applications.

Parameter Configuration

The following PowerFlex 40 parameters are used to configure the drive to operate on a network.

Parameter	Details	Reference
P036 [Start Source]	Set to 5 "RS485 (DSI) Port" if Start is controlled from the network.	Page 3-10
P038 [Speed Reference]	Set to 5 "RS485 (DSI) Port" if the Speed Reference is controlled from the network.	Page 3-12
A103 [Comm Data Rate]	Sets the data rate for the RS485 (DSI) Port. All nodes on the network must be set to the same data rate.	Page 3-31
A104 [Comm Node Addr]	Sets the node address for the drive on the network. Each device on the network requires a unique node address.	Page 3-31
A105 [Comm Loss Action]	Selects the drive's response to communication problems.	Page 3-32
A106 [Comm Loss Time]	Sets the time that the drive will remain in communication loss before the drive implements A105 [Comm Loss Action].	Page 3-32
A107 [Comm Format]	Sets the transmission mode, data bits, parity and stop bits for the RS485 (DSI) Port. All nodes on the network must be set to the same setting.	Page 3-32

Supported Modbus Function Codes

The peripheral interface (DSI) used on PowerFlex 40 drives supports some of the Modbus function codes.

Modbus Function Code (Decimal)	Command
03	Read Holding Registers
06	Preset (Write) Single Register
16 (10 Hexadecimal)	Preset (Write) Multiple Registers

Important: Modbus devices can be 0-based (registers are numbered starting at 0) or 1-based (registers are numbered starting at 1). Depending on the Modbus Master used, the register addresses listed on the following pages may need to be offset by +1. For example, Logic Command may be register address 8192 for some master devices (e.g. ProSoft 3150-MCM SLC Modbus scanner) and 8193 for others (e.g. PanelViews).

Writing (06) Logic Command Data

The PowerFlex 40 drive can be controlled via the network by sending Function Code 06 writes to register address 8192 (Logic Command). P036 [Start Source] must be set to 5 “RS485 (DSI) Port” in order to accept the commands.

In addition to being written, register address 8192 can be read using Function Code 03.

Logic Command		
Address (Decimal)	**Bit(s)**	**Description**
8192	0	1 = Stop, 0 = Not Stop
	1	1 = Start, 0 = Not Start
	2	1 = Jog, 0 = No Jog
	3	1 = Clear Faults, 0 = Not Clear Faults
	5,4	00 = No Command
		01 = Forward Command
		10 = Reverse Command
		11 = No Command
	6	Not Used in FRN 3.03 and earlier. In FRN 4.01 and later, activates Opto Output 1. Note: This bit controls the output when the value of parameter A058 is set to 20.
	7	Not Used in FRN 3.03 and earlier. In FRN 4.01 and later, activates Opto Output 2. Note: This bit controls the output when the value of parameter A061 is set to 20.
	9,8	00 = No Command
		01 = Accel Rate 1 Enable
		10 = Accel Rate 2 Enable
		11 = Hold Accel Rate Selected
	11,10	00 = No Command
		01 = Decel Rate 1 Enable
		10 = Decel Rate 2 Enable
		11 = Hold Decel Rate Selected
	14,13,12	000 = No Command
		001 = Freq. Source = P038 [Speed Reference]
		010 = Freq. Source = A069 [Internal Freq]
		011 = Freq. Source = Comms (Addr 8193)
		100 = A070 [Preset Freq 0]
		101 = A071 [Preset Freq 1]
		110 = A072 [Preset Freq 2]
		111 = A073 [Preset Freq 3]
	15	Not Used in FRN 3.03 and earlier. In FRN 4.01 and later, activates C-form relay. Note: This bit controls the output when the value of parameter A055 is set to 20.

Writing (06) Reference

The Speed Reference to a PowerFlex 40 drive can be controlled via the network by sending Function Code 06 writes to register address 8193 (Reference). P038 [Speed Reference] must be set to 5 “RS485 (DSI) Port” in order to accept the Speed Reference.

In addition to being written, register address 8193 can be read using Function Code 03.

Reference	
Address (Decimal)	**Description**
8193	A decimal value entered as xxx.x where the decimal point is fixed. For example, a decimal “100” equals 10.0 Hz and “543” equals 54.3 Hz.

Reading (03) Logic Status Data

The PowerFlex 40 Logic Status data can be read via the network by sending Function Code 03 reads to register address 8448 (Logic Status).

Logic Status		
Address (Decimal)	**Bit(s)**	**Description**
8448	0	1 = Ready, 0 = Not Ready
	1	1 = Active (Running), 0 = Not Active
	2	1 = Cmd Forward, 0 = Cmd Reverse
	3	1 = Rotating Forward, 0 = Rotating Reverse
	4	1 = Accelerating, 0 = Not Accelerating
	5	1 = Decelerating, 0 = Not Decelerating
	6	1 = Alarm, 0 = No Alarm
	7	1 = Faulted, 0 = Not Faulted
	8	1 = At Reference, 0 = Not At Reference
	9	1 = Reference Controlled by Comm
	10	1 = Operation Cmd Controlled by Comm
	11	1 = Parameters have been locked
	12	Digital Input 1 Status
	13	Digital Input 2 Status
	14	Digital Input 3 Status(1)
	15	Digital Input 4 Status(1)

(1) This status is available only with firmware revision FRN 2.xx and higher.

Reading (03) Feedback

The Feedback (Output Frequency) from the PowerFlex 40 drive can be read via the network by sending Function Code 03 reads to register address 8451 (Feedback).

Feedback[2]	
Address (Decimal)	**Description**
8451	A xxx.x decimal value where the decimal point is fixed. For example, a decimal "123" equals 12.3 Hz and "300" equals 30.0 Hz.

(2) Returns the same data as Reading (03) Parameter d001 [Output Freq].

Reading (03) Drive Error Codes

The PowerFlex 40 Error Code data can be read via the network by sending Function Code 03 reads to register address 8449 (Drive Error Codes).

Logic Status		
Address (Decimal)	**Value (Decimal)**	**Description**
8449	0	No Fault
	2	Auxiliary Input
	3	Power Loss
	4	Undervoltage
	5	Overvoltage
	6	Motor Stalled
	7	Motor Overload
	8	Heatsink Overtemperature
	12	HW Overcurrent (300%)
	13	Ground Fault
	29	Analog Input Loss
	33	Auto Restart Tries
	38	Phase U to Ground Short
	39	Phase V to Ground Short
	40	Phase W to Ground Short
	41	Phase UV Short
	42	Phase UW Short
	43	Phase VW Short
	63	Software Overcurrent
	64	Drive Overload
	70	Power Unit Fail
	80	AutoTune Fail
	81	Communication Loss
	100	Parameter Checksum Error
	122	I/O Board Fail

Reading (03) and Writing (06) Drive Parameters

To access drive parameters, the Modbus register address equals the parameter number. For example, a decimal “1” is used to address Parameter d001 [Output Freq] and decimal “39” is used to address Parameter P039 [Accel Time 1].

Additional Information

Refer to **http://www.ab.com/drives/** for additional information.

Notes:

RJ45 DSI Splitter Cable

The PowerFlex 40 drive provides a RJ45 port to allow the connection of a single peripheral device. The RJ45 DSI Splitter Cable can be used to connect a second DSI peripheral device to the drive.

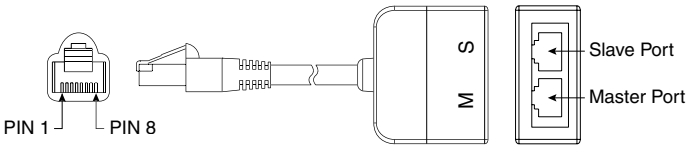
Connectivity Guidelines

ATTENTION: Risk of injury or equipment damage exists. The peripherals may not perform as intended if these Connectivity Guidelines are not followed. Precautions should be taken to follow these Connectivity Guidelines.

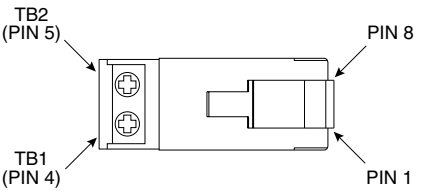
- Two peripherals maximum can be attached to a drive.
- If a single peripheral is used, it must be connected to the Master port (M) on the splitter and configured for “Auto” (default) or “Master.” Parameter 9 [Device Type] on the DSI / MDI keypads and Parameter 1 [Adapter Cfg] on the Serial Converter are used to select the type (Auto / Master / Slave).
- **Do not use the RJ45 Splitter Cable with a drive that has an internal network communication adapter installed.** Since only one additional peripheral can be added, the second peripheral can be connected directly to the RJ45 port on the drive. The internal Comm is always the Master, therefore the external peripheral must be configured as “Auto” (for temporary connections) or “Slave” (for permanent connections).
- If two peripherals will be powered up at the same time, one must be configured as the “Master” and connected to the Master port (M) and the other must be connected as the “Slave” and connected to the Slave port (S).

DSI Cable Accessories

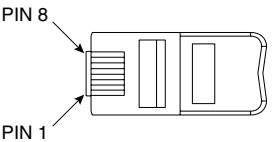
RJ45 Splitter Cable – Catalog Number: AK-U0-RJ45-SC1



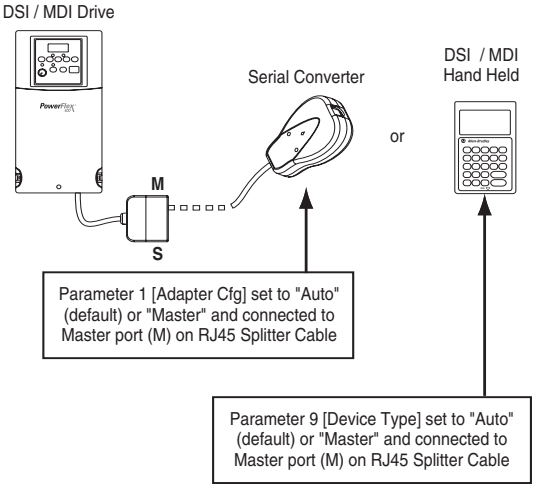
RJ45 Two-Position Terminal Block Adapter –
Catalog Number: AK-U0-RJ45-TB2P



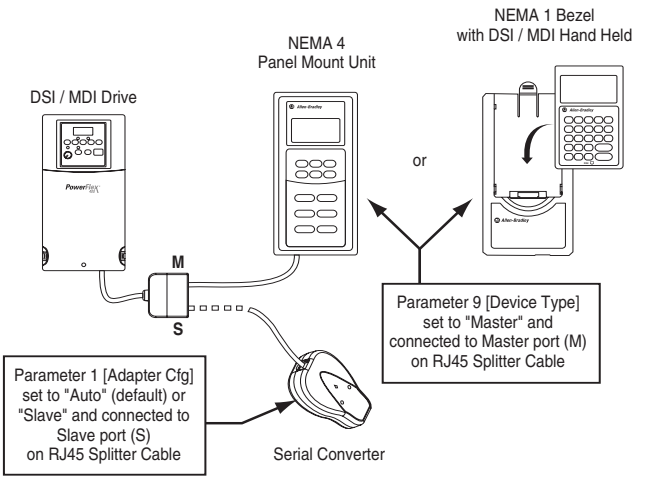
RJ45 Adapter with Integrated Termination Resistor –
Catalog Number: AK-U0-RJ45-TR1



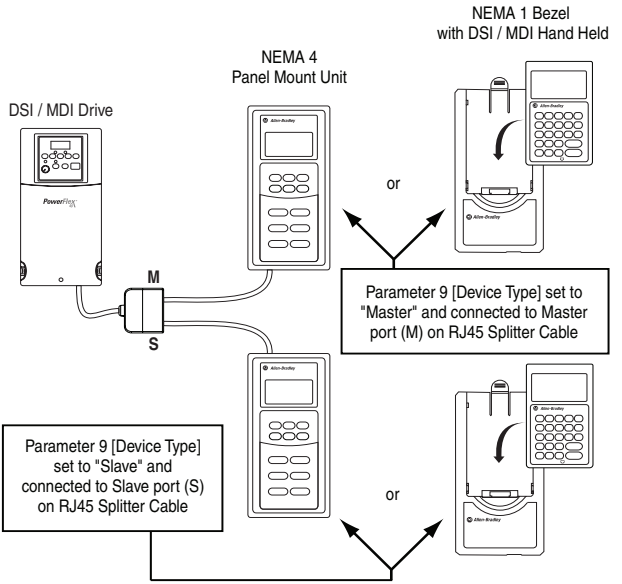
Connecting One Temporary Peripheral



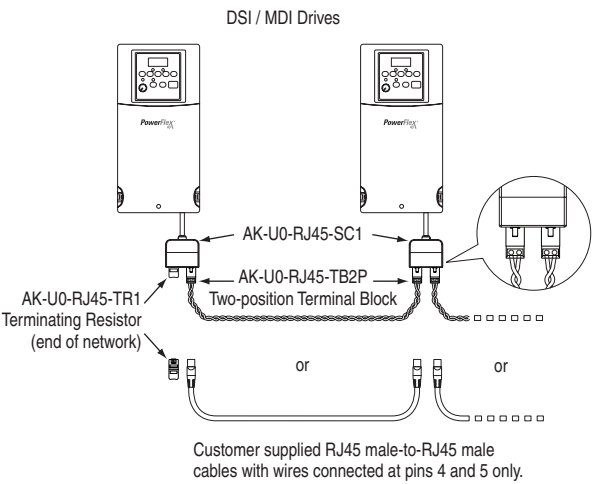
Connecting One Temporary Peripheral and One Permanent Peripheral



Connecting Two Permanent Peripherals



Connecting an RS-485 Network



Both the Master (M) and Slave (S) ports on the RJ45 Splitter Cable operate as standard RS-485 ports in this configuration.

StepLogic™, Basic Logic and Timer/Counter Functions

Four PowerFlex 40 logic functions provide the capability to program simple logic functions without a separate controller.

- StepLogic Function

  Steps through up to eight preset speeds based on programmed logic. Programmed logic can include conditions that need to be met from digital inputs programmed as “Logic In1” and “Logic In2” before stepping from one preset speed to the next. A timer is available for each of the eight steps and is used to program a time delay before stepping from one preset speed to the next. The status of a digital output can also be controlled based on the step being executed.

- Basic Logic Function

  Up to two digital inputs can be programmed as “Logic In1” and/or “Logic In2”. A digital output can be programmed to change state based on the condition of one or both inputs based on basic logic functions such as AND, OR, NOR. The basic logic functions can be used with or without StepLogic.

- Timer Function

  A digital input can be programmed for “Timer Start”. A digital output can be programmed as a “Timer Out” with an output level programmed to the desired time. When the timer reaches the time programmed into the output level the output will change state. The timer can be reset via a digital input programmed as “Reset Timer”.

- Counter Function

  A digital input can be programmed for “Counter In”. A digital output can be programmed as “Counter Out” with an output level programmed to the desired number of counts. When the counter reaches the count programmed into the output level the output will change state. The counter can be reset via a digital input programmed as “Reset Counter”.

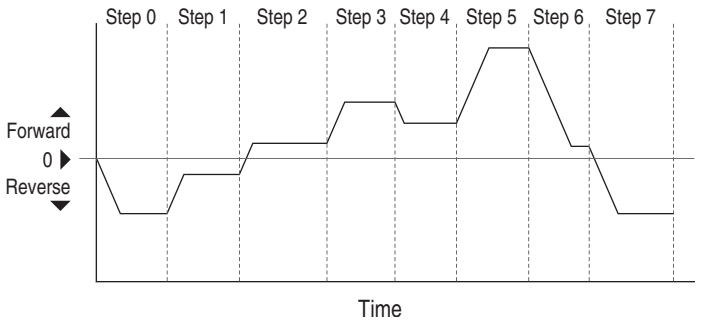
StepLogic Using Timed Steps

To activate this function, set parameter P038 [Speed Reference] to 6 “Stp Logic”. Three parameters are used to configure the logic, speed reference and time for each step.

- Logic is defined using parameters A140-A147 [Stp Logic x].
- Preset Speeds are set with parameters A070-A077 [Preset Freq x].
- Time of operation for each step is set with parameters A150-A157 [Stp Logic Time x].

The direction of motor rotation can be forward or reverse.

Figure E.1 Using Timed Steps



StepLogic Sequence

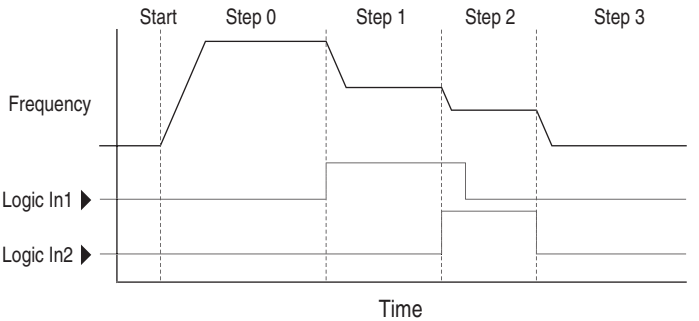
- Sequence begins with a valid start command.
- A normal sequence begins with Step 0 and transition to the next step when the corresponding StepLogic time has expired.
- Step 7 is followed by Step 0
- Sequence repeats until a stop is issued or a fault condition occurs.

StepLogic Using Basic Logic Functions

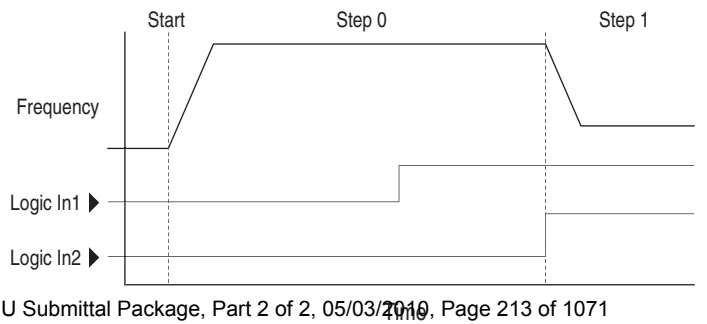
Digital input and digital output parameters can be configured to use logic to transition to the next step. Logic In1 and Logic In2 are defined by programming parameters A051-A054 [Digital Inx Sel] to option 23 “Logic In1” or option 24 “Logic In2”.

Example

- Run at Step 0.
- Transition to Step 1 when Logic In1 is true.
  Logic senses the edge of Logic In1 when it transitions from off to on. Logic In1 is not required to remain “on”.
- Transition to Step 2 when both Logic In1 and Logic In2 are true.
  The drive senses the level of both Logic In1 and Logic In2 and transitions to Step 2 when both are on.
- Transition to Step 3 when Logic In2 returns to a false or off state.
  Inputs are not required to remain in the “on” condition except under the logic conditions used for the transition from Step 2 to Step 3.



The step time value and the basic logic may be used together to satisfy machine conditions. For instance, the step may need to run for a minimum time period and then use the basic logic to trigger a transition to the next step.



Timer Function

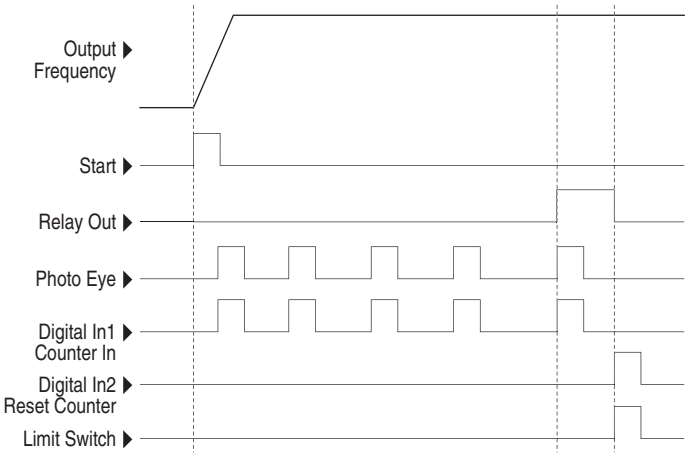
Digital inputs and outputs control the timer function and are configured with parameters A051-A054 [Digital Inx Sel] set to 18 “Timer Start” and 20 “Reset Timer”.

Digital outputs (relay and opto type) define a preset level and indicate when the level is reached. Level parameters A056 [Relay Out Level], A059 [Opto Out1 Level] and A062 [Opto Out2 Level] are used to set the desired time in seconds.

Parameters A055 [Relay Out Sel], A058 [Opto Out1 Sel] and A061 [Opto Out2 Sel] are set to option 16 “Timer Out” and causes the output to change state when the preset level is reached.

Example

- Drive starts up and accelerates to 30 Hz.
- After 30Hz has been maintained for 20 seconds, a 4-20mA analog input becomes the reference signal for speed control.
- The timer function is used to select a preset speed with a 20 second run time that overrides the speed reference while the digital input is active.
- Parameters are set to the following options:
  - P038 [Speed Reference] = 3 “4-20mA Input”
  - A051 [Digital In1 Sel] = 4 “Preset Freq”
  - A052 [Digital In2 Sel] = 18 “Timer Start”
  - A055 [Relay Out Sel] = 16 “Timer Out”
  - A056 [Relay Out Level] = 20.0 Secs
  - A071 [Preset Freq 1] = 30.0 Hz
- The control terminal block is wired such that a start command will also trigger the timer start.
- The relay output is wired to I/O Terminal 05 (Digital Input 1) so that it forces the input on when the timer starts.
- After the timer is complete, the output is turned off releasing the preset speed command. The drive defaults to following the analog input reference as programmed.



Note that a “Reset Timer” input is not required for this example since the “Timer Start” input both clears and starts the timer.

Counter Function

Digital inputs and outputs control the counter function and are configured with parameters A051-A054 [Digital Inx Sel] set to 19 “Counter In” and 21 “Reset Counter”.

Digital outputs (relay and opto type) define a preset level and indicate when the level is reached. Level parameters A056 [Relay Out Level], A059 [Opto Out1 Level] and A062 [Opto Out2 Level] are used to set the desired count value.

Parameters A055 [Relay Out Sel], A058 [Opto Out1 Sel] and A061 [Opto Out2 Sel] are set to 17 “Counter Out” which causes the output to change state when the level is reached.

Example

- A photo eye is used to count packages on a conveyor line.
- An accumulator holds the packages until 5 are collected.
- A diverter arm redirects the group of 5 packages to a bundling area.
- The diverter arm returns to its original position and triggers a limit switch that resets the counter.
- Parameters are set to the following options:
  - A051 [Digital In1 Sel] set to 19 to select “Counter In”
  - A052 [Digital In2 Sel] set to 21 to select “Reset Counter”
  - A055 [Relay Out Sel] set to 17 to select “Counter Out”
  - A056 [Relay Out Level] set to 5.0 (counts)

StepLogic Parameters

Table E.A Code Descriptions for Parameters A140-A147

Digit 3	Digit 2	Digit 1	Digit 0
0	0	F	1

Table E.B Digit 3 – Defines the action during the step currently executing.

Setting	Accel/Decel Parameters Used	StepLogic Output State	Commanded Direction
0	1	Off	FWD
1	1	Off	REV
2	1	Off	No Output
3	1	On	FWD
4	1	On	REV
5	1	On	No Output
6	2	Off	FWD
7	2	Off	REV
8	2	Off	No Output
9	2	On	FWD
A	2	On	REV
b	2	On	No Output

Table E.C Digit 2 – Defines what step to jump to or how to end program when the logic conditions specified in Digit 1 are met.

Setting	Logic
0	Jump to Step 0
1	Jump to Step 1
2	Jump to Step 2
3	Jump to Step 3
4	Jump to Step 4
5	Jump to Step 5
6	Jump to Step 6
7	Jump to Step 7
8	End Program (Normal Stop)
9	End Program (Coast to Stop)
A	End Program and Fault (F2)

Table E.D Digit 1 – Defines what logic must be met to jump to a step other than the very next step.

Setting	Description	Logic
0	Skip Step (jump immediately)	SKIP
1	Step based on the time programmed in the respective [Stp Logic Time x] parameter.	TIMED
2	Step if “Logic In1” is active (logically true)	TRUE
3	Step if “Logic In2” is active (logically true)	TRUE
4	Step if “Logic In1” is not active (logically false)	FALSE
5	Step if “Logic In2” is not active (logically false)	FALSE
6	Step if either “Logic In1” or “Logic In2” is active (logically true)	OR
7	Step if both “Logic In1” and “Logic In2” is active (logically true)	AND
8	Step if neither “Logic In1” or “Logic In2” is active (logically true)	NOR
9	Step if “Logic In1” is active (logically true) and “Logic In2” is not active (logically false)	XOR
A	Step if “Logic In2” is active (logically true) and “Logic In1” is not active (logically false)	XOR
b	Step after [Stp Logic Time x] and “Logic In1” is active (logically true)	TIMED AND
C	Step after [Stp Logic Time x] and “Logic In2” is active (logically true)	TIMED AND
d	Step after [Stp Logic Time x] and “Logic In1” is not active (logically false)	TIMED OR
E	Step after [Stp Logic Time x] and “Logic In2” is not active (logically false)	TIMED OR
F	Do not step OR no “jump to”, so use Digit 0 logic	IGNORE

Table E.E Digit 0 – Defines what logic must be met to jump to the very next step.

Setting	Description	Logic
0	Skip Step (jump immediately)	SKIP
1	Step based on the time programmed in the respective [Stp Logic Time x] parameter.	TIMED
2	Step if “Logic In1” is active (logically true)	TRUE
3	Step if “Logic In2” is active (logically true)	TRUE
4	Step if “Logic In1” is not active (logically false)	FALSE
5	Step if “Logic In2” is not active (logically false)	FALSE
6	Step if either “Logic In1” or “Logic In2” is active (logically true)	OR
7	Step if both “Logic In1” and “Logic In2” is active (logically true)	AND
8	Step if neither “Logic In1” or “Logic In2” is active (logically true)	NOR
9	Step if “Logic In1” is active (logically true) and “Logic In2” is not active (logically false)	XOR
A	Step if “Logic In2” is active (logically true) and “Logic In1” is not active (logically false)	XOR
b	Step after [Stp Logic Time x] and “Logic In1” is active (logically true)	TIMED AND
C	Step after [Stp Logic Time x] and “Logic In2” is active (logically true)	TIMED AND
d	Step after [Stp Logic Time x] and “Logic In1” is not active (logically false)	TIMED OR
E	Step after [Stp Logic Time x] and “Logic In2” is not active (logically false)	TIMED OR
F	Use logic programmed in Digit 1	IGNORE

PID Set Up

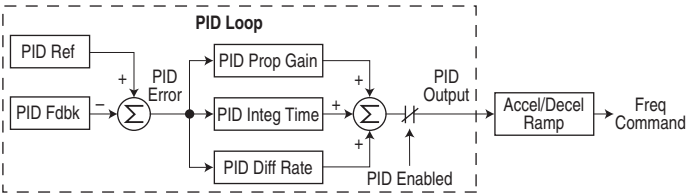
PID Loop

The PowerFlex 40 has a built-in PID (proportional, integral, differential) control loop. The PID loop is used to maintain a process feedback (such as pressure, flow or tension) at a desired set point. The PID loop works by subtracting the PID feedback from a reference and generating an error value. The PID loop reacts to the error, based on the PID Gains, and outputs a frequency to try to reduce the error value to 0. To enable the PID loop, parameter A132 [PID Ref Sel] must be set to an option other than 0 “PID Disabled”.

Exclusive Control and Trim Control are two basic configurations where the PID loop may be used.

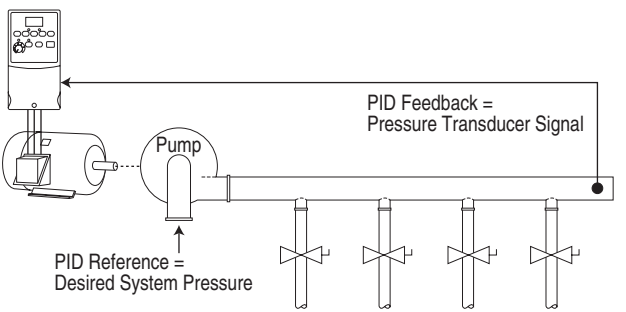
Exclusive Control

In Exclusive Control, the Speed Reference becomes 0, and the PID Output becomes the entire Freq Command. Exclusive Control is used when A132 [PID Ref Sel] is set to option 1, 2, 3 or 4. This configuration does not require a master reference, only a desired set point, such as a flow rate for a pump.



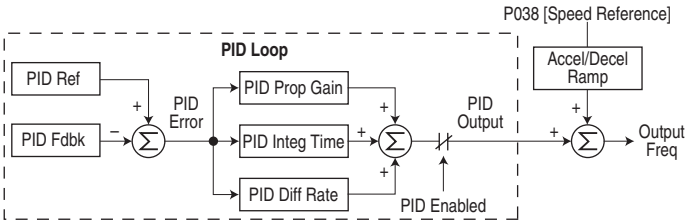
Example

- In a pumping application, the PID Reference equals the Desired System Pressure set point.
- The Pressure Transducer signal provides PID Feedback to the drive. Fluctuations in actual system pressure, due to changes in flow, result in a PID Error value.
- The drive output frequency increases or decreases to vary motor shaft speed to correct for the PID Error value.
- The Desired System Pressure set point is maintained as valves in the system are opened and closed causing changes in flow.
- When the PID Control Loop is disabled, the Commanded Speed is the Ramped Speed Reference.



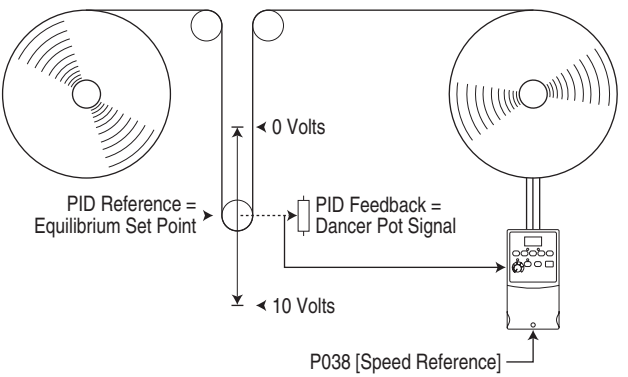
Trim Control

In Trim Control, the PID Output is added to the Speed Reference. In Trim mode, the output of the PID loop bypasses the accel/decel ramp as shown. Trim Control is used when A132 [PID Ref Sel] is set to option 5, 6, 7 or 8.



Example

- In a winder application, the PID Reference equals the Equilibrium set point.
- The Dancer Pot signal provides PID Feedback to the drive. Fluctuations in tension result in a PID Error value.
- The Master Speed Reference sets the wind/unwind speed.
- As tension increases or decreases during winding, the Speed Reference is trimmed to compensate. Tension is maintained near the Equilibrium set point.



PID Reference and Feedback

Parameter A132 [PID Ref Sel] is used to enable the PID mode (A132 ¦ 0 “PID Disabled”) and to select the source of the PID Reference. If A132 [PID Ref Sel] is not set to 0 “PID Disabled”, PID can still be disabled by select programmable digital input options (parameters A051-A054) such as “Jog”, “Local” or “PID Disable”.

Table F.A A132 [PID Ref Sel] Options

Option	Description
0 “PID Disabled”	Disables the PID loop (default setting)
1 “PID Setpoint“	Selects Exclusive Control. A137 [PID Setpoint] will be used to set the value of the PID Reference
2 “0-10V Input”	Selects Exclusive Control. Selects the 0-10V Input. Note that the PID will not function with a bipolar analog input. It will ignore any negative voltages and treat them like a zero.
3 “4-20mA Input”	Selects Exclusive Control. Selects the 4-20mA Input.
4 “Comm Port”	Selects Exclusive Control. The reference word from a communication network (see Appendix C for details on the reference word) such as Modbus RTU or DeviceNet becomes the PID Reference. The value sent over the network is scaled so that P035 [Maximum Freq] x 10 = 100% reference. For example, with [Maximum Freq] = 60 Hz, a value of 600 sent over the network would represent 100% reference.
5 “Setpnt, Trim”	Selects Trim Control. A137 [PID Setpoint] will be used to set the value of the PID Reference.
6 “0-10V, Trim”	Selects Trim Control. Selects the 0-10V Input. Note that the PID will not function with a bipolar analog input. It will ignore any negative voltages and treat them like a zero.
7 “4-20mA, Trim”	Selects Trim Control. Selects the 4-20mA Input.
8 “Comm, Trim”	Selects Trim Control. The reference word from a communication network (see Appendix C for details on the reference word) such as Modbus RTU or DeviceNet becomes the PID Reference. The value sent over the network is scaled so that P035 [Maximum Freq] x 10 = 100% reference. For example, with [Maximum Freq] = 60 Hz, a value of 600 sent over the network would represent 100% reference.

A133 [PID Feedback Sel] is used to select the source of the PID feedback.

Table F.B A133 [PID Feedback Sel] Options

Option	Description
0 “0-10V Input”	Selects the 0-10V Input (default setting). Note that the PID will not function with a bipolar analog input. It will ignore any negative voltages and treat them like a zero.
1 “4-20mA Input“	Selects the 4-20mA Input.
2 “Comm Port”	The reference word from a communication network (see Appendix C of the PowerFlex 40 User Manual for details on the reference word) such as Modbus RTU or DeviceNet becomes the PID Feedback. The value sent over the network is scaled so that P035 [Maximum Freq] x 10 = 100% Feedback. For example, with [Maximum Freq] = 60 Hz, a value of 600 sent over the network would represent 100% Feedback.

Analog PID Reference Signals

Parameters A110 [Anlg In 0-10V Lo] and A111 [Anlg In 0-10V Hi] are used to scale or invert an analog PID Reference.

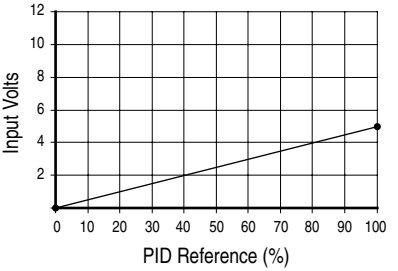
Important: Firmware version FRN 2.xx also allows PID Feedback scaling from an analog input.

Examples

Scale Function

For a 0-5 volt signal, the following parameter settings are used so that a 0 volt signal = 0% PID Reference and a 5 volt signal = 100% PID Reference.

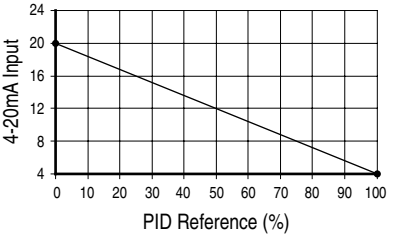
- A110 [Anlg In 0-10V Lo] = 0.0%
- A111 [Anlg In 0-10V Hi] = 50.0%
- A132 [PID Ref Sel] = 0 “0-10V Input”



Invert Function

For a 4-20mA signal, the following parameter settings are used so that a 20mA signal = 0% PID Reference and a 4mA signal = 100% PID Reference.

- A112 [Anlg In 4-20mA Lo] = 100.0%
- A113 [Anlg In 4-20mA Hi] = 0.0%
- A132 [PID Ref Sel] = 3 “4-20mA Input”



Alternatively, you can set the value of A167 [PID Invert Error] to 1 to change the sign of the PID error. See A167 [PID Invert Error] in Chapter 3 for more details.

PID Deadband

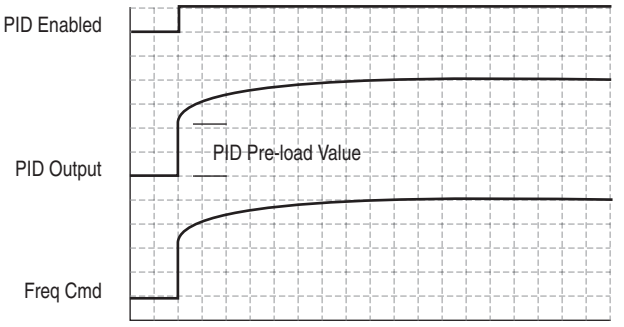
Parameter A138 [PID Deadband] is used to set a range, in percent, of the PID Reference that the drive will ignore.

Example

- [PID Deadband] is set to 5.0
- The PID Reference is 25.0%
- The PID Regulator will not act on a PID Error that falls between 20.0 and 30.0%

PID Preload

The value set in A139 [PID Preload], in Hertz, will be pre-loaded into the integral component of the PID at any start or enable. This will cause the drive's frequency command to initially jump to that preload frequency, and the PID loop starts regulating from there.



PID Limits

A130 [PID Trim Hi] and A131 [PID Trim Lo] are used to limit the PID output and are only used in trim mode. [PID Trim Hi] sets the maximum frequency for the PID output in trim mode. [PID Trim Lo] sets the reverse frequency limit for the PID output in trim mode. Note that when the PID reaches the Hi or Lo limit, the PID regulator stops integrating so that windup does not occur.

PID Gains

The proportional, integral, and differential gains make up the PID regulator.

- A134 [PID Prop Gain]
  The proportional gain (unitless) affects how the regulator reacts to the magnitude of the error. The proportional component of the PID regulator outputs a speed command proportional to the PID error. For example, a proportional gain of 1 would output 100% of max frequency when the PID error is 100% of the analog input range. A larger value for [PID Prop Gain] makes the proportional component more responsive, and a smaller value makes it less responsive. Setting [PID Prop Gain] to 0.00 disables the proportional component of the PID loop.
- A135 [PID Integ Time]
  The integral gain (units of seconds) affects how the regulator reacts to error over time and is used to get rid of steady state error. For example, with an integral gain of 2 seconds, the output of the integral gain component would integrate up to 100% of max frequency when the PID error is 100% for 2 seconds. A larger value for [PID Integ Time] makes the integral component less responsive, and a smaller value makes it more responsive. Setting [PID Integ Time] to 0 disables the integral component of the PID loop.
- A136 [PID Diff Rate]
  The Differential gain (units of 1/seconds) affects the rate of change of the PID output. The differential gain is multiplied by the difference between the previous error and current error. Thus, with a large error the D has a large effect and with a small error the D has less of an effect. This parameter is scaled so that when it is set to 1.00, the process response is 0.1% of [Maximum Freq] when the process error is changing at 1% / second. A larger value for [PID Diff Rate] makes the differential term have more of an effect and a small value makes it have less of an effect. In many applications, the D gain is not needed. Setting [PID Diff Rate] to 0.00 (factory default) disables the differential component of the PID loop.

Guidelines for Adjusting the PID Gains

1. Adjust the proportional gain. During this step it may be desirable to disable the integral gain and differential gain by setting them to 0. After a step change in the PID Feedback:
   - If the response is too slow increase A134 [PID Prop Gain].
   - If the response is too quick and/or unstable (see Figure F.1), decrease A134 [PID Prop Gain].
   - Typically, A134 [PID Prop Gain] is set to some value below the point where the PID begins to go unstable.
2. Adjust the integral gain (leave the proportional gain set as in Step 1). After a step change in the PID Feedback:
   - If the response is too slow (see Figure F.2), or the PID Feedback does not become equal to the PID Reference, decrease A135 [PID Integ Time].
   - If there is a lot of oscillation in the PID Feedback before settling out (see Figure F.3), increase A135 [PID Integ Time].
3. At this point, the differential gain may not be needed. However, if after determining the values for A134 [PID Prop Gain] and A135 [PID Integ Time]:
   - Response is still slow after a step change, increase A136 [PID Diff Rate].
   - Response is still unstable, decrease A136 [PID Diff Rate].

The following figures show some typical responses of the PID loop at different points during adjustment of the PID Gains.

Figure F.1 Unstable

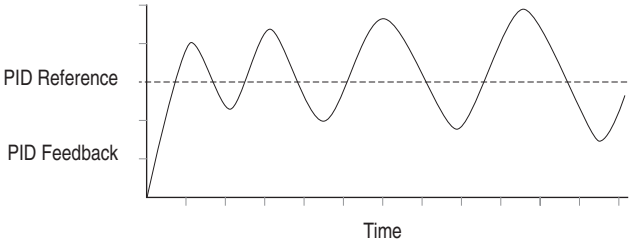


Figure F.2 Slow Response – Over Damped

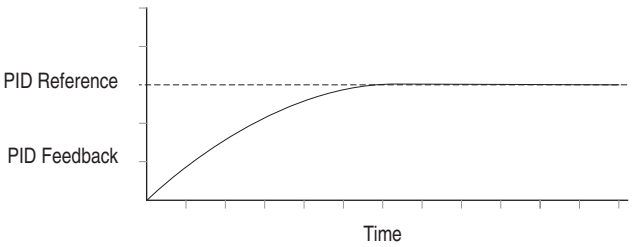


Figure F.3 Oscillation – Under Damped

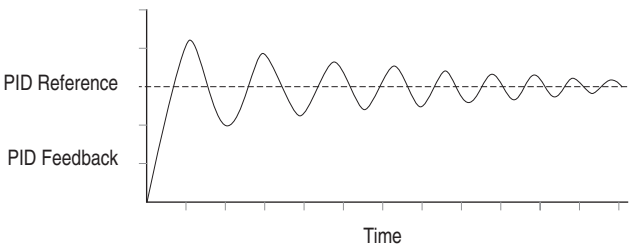
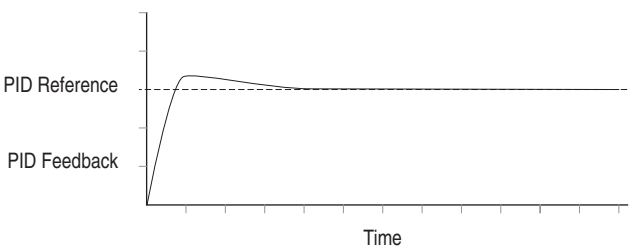


Figure F.4 Good Response – Critically Damped



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Notes:

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Variable Frequency Drive 480VAC 3-Phase, 3HP 6A, 2.2kW, Allen-Bradley, 22B-D6P0N104

PowerFlex® 4 and 40

Technical Data

ADJUSTABLE FREQUENCY AC DRIVES

LISTEN. THINK. SOLVE.®

Allen-Bradley • Rockwell Software

Rockwell Automation

Product Overview

Providing users with powerful motor speed control in a compact, space saving design, the Allen-Bradley® PowerFlex® 4 and 40 AC drives are the smallest and most cost-effective members of the PowerFlex® family of drives. Available in power ratings from 0.2 to 11 kW (0.25 to 15 HP) and in voltage classes of 120, 240, 480 and 600 volts, PowerFlex 4 and 40 are designed to meet global OEM and end-user demands for flexibility, space savings, ease of use and are cost-effective alternatives for speed control of applications such as machine tools, fans, pumps and conveyors and material handling systems

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Reference Materials

For additional PowerFlex 4 and 40 data and general drive information, refer to the following publications:

Title	Publication	Available Online at . . .
PowerFlex 4 User Manual	22A-UM001...	**www.rockwellautomation.com/literature**
PowerFlex 40 User Manual	22B-UM001...	
Wiring and Grounding Guidelines for PWM AC Drives	DRIVES-IN001...	
Preventive Maintenance of Industrial Control and Drive System Equipment	DRIVES-TD001...	
Safety Guidelines for the Application, Installation and Maintenance of Solid State Control	SGI-1.1	

For other information, contact Allen-Bradley Drives Technical Support:

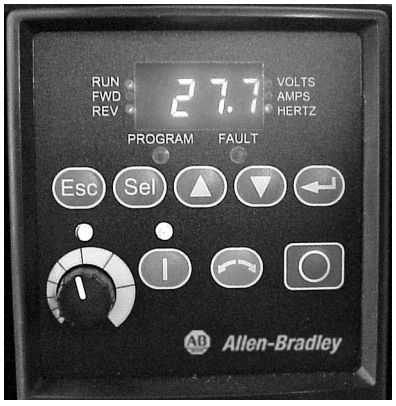
Title	Online at . . .
Allen-Bradley Drives Technical Support	**www.ab.com/support/abdrives**

Shaded areas are applicable to PowerFlex 40 only.

Packaging and Mounting

- Installation can be a virtual snap using the **DIN rail mounting** feature on A and B frame drives. Panel mounting is also available, providing added flexibility.
- **Flange mount** drives are available to reduce overall enclosure size.
- **Zero Stacking**™ is allowable for ambient temperatures up to 40°C, saving valuable panel space. 50°C ambient temperatures are permitted with minimal spacing between drives.
- **Integral filtering** is available on all 230V single phase ratings, providing a cost-effective means of meeting EN55011, Class A and B EMC requirements. External filters provide compliance to Class A and B requirements for all PowerFlex 4 and 40 ratings.
- An optional **IP30, NEMA/UL Type 1 conduit box** is easily adapted to the standard IP20 (NEMA Type Open) product, providing increased environmental ratings.
- **IP66, NEMA/UL Type 4X/12** (Indoor) for mounting directly in the product environment. Listed by UL to resist dust, dirt, etc. and survive high pressure water spray. Also certified by NSF to ensure conformity with international food equipment standards.

Start Up, Programming and Operation



- An **integral keypad** provides out of the box operation using the local potentiometer and control keys.
- The 10 most common application parameters are contained in the **Basic Program Group**, making programming fast and easy.
- The **programming keys** have the same function as all other PowerFlex drives, so if you can program one PowerFlex drive, you can program them all.
- **4 digit display** with 10 additional LED indicators provides an intuitive display of drive status and information.
- Integral **RS-485 communications** can be used for programming from a PC. It can also be used in a multi-drop network configuration. A serial converter module provides connectivity to any controller with a DF1 port.
- A **NEMA/UL Type 4X** remote and **NEMA/UL Type 1 hand-held LCD keypad** provide additional programming and control flexibility, both featuring the popular CopyCat function.

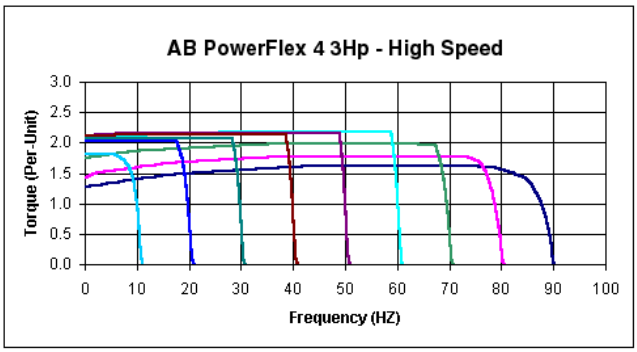
Optimized Performance

- **Removable MOV** to ground provides trouble-free operation when used on ungrounded distribution systems.
- A **relay pre-charge** limits inrush current.
- **Integral brake transistor**, available on all ratings (except no brake version), provides dynamic braking capability with simple low cost brake resistors.
- DIP switch settable **24V DC sink or source control** for control wiring flexibility.
- 150% overload for 60 seconds or 200% overload for 3 seconds provides **robust overload protection**.
- **Adjustable PWM frequency up to 16 kHz** ensures quiet operation.

Sensorless Vector Performance

PowerFlex 4

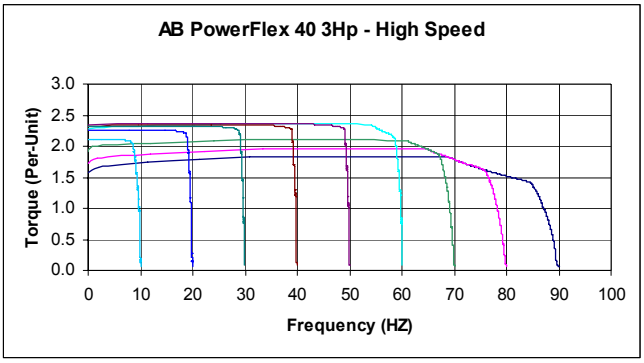
- Drive automatically provides auto boost (IR compensation) and slip compensation.
- Provides excellent speed regulation and high levels of torque across the entire speed range of the drive, and improved speed regulation even as loading increases.



Sensorless Vector Control

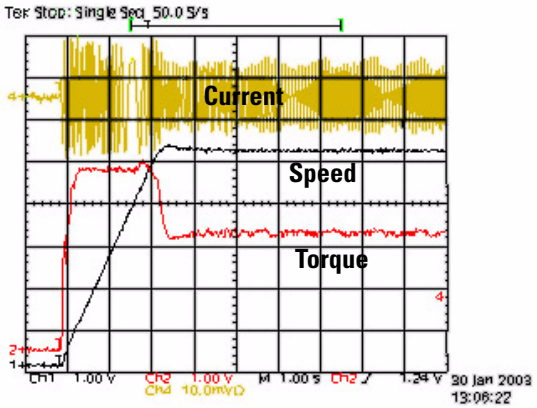
PowerFlex 40

- Sensorless Vector Control provides exceptional speed regulation and very high levels of torque across the entire speed range of the drive.
- The Autotune feature allows the PowerFlex 40 to adapt to individual motor characteristics.



Performance

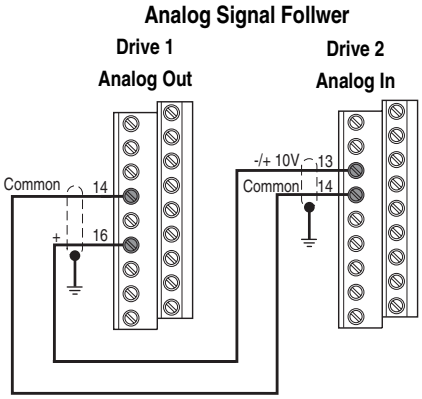
- This graph depicts the ability of a PowerFlex 40 drive to accelerate into at least 150% load. A PowerFlex 4 will perform similarly, but with a slightly higher acceleration time.
- At 100% motor load, the drive will run the motor at synchronous speed.
- Excellent current regulation.
- Linear acceleration.
- Best in class digital input response time and repeatability.



Performance

- **Sensorless Vector Control** develops high torque over a wide speed range and adapts to individual motor characteristics.
- **Variable PWM** allows the drive to output more current at low frequencies.
- Integral **PID** functionality enhances application flexibility.
- **Timer, Counter, Basic Logic and StepLogic™ functions** can reduce hardware design costs and simplify control schemes.
  - **Timer function**: Relay or opto outputs controlled by drive performing timer function. Timer is initiated by activating a digital input programmed as "Timer Start."
  - **Counter function**: Relay or opto outputs controlled by drive performing counter function. Counter function is activated by a digital input programmed as "Counter Input."
  - **Basic Logic**: Relay or opto outputs controlled by status of digital inputs programmed as "Logic Inputs." Performs basic Boolean logic.
  - **StepLogic**: Logic-based steps using preset speed settings. Each step can be programmed for a specific speed, direction and accel/decel profile. Drive outputs can be used to indicate which step is being performed.

I/O



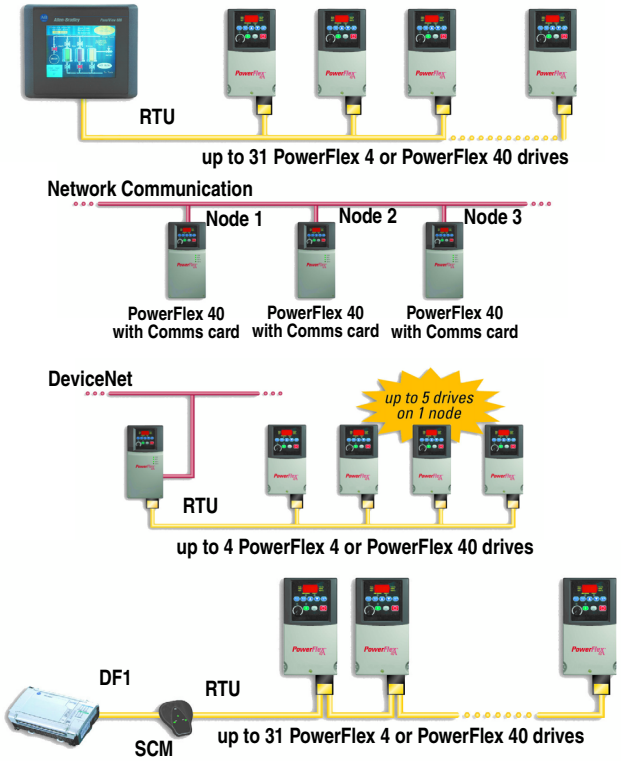
- **Two (2) Analog Inputs** (one unipolar and one bipolar) are independently isolated from the rest of the drive I/O. These inputs can be toggled between via a digital input.
- **Three (3) fixed** and **four (4) fully programmable Digital Inputs** provide application versatility.
- **One (1) Analog Output** is DIP switch selectable for either 0-10V or 0-20mA. This scalable, 10-bit output is suitable for metering or as a speed reference for another drive.
- **Two (2) Opto Outputs** and **one (1) form C relay output** can be used to indicate various drive, motor or logic conditions.

Communications

- Integral communication cards such as DeviceNet™, EtherNet/IP™, PROFIBUS™ DP, LonWorks® and, ControlNet™ can improve machine performance.
- The DSI Wireless Interface Module (WIM) provides a wireless communication interface between a Pocket PC, laptop computer or desktop computer equipped with Bluetooth® wireless technology, and any Allen-Bradley® product supporting the DSI™ protocol.
- Field installed option allows for future addition of stand-alone drives to a network.
- Online EDS file creation with RS NetWorx™ providing ease of set-up on a network.

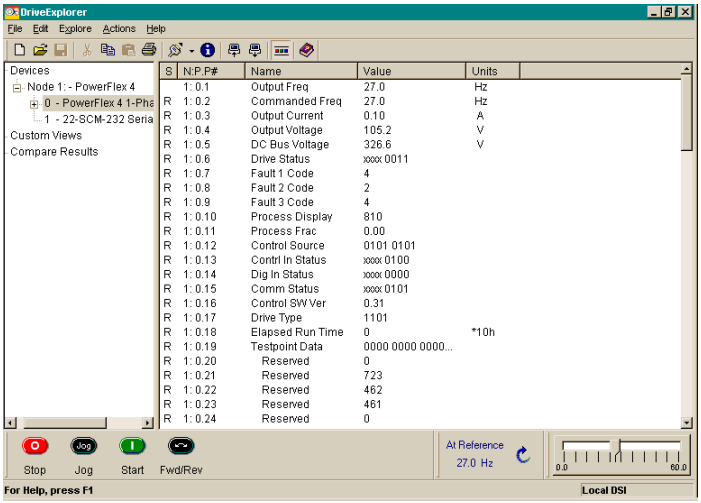
Versatile Programming and Network Solutions

- PowerFlex 4 and PowerFlex 40 are compatible with any device that acts as a RTU Master and supports standard 03 and 06 RTU commands.
- A network can be configured using PowerFlex 40 drives with optional communication cards for high performance and flexible configuration capabilities.
  - BACnet
  - ControlNet
  - DeviceNet
  - EtherNet/IP
  - LonWorks
  - PROFIBUS DP
- A multi-drive solution can be reached using a single PowerFlex 40 DeviceNet option, with the ability for up to five (5) drives to reside on one (1) node.
- Integral RS485 communications enable the drives to be used in a multi-drop network configuration. A serial converter module (SCM) provides connectivity to any controller with a DF1 port. The SCM can be eliminated if the controller acts as a RTU Master.



PC Programming Software

Through the use of a Serial Converter Module and DriveExplorer™ or DriveTools™ SP software, programming can be greatly simplified.



DriveExplorer Software

- View and modify drive and adapter parameters in a method similar to the file management capability of Microsoft Windows Explorer.
- Operate the drive via an on-screen Control Bar, which is a tool that allows you to start, stop, and change the speed reference of the drive.
- Save, restore and print parameter information.
- Compare current parameters with factory defaults or previously saved parameter values.
- Edit, upload and download parameters.

DriveTools SP Software

- Online and offline programming capability
- In-grid and dialog-based parameter editing
- Immediate visual indication of drive and communication status when viewing online drive
- Integrated HTML Help architecture

Use the chart below to assist in determining which product is most appropriate for an application.

Feature	PowerFlex® 4	PowerFlex® 40
Catalog Reference	22A…	22B…
Maximum (kW)HP Rating/Input Voltage	(1.1)1.5 HP/115V, 1ø	(1.1) 1.5 HP/115V, 1ø
	(2.2) 3 HP/230V, 1ø	(2.2) 3 HP/230V, 1ø
	(3.7) 5 HP/230V, 3ø	(7.5) 10 HP/230V, 3ø
	(3.7) 5 HP/460V, 3ø	(11.0) 15 HP/460V, 3ø
		(11.0) 15 HP/600V, 3ø
Overload Capacity	150% for 60 seconds 200% for 3 seconds	150% for 60 seconds 200% for 3 seconds
IP30, NEMA/UL Type 1 Option	●	●
IP66, NEMA/UL Type 4X/12 (Indoor)		● ❷
EMC Filtering	Internal - 1ø, 230V External - All 1ø, 115V and 3ø Ratings	Internal - 1ø, 230V External - All 1ø, 115V and 3ø Ratings
DIN Rail Mounting Standard	●	● (Through 5 HP)
Integral Keypad with Speed Pot	●	●
Keypad - Remote LCD	●	●
Keypad CopyCat Function	●	●
Control Type	V/Hz	Sensorless Vector & V/Hz
Internal DB Transistor	● Not available on no brake models.	●
Preset Speeds	4	8
Carrier Frequency	2-16 kHz	2-16 kHz
Skip Frequency		●
Process Control Loop		● (PID)
StepLogic Functionality		●
Timer/Counter Functions		●
Control Voltage	24V sink/source	24V sink/source
Discrete Inputs	3 fixed for START/STOP/REV	3 fixed for START/STOP/REV
	2 fully programmable	4 fully programmable
Analog Input - Unipolar	1 (0-10V or 4-20 mA)	2 (0-10V and 4-20 mA)
Analog Input - Bipolar		1 (+/- 10V) ❸
Analog Response	2 Hz (500 ms)	100 Hz (10 ms)
Relay Output	1 - N.O/N.C. dry contact	1 - N.O./N.C. dry contact
Digital/Optocoupler Output		2
Analog Output		● (0-10V or 4-20 mA)
Integral RS485	●	●
RS232 *(Requires use of Serial Converter Module)*	●	●
BACnet	● ❶	●
ControlNet	● ❶	●
DeviceNet	● ❶	●
EtherNet/IP	● ❶	●
LonWorks	● ❶	●
PROFIBUS DP	● ❶	●

❶ With 22-XCOMM-DC-BASE External mounting kit.

❷ Frame B only.

❸ When using bipolar input, the 0-10V unipolar input cannot be used.

Catalog Number Explanation

Position	1-3	4	5	6-8	9	10	11	12	13-14
	22A	–	A	1P5	N	1	1	4	AA
	a		b	c	d	e	f	g	h

a

Drive	
Code	Type
22A	PowerFlex 4
22B	PowerFlex 40

b

Voltage Rating		
Code	Voltage	Ph.
V	120V ac	1
A	240V ac	1
B	240V ac	3
D	480V ac	3
E	600V ac	3

c1

Rating		
100-120V Single-Phase Input		
Code	Amps	kW (Hp)
2P3	2.3	0.4 (0.5)
5P0	5.0	0.75 (1.0)
6P0	6.0	1.1 (1.5)

c2

Rating		
200-240V Single-Phase Input		
Code	Amps	kW (Hp)
2P3	2.3	0.4 (0.5)
5P0	5.0	0.75 (1.0)
8P0	8.0	1.5 (2.0)
012	12	2.2 (3.0)

c3

Rating		
200-240V Three-Phase Input		
Code	Amps	kW (Hp)
2P3	2.3	0.4 (0.5)
5P0	5.0	0.75 (1.0)
8P0	8.0	1.5 (2.0)
012	12	2.2 (3.0)
017	17.5	3.7 (5.0)
024	24	5.5 (7.5)
033	33	7.5 (10)

c4

Rating		
380-480V Three-Phase Input		
Code	Amps	kW (Hp)
1P4	1.4	0.4 (0.5)
2P3	2.3	0.75 (1.0)
4P0	4.0	1.5 (2.0)
6P0	6.0	2.2 (3.0)
010	10.5	4.0 (5.0)
012	12	5.5 (7.5)
017	17	7.5 (10)
024	24	11 (15)

c5

Rating		
460-600V Three-Phase Input		
Code	Amps	kW (Hp)
1P7	1.7	0.75 (1.0)
3P0	3.0	1.5 (2.0)
4P2	4.2	2.2 (3.0)
6P6	6.6	4.0 (5.0)
9P9	9.9	5.5 (7.5)
012	12	7.5 (10)
019	19	11 (15)

d

Enclosure	
Code	Enclosure
C	IP66, NEMA/UL Type 4X *
F	Flange Mount - IP20, NEMA/UL Type Open
H	Replacement Plate Drive - IP20, NEMA/UL Type Open Contact factory for ordering information.
N	Panel Mount - IP20, NEMA/UL Type Open

* Check availability before ordering.

e

HIM	
Code	Interface Module
1	Fixed Keypad

f

Emission Class	
Code	Rating
0	Not Filtered
1	Filtered

g

Brake IGBT	
Code	Description
3	Without Brake
4	With Brake

h

Optional	
Code	Purpose
AA through ZZ	Reserved for custom firmware

Product Selection

Drive Ratings			PowerFlex 4			IP 20 Flange Mount ❷	PowerFlex 40			IP 66, UL Type 4X Panel Mount	IP 20 Flange Mount ❷
Input Voltage	kW	HP	Output Current	Catalog Number	Frame Size	Catalog Number	Output Current	Catalog Number	Frame Size	Catalog Number	Catalog Number
120V 50/60 Hz 1-Phase No Filter	0.2	0.25	1.5A	22A-V1P5N104	A	22A-V1P5F104	—	—	—	—	—
	0.4	0.5	2.3A	22A-V2P3N104	A	22A-V2P3F104	2.3A	22B-V2P3N104	B	22B-V2P3C104	22B-V2P3F104
	0.75	1.0	4.5A	22A-V4P5N104	B	22A-V4P5F104	5.0A	22B-V5P0N104	B	22B-V5P0C104	22B-V5P0F104
	1.1	1.5	6.0A	22A-V6P0N104	B	22A-V6P0F104	6.0A	22B-V6P0N104	B	22B-V6P0C104	22B-V6P0F104
240V 50/60 Hz 1-Phase NO BRAKE No Filter	0.2	0.25	1.4A	22A-A1P4N103	A	—	—	—	—	—	—
	0.4	0.5	2.1A	22A-A2P1N103	A	—	—	—	—	—	—
	0.75	1.0	3.6A	22A-A3P6N103	A	—	—	—	—	—	—
	1.5	2.0	6.8A	22A-A6P8N103	B	—	—	—	—	—	—
	2.2	3.0	9.6	22A-A9P6N103	B	—	—	—	—	—	—
240V 50/60 Hz 1-Phase NO BRAKE With Integral "S Type" EMC Filter ❶	0.2	0.25	1.4A	22A-A1P4N113	A	—	—	—	—	—	—
	0.4	0.5	2.1A	22A-A2P1N113	A	—	—	—	—	—	—
	0.75	1.0	3.6A	22A-A3P6N113	A	—	—	—	—	—	—
	1.5	2.0	6.8A	22A-A6P8N113	B	—	—	—	—	—	—
	2.2	3.0	9.6	22A-A9P6N113	B	—	—	—	—	—	—
240V 50/60 Hz 1-Phase With Integral "S Type" EMC Filter ❶	0.2	0.25	1.5A	22A-A1P5N114	A	—	—	—	—	—	—
	0.4	0.5	2.3A	22A-A2P3N114	A	—	2.3A	22B-A2P3N114	B	—	—
	0.75	1.0	4.5A	22A-A4P5N114	A	—	5.0A	22B-A5P0N114	B	—	—
	1.5	2.0	8.0A	22A-A8P0N114	B	—	8.0A	22B-A8P0N114	B	—	—
	2.2	3.0	—	—	—	—	12.0A	22B-A012N114	C	—	—
240V 50/60 Hz 1-Phase No Filter	0.2	0.25	1.5A	22A-A1P5N104	A	22A-A1P5F104	—	—	—	—	—
	0.4	0.5	2.3A	22A-A2P3N104	A	22A-A2P3F104	2.3A	22B-A2P3N104	B	22B-A2P3C104	22B-A2P3F104
	0.75	1.0	4.5A	22A-A4P5N104	A	22A-A4P5F104	5.0A	22B-A5P0N104	B	22B-A5P0C104	22B-A5P0F104
	1.5	2.0	8.0A	22A-A8P0N104	B	22A-A8P0F104	8.0A	22B-A8P0N104	B	22B-A8P0C104	22B-A8P0F104
	2.2	3.0	—	—	—	—	12.0A	22B-A012N104	C	—	22B-A012F104
240V 50/60 Hz 3-Phase No Filter	0.2	0.25	1.5A	22A-B1P5N104	A	22A-B1P5F104	—	—	—	—	—
	0.4	0.5	2.3A	22A-B2P3N104	A	22A-B2P3F104	2.3A	22B-B2P3N104	B	22B-B2P3C104	22B-B2P3F104
	0.75	1.0	4.5A	22A-B4P5N104	A	22A-B4P5F104	5.0A	22B-B5P0N104	B	22B-B5P0C104	22B-B5P0F104
	1.5	2.0	8.0A	22A-B8P0N104	A	22A-B8P0F104	8.0A	22B-B8P0N104	B	22B-B8P0C104	22B-B8P0F104
	2.2	3.0	12.0A	22A-B012N104	B	22A-B012F104	12.0A	22B-B012N104	B	22B-B012C104	22B-B012F104
	3.7	5.0	17.5A	22A-B017N104	B	22A-B017F104	17.5A	22B-B017N104	B	22B-B017C104	22B-B017F104
	5.5	7.5	—	—	—	—	24.0A	22B-B024N104	C	—	22B-B024F104
	7.5	10.0	—	—	—	—	33.0A	22B-B033N104	C	—	22B-B033F104
480V 50/60 Hz 3-Phase No Filter	0.4	0.5	1.4A	22A-D1P4N104	A	22A-D1P4F104	1.4A	22B-D1P4N104	B	22B-D1P4C104	22B-D1P4F104
	0.75	1.0	2.3A	22A-D2P3N104	A	22A-D2P3F104	2.3A	22B-D2P3N104	B	22B-D2P3C104	22B-D2P3F104
	1.5	2.0	4.0A	22A-D4P0N104	A	22A-D4P0F104	4.0A	22B-D4P0N104	B	22B-D4P0C104	22B-D4P0F104
	2.2	3.0	6.0A	22A-D6P0N104	B	22A-D6P0F104	6.0A	22B-D6P0N104	B	22B-D6P0C104	22B-D6P0F104
	3.7	5.0	8.7A	22A-D8P7N104	B	22A-D8P7F104	—	—	—	—	—
	4.0	5.0	—	—	—	—	10.5A	22B-D010N104	B	22B-D010C104	22B-D010F104
	5.5	7.5	—	—	—	—	12.0A	22B-D012N104	C	—	22B-D012F104
	7.5	10.0	—	—	—	—	17.0A	22B-D017N104	C	—	22B-D017F104
	11.0	15.0	—	—	—	—	24.0A	22B-D024N104	C	—	22B-D024F104 ❸
600V 50/60 Hz 3-Phase No Filter	0.75	1.0	—	—	—	—	1.7A	22B-E1P7N104	B	22B-E1P7C104	22B-E1P7F104
	1.5	2.0	—	—	—	—	3.0A	22B-E3P0N104	B	22B-E3P0C104	22B-E3P0F104
	2.2	3.0	—	—	—	—	4.2A	22B-E4P2N104	B	22B-E4P2C104	22B-E4P2F104
	4.0	5.0	—	—	—	—	6.6A	22B-E6P6N104	B	22B-E6P6C104	22B-E6P6F104
	5.5	7.5	—	—	—	—	9.9A	22B-E9P9N104	C	—	22B-E9P9F104
	7.5	10.0	—	—	—	—	12.0A	22B-E012N104	C	—	22B-E012F104
	11.0	15.0	—	—	—	—	19.0A	22B-E019N104	C	—	22B-E019F104

❶ This filter is suitable for use with a cable length of at least 10 meters for Class A and 1 meter for Class B environments.

❷ Meets IP40/54/65 (NEMA 1/12/4/4X) when installed in an enclosure of like rating.

❸ Requires use of external DC Bus Inductor or AC Line Reactor.

Shaded areas are applicable to PowerFlex 40 only.

User Installed Options

IP30/NEMA 1/UL Type 1 Conversion Kit

Item	Description	Drive Frame	PowerFlex 4 Catalog Number ❶	PowerFlex 40 Catalog Number ❶
IP30/NEMA 1/UL Type 1 Kit	Field installed kit. Converts drive to IP30/NEMA 1/UL Type 1 enclosure. Includes conduit box with mounting screws and plastic top panel.	A	22-JBAA	–
		B	22-JBAB	22-JBAB
		C	–	22-JBAC
IP30/NEMA 1/UL Type 1 Kit with Communication Option	Field installed kit. Converts drive to IP30/NEMA 1/UL Type 1 enclosure. Includes communication option conduit box with mounting screws and plastic top panel.	B	–	22-JBCB
		C	–	22-JBCC

Human Interface Module Option Kits and Accessories

Item	Description	Catalog Number ❶
Remote Human Interface Modules (HIMs)	LCD Display, Remote Panel Mount, Digital Speed Control, CopyCat capable, IP66 (NEMA Type 4X/12) indoor use only. Includes 2.0 meter cable.	22-HIM-C2S
	LCD Display, Remote Handheld, Digital Speed Control, Full Numeric Keypad, CopyCat capable, IP30 (NEMA Type 1). Includes 1.0 meter cable. Can be panel mounted with optional Bezel Kit.	22-HIM-A3
	Remote Handheld, Wireless Interface Module with *Bluetooth®* technology, IP30 (NEMA Type 1). Panel Mount with optional Bezel Kit.	22-WIM-N1
	Remote Panel Mount, Wireless Interface Module with *Bluetooth®* technology, IP66 (NEMA Type 4X/12) indoor use only.	22-WIM-N4S
Bezel Kit	Panel Mount for LCD Display, Remote Handheld unit, IP30 (NEMA Type 1). Includes a 22-RJ45CBL-C20 cable.	22-HIM-B1
DSI HIM Cable	DSI HIM Cable (DSI HIM to RJ45 cable) 1.0 Meter (3.3 Feet) 2.9 Meter (9.51 Feet)	 22-HIM-H10 22-HIM-H30

Communication Option Kits

Item	Description	Catalog Number ❶
Serial Converter Module (RS485 to RS232)	Provides serial communication via DF1 protocol for use with DriveExplorer™ and DriveExecutive™ software. Smart Self-powered Serial Converter (RS-232) includes: DSI to RS232 serial converter DriveExplorer Lite Version 3.01 or later 1203-SFC and 22-RJ45CBL-C20 Cables	22-SCM-232
Serial Cable	2.0 meter serial cable with a locking low profile connector to connect to the serial converter and a 9-pin sub-miniature D female connector to connect to a computer.	1203-SFC
Null Cable Converter	For use when connecting the serial converter to DriveExplorer on a handheld PC.	1203-SNM
Universal Serial Bus™ (USB) Converter	Provides a direct, isolated USB connection for use with DriveExplorer and DriveExecutive software. Includes 2.0 meter USB cable, 20-HIM-H10 and 22-HIM-H10 cables.	1203-USB
DSI Cable	2.0 meter RJ45 to RJ45 cable, male to male connectors.	22-RJ45CBL-C20
Splitter Cable	RJ45 one to two port splitter cable.	AK-U0-RJ45-SC1
Terminating Resistors	RJ45 120 Ohm resistor (2 pieces).	AK-U0-RJ45-TR1
Terminal Block	RJ45 Two position terminal block (6 pieces).	AK-U0-RJ45-TB2P
External DSI Communications Kit	External communications kit for 22-COMM Communication Adapters. Multi-Drive capability allows connectivity for up to 5 drives.	22-XCOMM-DC-BASE
External Comms Power Supply	Optional 100-240V AC power supply for external DSI communications kit.	20-XCOMM-AC-PS1
Communication Adapters	Embedded communication option for use with the PowerFlex family of drives. Requires a Communication Adapter Cover (Ordered Separately). BACnet ControlNet DeviceNet EtherNet/IP LonWorks PROFIBUS DP	 22-COMM-B 22-COMM-C 22-COMM-D 22-COMM-E 22-COMM-L 22-COMM-P
Compact I/O Module	Provides 3 channels that can be individually configured for Single, Multi-Drive, and Modbus RTU modes.	1769-SM2
Communication Adapter Covers	Houses the optional communication adapters. These covers add 25 mm (0.98 in.) to the overall depth of the drive. PowerFlex 40 Drive Frame B PowerFlex 40 Drive Frame C	 22B-CCB 22B-CCC

❶ For pricing information, refer to the PowerFlex 4 Price List, publication 22A-PL001 and PowerFlex 40 Price List, publication 22B-PL001.

Shaded areas are applicable to PowerFlex 40 only.

PC Programming Software

Item	Description	Catalog Number
DriveTools SP Software	"Windows" based software package that provides an intuitive means for monitoring or configuring Allen-Bradley drives and communications adapters online and offline. Compatibility: Windows 98, ME, NT, 4.0 (Service Pack 3 or later), 2000 and XP. ❶	9303-4DTE01ENE
DriveExplorer™ Software	"Windows" based software package that provides an intuitive means for monitoring or configuring Allen-Bradley drives and communications adapters online and offline. Compatibility: Windows 98, ME, NT, 4.0 (Service Pack 3 or later), 2000 and XP. ❶	9306-4EXP01ENE

❶ See www.ab.com/drive/ for support devices.

DC Bus Inductors

Input Voltage	kW	HP	Amps	Inductance mh	MTE Catalog Number
240V 50/60 Hz 3-Phase	5.5	7.5	32	0.85	32RB001
	7.5	10.0	40	0.5	40RB001
480V 50/60 Hz 3-Phase	5.5	7.5	18	3.75	18RB004
	7.5	10.0	25	4.0	25RB005
	11.0	15.0	32	2.68	32RB003
600V 50/60 Hz 3-Phase	5.5	7.5	12	6.0	12RB004
	7.5	10.0	18	6.0	18RB005
	11.0	15.0	25	4.0	25RB005

Dynamic Brake Resistors

Drive Ratings			PowerFlex 4	PowerFlex 40
Input Voltage	kW	HP	Catalog Number ❶	Catalog Number ❶
120V 50/60 Hz 1-Phase	0.2	0.25	AK-R2-091P500	–
	0.4	0.5	AK-R2-091P500	
	0.75	1.0	AK-R2-091P500	
	1.1	1.5	AK-R2-091P500	
240V 50/60 Hz 1-Phase	0.2	0.25	AK-R2-091P500	–
	0.4	0.5	AK-R2-091P500	
	0.75	1.0	AK-R2-091P500	
	1.5	2.0	AK-R2-091P500	
	2.2	3.0	–	AK-R2-047P500
240V 50/60 Hz 3-Phase	0.2	0.25	AK-R2-091P500	–
	0.4	0.5	AK-R2-091P500	
	0.75	1.0	AK-R2-091P500	
	1.5	2.0	AK-R2-091P500	
	2.2	3.0	AK-R2-047P500	
	3.7	5.0	AK-R2-047P500	
	5.5	7.5	–	AK-R2-030P1K2
	7.5	10.0	–	AK-R2-030P1K2
480V 50/60 Hz 3-Phase	0.4	0.5	AK-R2-360P500	
	0.75	1.0	AK-R2-360P500	
	1.5	2.0	AK-R2-360P500	
	2.2	3.0	AK-R2-120P1K2	
	4.0	5.0	AK-R2-120P1K2	
	5.5	7.5	–	AK-R2-120P1K2
	7.5	10.0	–	AK-R2-120P1K2
	11.0	15.0	–	AK-R2-120P1K2❷
600V 50/60 Hz 3-Phase No Filter	0.75	1.0	–	AK-R2-360P500
	1.5	2.0	–	AK-R2-360P500
	2.2	3.0	–	AK-R2-120P1K2
	4.0	5.0	–	AK-R2-120P1K2
	5.5	7.5	–	AK-R2-120P1K2
	7.5	10.0	–	AK-R2-120P1K2
	11.0	15.0	–	AK-R2-120P1K2❷

❶ Resistors listed in this table are rated for a minimum 5% duty cycle. See publication no. PFLEX-AT001x-EN-P for additional information.

❷ Requires two resistors wired in parallel.

3% Line Reactors

Input Voltage	kW	HP	Fundamental Amps	Max Continuous Amps	Inductance mh	Watts Loss	Catalog Number ❶
240V 50/60 Hz 3-Phase	0.2	0.25	2	3	12.0	7.5 W	1321-3R2-A
	0.4	0.5	4	6	12.0	21 W	1321-3R4-D
	0.75	1.0	8	12	3.0	29 W	1321-3R8-B
	1.5	2.0	8	12	1.5	19.5 W	1321-3R8-A
	2.2	3.0	12	18	1.25	26 W	1321-3R12-A
	3.7	5.0	18	27	0.8	36 W	1321-3R18-A
	5.5	7.5	25	37.5	0.5	48 W	1321-3R25-A
	7.5	10.0	35	52.5	0.4	49 W	1321-3R35-A
480V 50/60 Hz 3-Phase	0.4	0.5	2	3	20.0	11.3 W	1321-3R2-B
	0.75	1.0	4	6	9.0	20 W	1321-3R4-C
	1.5	2.0	4	6	6.5	20 W	1321-3R4-B
	2.2	3.0	8	12	5.0	25.3 W	1321-3R8-C
	3.7	5.0	8	12	3.0	29 W	1321-3R8-B
	4.0	5.0	12	18	2.5	31 W	1321-3R12-B
	5.5	7.5	12	18	2.5	31 W	1321-3R12-B
	7.5	10.0	18	27	1.5	43 W	1321-3R18-B
	11.0	15.0	25	37.5	1.2	52 W	1321-3R25-B
600V 50/60 Hz 3-Phase No Filter	0.75	1.0	2	3	20.0	11.3 W	1321-3R2-B
	1.5	2.0	4	6	6.5	20 W	1321-3R4-B
	2.2	3.0	4	6	6.5	20 W	1321-3R4-B
	4.0	5.0	8	12	5.0	25.3 W	1321-3R8-C
	5.5	7.5	12	18	2.5	31 W	1321-3R12-B
	7.5	10.0	12	18	2.5	31 W	1321-3R12-B
	11.0	15.0	18	27	1.5	43 W	1321-3R18-B

❶ Catalog numbers listed are for 3% impedance open style units. NEMA Type 1 and 5% impedance reactor types are also available. Refer to publication 1321-TD001x-EN-P.

Shaded areas are applicable to PowerFlex 40 only.

PowerFlex 4 EMC Filters

Drive Ratings			S Type Filter Catalog Number ❶	L Type Filter Catalog Number ❷
Input Voltage	kW	HP		
120V 50/60 Hz 1-Phase	0.2	0.25	–	22-RF010-AL
	0.4	0.5	–	22-RF010-AL
	0.75	1.0	–	22-RF018-BL
240V 50/60 Hz 1-Phase	0.2	0.25	❸	22-RF010-AL
	0.4	0.5	❸	22-RF010-AL
	0.75	1.0	❸	22-RF010-AL
	1.5	2.0	❸	22-RF018-BL
240V 50/60 Hz 3-Phase	0.2	0.25	22-RF9P5-AS	22-RF9P5-AL
	0.4	0.5	22-RF9P5-AS	22-RF9P5-AL
	0.75	1.0	22-RF9P5-AS	22-RF9P5-AL
	1.5	2.0	22-RF9P5-AS	22-RF9P5-AL
	2.2	3.0	22-RF021-BS	22-RF021-BL
	3.7	5.0	22-RF021-BS	22-RF021-BL
480V 50/60 Hz 3-Phase	0.4	0.5	22-RF5P7-AS	22-RF5P7-AL
	0.75	1.0	22-RF5P7-AS	22-RF5P7-AL
	1.5	2.0	22-RF5P7-AS	22-RF5P7-AL
	2.2	3.0	22-RF012-BS	22-RF012-BL
	4.0	5.0	22-RF012-BS	22-RF012-BL

PowerFlex 40 EMC Filters

Drive Ratings			S Type Filter Catalog Number ❶	L Type Filter Catalog Number ❷
Input Voltage	kW	HP		
120V 50/60 Hz 1-Phase	0.4	0.5	–	22-RF018-BL
	0.75	1.0	–	22-RF018-BL
	1.1	1.5	–	22-RF018-BL
240V 50/60 Hz 1-Phase	0.4	0.5	❸	22-RF018-BL
	0.75	1.0	❸	22-RF018-BL
	1.5	2.0	❸	22-RF018-BL
	2.2	3.0	❸	22-RF025-CL
240V 50/60 Hz 3-Phase	0.4	0.5	22-RF021-BS ❹	22-RF021-BL
	0.75	1.0	22-RF021-BS ❹	22-RF021-BL
	1.5	2.0	22-RF021-BS ❹	22-RF021-BL
	2.2	3.0	22-RF021-BS ❹	22-RF021-BL
	3.7	5.0	22-RF021-BS ❹	22-RF021-BL
	5.5	7.5	22-RF034-CS	22-RF034-CL
	7.5	10.0	22-RF034-CS	22-RF034-CL
480V 50/60 Hz 3-Phase	0.4	0.5	22-RF012-BS	22-RF012-BL
	0.75	1.0	22-RF012-BS	22-RF012-BL
	1.5	2.0	22-RF012-BS	22-RF012-BL
	2.2	3.0	22-RF012-BS	22-RF012-BL
	4.0	5.0	22-RF012-BS	22-RF012-BL
	5.5	7.5	22-RF018-CS	22-RF018-CL
	7.5	10.0	22-RF018-CS	22-RF018-CL
	11.0	15.0	22-RF026-CS	22-RF026-CL
600V 50/60 Hz 3-Phase	0.75	1.0	–	22-RF8P0-BL
	1.5	2.0	–	22-RF8P0-BL
	2.2	3.0	–	22-RF8P0-BL
	4.0	5.0	–	22-RF8P0-BL
	5.5	7.5	–	22-RF015-CL
	7.5	10.0	–	22-RF015-CL
	11.0	15.0	–	22-RF024-CL

❶ This filter is suitable for use with a cable length up to 10 meters for Class A and 1 meter for Class B environments.

❷ This filter is suitable for use with a cable length up to 100 meters for Class A and 5 meters for Class B environments.

❸ Drives are available in these ratings with internal “S Type” filters.

❹ Filter must be Series B or later.

PowerFlex 4 & 40 Spare Parts

Description	Catalog Number
PowerFlex 4 Fan Replacement Kit - Frame A	SK-U1-FAN1-A1
PowerFlex 4/40 Fan Replacement Kit - Frame B, 1 Fan	SK-U1-FAN1-B1
PowerFlex 4/40 Fan Replacement Kit - Frame B, 2 Fans	SK-U1-FAN2-B1
PowerFlex 40 Fan Replacement Kit - Frame C, 1 Fan	SK-U1-FAN1-C1
PowerFlex 40 Fan Replacement Kit - Frame C, 1 Fan (15 HP)	SK-U1-FAN1-C2
PowerFlex 4 Frame A Cover with Power Terminal Guard	SK-U1-ACVR1-A1
PowerFlex 4 Frame B Cover with Power Terminal Guard	SK-U1-ACVR1-B1
PowerFlex 40 Frame B Cover with Power Terminal Guard	SK-U1-BCVR1-B1
PowerFlex 40 Frame C Cover with Power Terminal Guard	SK-U1-BCVR1-C1

Shaded areas are applicable to PowerFlex 40 only.

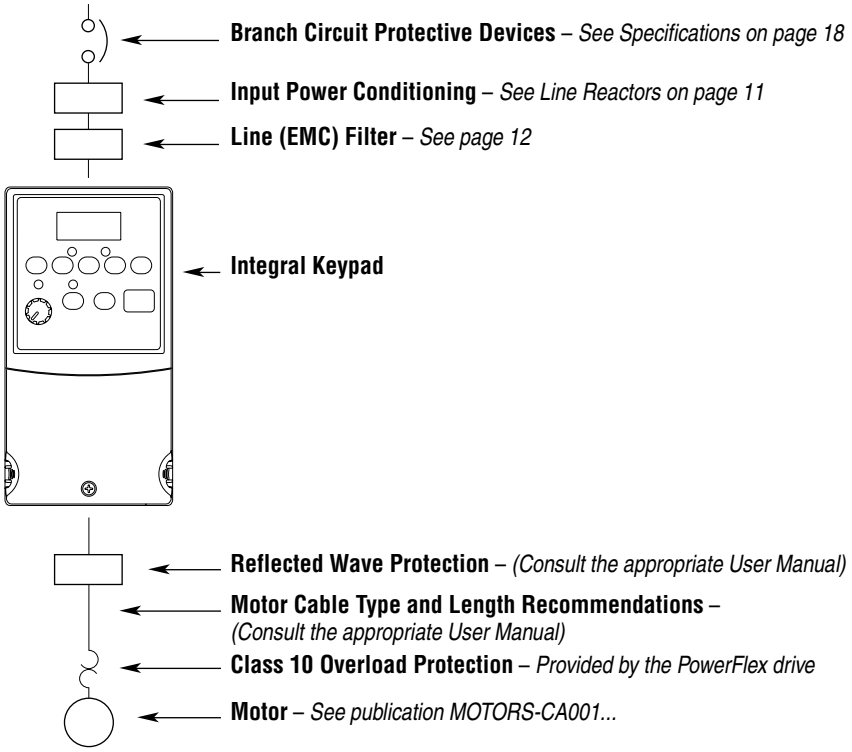
Installation Considerations

PowerFlex 4 and 40 drives have the following built in protective features to help simplify installation.

- Ground fault protection while starting and running ensures reliable operation
- Electronic motor overload protection increases motor life
- Removable MOV to ground ensures compatibility with ungrounded systems
- 6kV transient protection provides increased robustness for 380-480V system voltages

There are many other factors that must be considered for optimal performance in any given application. The block diagram below highlights the primary installation considerations. Consult the PowerFlex 4 or PowerFlex 40 User Manual, Publications 22A-UM001… or 22B-UM001… available online at **www.ab.com/manuals/dr**, for detailed recommendations on input power conditioning, CE conformance (EMC filtering), dynamic braking, reflected wave protection, motor cable types and motor cable distances.

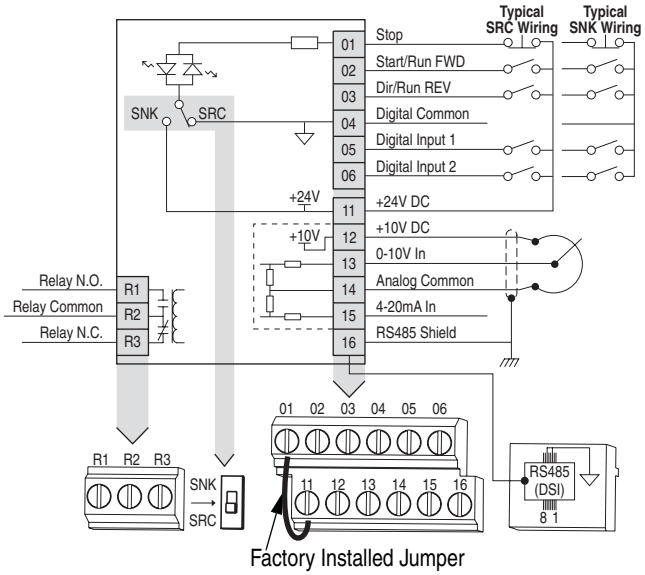
Block Diagram



Control Wiring

PowerFlex 4

- The control logic is 24V DC and can be set for either Sink or Source control via a DIP switch setting.
- Control terminal screws are sized for a conventional blade screw driver.
- I/O Terminals 1, 2 and 3 are dedicated for Stop, Start and Reverse operation respectively. These I/O Terminals can be programmed for 2- or 3-Wire operation to meet application requirements.
- I/O Terminals 4 and 5 are programmable and provide added flexibility. Programmable functions include:
  - Local Control
  - Preset Frequencies
  - Jog
  - RS485 Control
  - Second Accel/Decel
  - Auxiliary Fault
  - Clear Fault
- Speed can be controlled via a 0-10V input or 4-20 mA input. Both are electrically isolated from the drive.
- One form C relay can be programmed to provide the status of a wide variety of drive conditions.
- The drive is shipped with a jumper installed between I/O Terminals 01 and 11 to allow out of box operation from the keypad.



No.	Signal	Default	Description
R1	Relay N.O.	Fault	Normally open contact for output relay.
R2	Relay Common	–	Common for output relay.
R3	Relay N.C.	Fault	Normally closed contact for output relay.

	30V DC	125V AC	240V AC
Resistive	3.0 A	3.0 A	3.0 A
Inductive	0.5 A	0.5 A	0.5 A

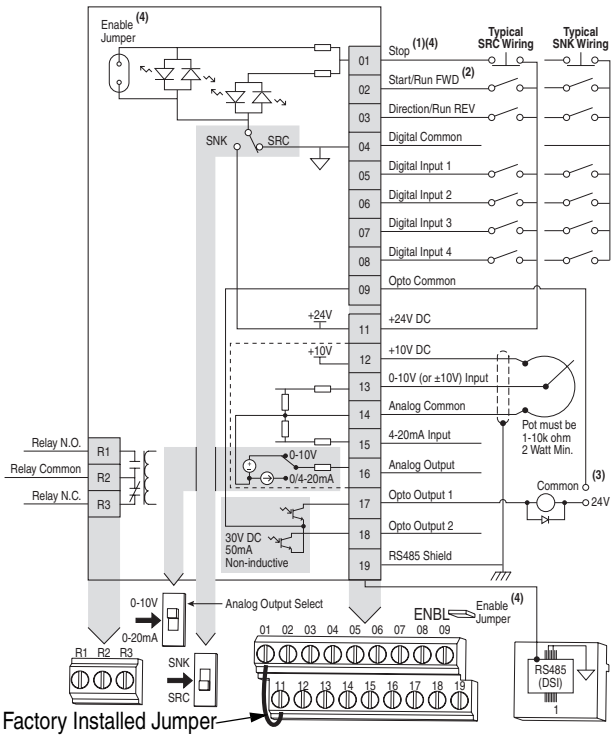
Sink/Source DIP Switch		Source (SRC)	Inputs can be wired as Sink (SNK) or Source (SRC) via DIP Switch setting.

01	Stop(1)	Coast	The factory installed jumper or a normally closed input must be present for the drive to start.
02	Start/Run FWD	Not Active	Command comes from the integral keypad by default. To disable reverse operation, see A095 [Reverse Disable].
03	Direction/Run REV	Not Active	
04	Digital Common	–	For digital inputs. Electronically isolated with digital inputs from analog I/O.
05	Digital Input 1	Preset Freq	Program with A051 [Digital In1 Sel].
06	Digital Input 2	Preset Freq	Program with A052 [Digital In2 Sel].
11	+24V DC	–	Drive supplied power for digital inputs. Maximum output current is 100mA.
12	+10V DC	–	Drive supplied power for 0-10V external potentiometer. Maximum output current is 15mA.
13	0-10V In(1)	Not Active	For external 0-10V input supply (input impedance = 100k ohm) or potentiometer wiper.
14	Analog Common	–	For 0-10V In or 4-20mA In. Electronically isolated with analog inputs from digital I/O.
15	4-20mA In (1)	Not Active	For external 4-20mA input supply (input impedance = 250 ohm).
16	RS485 (DSI) Shield	–	Terminal should be connected to safety ground - PE when using the RS485 (DSI) communications port.

(1) Only one analog frequency source may be connected at a time. If more than one reference is connected at the same time, an undetermined frequency reference will result.

PowerFlex 40

- The control logic is 24V DC and can be set for either Sink or Source control via a DIP switch setting.
- Control terminal screws are sized for a conventional blade screw driver.
- I/O Terminals 1, 2 and 3 are dedicated for Stop, Start and Reverse operation respectively. These I/O Terminals can be programmed for 2- or 3-Wire operation to meet application requirements.
- I/O Terminals 5, 6, 7 and 8 are programmable and provide added flexibility. Programmable functions include Local Control, Jog, Second Accel/Decel, Clear Fault, Preset Frequencies, RS485 Control and Auxiliary Fault.
- Speed can be controlled via a 0-10V input and/or 4-20 mA input. Both inputs are independently isolated from the rest of the drive and can be used for applications such as PID. Voltage input can be programmed for bipolar operation.
- The drive is shipped with a jumper installed between I/O Terminals 01 and 11 to allow out of box operation from the keypad.



No.	Signal	Default	Description
R1	Relay N.O.	Fault	Normally open contact for output relay.
R2	Relay Common	–	Common for output relay.
R3	Relay N.C.	Fault	Normally closed contact for output relay.

Analog Output Select DIP Switch	0-10V	Sets analog output to either voltage or current. Setting must match A065 [Analog Out Sel].
Sink/Source DIP Switch	Source (SRC)	Inputs can be wired as Sink (SNK) or Source (SRC) via DIP Switch setting.

01	Stop	Coast	The factory installed jumper or a normally closed input must be present for the drive to start.
02	Start/Run FWD	Not Active	Command comes from the integral keypad by default. To disable reverse operation, see A095 [Reverse Disable].
03	Direction/Run REV	Not Active	
04	Digital Common	–	For digital inputs. Electronically isolated with digital inputs from analog I/O and opto outputs.
05	Digital Input 1	Preset Freq	Program with A051 [Digital In1 Sel].
06	Digital Input 2	Preset Freq	Program with A052 [Digital In2 Sel].
07	Digital Input 3	Local	Program with A053 [Digital In3 Sel].
08	Digital Input 4	Jog Forward	Program with A054 [Digital In4 Sel].
09	Opto Common	–	For opto-coupled outputs. Electronically isolated with opto outputs from analog I/O and digital inputs.
11	+24V DC	–	Referenced to Digital Common. Drive supplied power for digital inputs. Maximum output current is 100mA.
12	+10V DC	–	Referenced to Analog Common. Drive supplied power for 0-10V external potentiometer. Maximum output current is 15mA.
13	±10V In (1)	Not Active	For external 0-10V (unipolar) or ±10V (bipolar) input supply (input impedance = 100k ohm) or potentiometer wiper.
14	Analog Common	–	For 0-10V In or 4-20mA In. Electronically isolated with analog inputs and outputs from digital I/O and opto outputs.
15	4-20mA In (1)	Not Active	For external 4-20mA input supply (input impedance = 250 ohm).
16	Analog Output	OutFreq 0-10	The default analog output is 0-10V. To covert to a current value, change the Analog Output Select DIP Switch to 0-20mA. Program with A065 [Analog Out Sel]. Max analog value can be scaled with A066 [Analog Out High]. Maximum Load:4-20mA = 525 ohm (10.5V) 0-10V = 1k ohm (10mA)
17	Opto Output 1	MotorRunning	Program with A058 [Opto Out1 Sel]
18	Opto Output 2	At Frequency	Program with A061 [Opto Out2 Sel]
19	RS485 (DSI) Shield	–	Terminal should be connected to safety ground - PE when using the RS485 (DSI) communications port.

(1) 0-10V In and 4-20mA In are distinct input channels and may be connected simultaneously Inputs may be used independently for speed control or jointly when operating in PID mode.

Specifications

Drive Ratings — PowerFlex 4										
	Output Ratings		Input Ratings			Branch Circuit Protection			Power Dissipation	
Catalog Number	kW (HP)	Amps	Voltage Range	kVA	Amps	Fuses ❶	140M Motor Protectors ❷	Contactors	Internal	Total
100 - 120V AC – 1-Phase Input, 0 - 230V 3-Phase Output										
22A-V1P5N104	0.2 (0.25)	1.5	90-126	0.75	6.0	10	140M-C2E-C10	100-C09	10	25
22A-V2P3N104	0.4 (0.5)	2.3	90-126	1.15	9.0	15	140M-C2E-C16	100-C12	9	30
22A-V4P5N104	0.75 (1.0)	4.5	90-126	2.25	18.0	30	140M-D8E-C20	100-C23	12	50
22A-V6P0N104	1.1 (1.5)	6.0	90-126	3.00	24.0	40	140M-D8E-C32	100-C37	12	70
200 - 240V AC – 1-Phase Input, 0 - 230V 3-Phase Output (No Brake) ❸										
22A-A1P4N103	0.2 (0.25)	1.4	180-265	0.7	3.2	6	140M-C2E-B40	100-C09	10	25
22A-A2P1N103	0.4 (0.5)	2.1	180-265	1.05	5.3	10	140M-C2E-B63	100-C09	9	30
22A-A3P6N103	0.75 (1.0)	3.6	180-265	1.8	9.2	15	140M-C2E-C16	100-C12	12	50
22A-A6P8N103	1.5 (2.0)	6.8	180-265	3.4	14.2	25	140M-C2E-C16	100-C16	16	80
22A-A9P6N103	2.2 (3.0)	9.6	180-265	4.8	19.6	30	140M-D8E-C25	100-C23	11	110
200 - 240V AC – 1-Phase Input, 0 - 230V 3-Phase Output ❸										
22A-A1P5N104	0.2 (0.25)	1.5	180-265	0.75	5.0	10	140M-C2E-B63	100-C09	10	25
22A-A2P3N104	0.4 (0.5)	2.3	180-265	1.15	6.0	10	140M-C2E-B63	100-C09	9	30
22A-A4P5N104	0.75 (1.0)	4.5	180-265	2.25	10.0	15	140M-C2E-C16	100-C12	12	50
22A-A8P0N104	1.5 (2.0)	8.0	180-265	4.0	18.0	30	140M-D8E-C20	100-C23	16	80
200 - 240V AC – 3-Phase Input, 0 - 230V 3-Phase Output										
22A-B1P5N104	0.2 (0.25)	1.5	180-265	0.75	1.8	3	140M-C2E-B25	100-C09	10	25
22A-B2P3N104	0.4 (0.5)	2.3	180-265	1.15	2.5	6	140M-C2E-B40	100-C09	9	30
22A-B4P5N104	0.75 (1.0)	4.5	180-265	2.25	5.2	10	140M-C2E-C10	100-C09	12	50
22A-B8P0N104	1.5 (2.0)	8.0	180-265	4.0	9.5	15	140M-C2E-C16	100-C12	16	80
22A-B012N104	2.2 (3.0)	12.0	180-265	5.5	15.5	25	140M-C2E-C16	100-C16	16	115
22A-B017N104	3.7 (5.0)	17.5	180-265	8.6	21.0	35	140M-F8E-C25	100-C23	16	165
380 - 480V AC – 3-Phase Input, 0 - 460V 3-Phase Output										
22A-D1P4N104	0.4 (0.5)	1.4	340-528	1.4	1.8	3	140M-C2E-B25	100-C09	15	30
22A-D2P3N104	0.75 (1.0)	2.3	340-528	2.3	3.2	6	140M-C2E-B40	100-C09	13	40
22A-D4P0N104	1.5 (2.0)	4.0	340-528	4.0	5.7	10	140M-C2E-B63	100-C09	13	60
22A-D6P0N104	2.2 (3.0)	6.0	340-528	5.9	7.5	15	140M-C2E-C10	100-C09	17	90
22A-D8P7N104	3.7 (5.0)	8.7	340-528	8.6	9.0	15	140M-C2E-C16	100-C16	14	145

❶ Recommended Fuse Type: UL Class J, CC, T or Type BS88; 600V (550V) or equivalent.

❷ Refer to Bulletin 140M Motor Protectors Selection Guide, publication 140-SG001... to determine the frame and breaking capacity required for your application.

❸ 200-240V AC - 1-Phase drives are also available with an integral EMC filter. Catalog suffix changes from N104 to N114 or N103 to N113.

Drive Ratings — PowerFlex 40										
	Output Ratings		Input Ratings			Branch Circuit Protection			Power Dissipation	
Catalog Number	kW (HP)	Amps	Voltage Range	kVA	Amps	Fuses ❶	140M Motor Protectors ❷	Contactors	Internal	Total
100 - 120V AC – 1-Phase Input, 0 - 230V 3-Phase Output										
22B-V2P3N104	0.4 (0.5)	2.3	90-132	1.15	9.0	15	140M-C2E-C16	100-C12	9	30
22B-V5P0N104	0.75 (1.0)	5.0	90-132	2.45	20.3	35	140M-D8E-C20	100-C23	12	55
22B-V6P0N104	1.1 (1.5)	6.0	90-132	3.0	24.0	40	140M-F8E-C32	100-C37	12	70
200 - 240V AC – 1-Phase Input, 0 - 230V 3-Phase Output ❸										
22B-A2P3N104	0.4 (0.5)	2.3	180-264	1.15	6.0	10	140M-C2E-B63	100-C09	9	30
22B-A5P0N104	0.75 (1.0)	5.0	180-264	2.45	12.0	20	140M-C2E-C16	100-C12	12	55
22B-A8P0N104	1.5 (2.0)	8.0	180-264	4.0	18.0	30	140M-D8E-C20	100-C23	16	80
22B-A012N104	2.2 (3.0)	12.0	180-264	5.5	25.0	40	140M-F8E-C32	100-C37	11	110
200 - 240V AC – 3-Phase Input, 0 - 230V 3-Phase Output										
22B-B2P3N104	0.4 (0.5)	2.3	180-264	1.15	2.5	6	140M-C2E-B40	100-C07	9	30
22B-B5P0N104	0.75 (1.0)	5.0	180-264	2.45	5.7	10	140M-C2E-C10	100-C09	12	55
22B-B8P0N104	1.5 (2.0)	8.0	180-264	4.0	9.5	15	140M-C2E-C16	100-C12	16	80
22B-B012N104	2.2 (3.0)	12.0	180-264	5.5	15.5	25	140M-C2E-C16	100-C23	16	115
22B-B017N104	3.7 (5.0)	17.5	180-264	8.6	21.0	35	140M-F8E-C25	100-C23	16	165
22B-B024N104	5.5 (7.5)	24.0	180-264	11.8	26.1	40	140M-F8E-C32	100-C37	28	225
22B-B033N104	7.5 (10.0)	33.0	180-264	16.3	34.6	60	140M-F8E-C45	100-C60	28	290
380 - 480V AC – 3-Phase Input, 0 - 460V 3-Phase Output										
22B-D1P4N104	0.4 (0.5)	1.4	342-528	1.4	1.8	3	140M-C2E-B25	100-C07	15	30
22B-D2P3N104	0.75 (1.0)	2.3	342-528	2.3	3.2	6	140M-C2E-B40	100-C07	13	40
22B-D4P0N104	1.5 (2.0)	4.0	342-528	4.0	5.7	10	140M-C2E-B63	100-C09	13	60
22B-D6P0N104	2.2 (3.0)	6.0	342-528	5.9	7.5	15	140M-C2E-C10	100-C09	17	90
22B-D010N104	4.0 (5.0)	10.5	342-528	10.3	13.0	20	140M-C2E-C16	100-C23	14	150
22B-D012N104	5.5 (7.5)	12.0	342-528	11.8	14.2	25	140M-D8E-C20	100-C23	23	160
22B-D017N104	7.5 (10.0)	17.0	342-528	16.8	18.4	30	140M-D8E-C20	100-C23	24	200
22B-D024N104	11.0 (15.0)	24.0	342-528	23.4	26.0	50	140M-F8E-C32	100-C43	25	285
460 - 600V AC – 3-Phase Input, 0 - 575V 3-Phase Output										
22B-E1P7N104	0.75 (1.0)	1.7	414-660	2.1	2.3	6	140M-C2E-B25	100-C09	13	40
22B-E3P0N104	1.5 (2.0)	3.0	414-660	3.65	3.8	6	140M-C2E-B40	100-C09	13	60
22B-E4P2N104	2.2 (3.0)	4.2	414-660	5.2	5.3	10	140M-C2E-B63	100-C09	17	90
22B-E6P6N104	4.0 (5.0)	6.6	414-660	8.1	8.3	15	140M-C2E-C10	100-C09	14	150
22B-E9P9N104	5.5 (7.5)	9.9	414-660	12.1	11.2	20	140M-C2E-C16	100-C16	23	160
22B-E012N104	7.5 (10.0)	12.2	414-660	14.9	13.7	25	140M-C2E-C16	100-C23	24	200
22B-E019N104	11.0 (15.0)	19.0	414-660	23.1	24.1	40	140M-D8E-C25	100-C30	25	285

❶ Recommended Fuse Type: UL Class J, CC, T or Type BS88; 600V (550V) or equivalent.

❷ Refer to Bulletin 140M Motor Protectors Selection Guide, publication 140-SG001... to determine the frame and breaking capacity required for your application.

❸ 200-240V AC - 1-Phase drives are also available with an integral EMC filter. Catalog suffix changes from N104 to N114 or N103 to N113.

Input/Output Ratings	Output Frequency:	PowerFlex 4: 0-240 Hz (Programmable) PowerFlex 40: 0-400 Hz (Programmable)
	Efficiency:	97.5% (Typical)
Approvals	UL508C c UL CSA C 22.2 No. 14 EN 61800-3 CE	LV Directive 73/23/EEC LV: EN 50178, EN 60204 EMC Directive 89/336/EEC EMC: EN 61800-3
Control Inputs	Digital SRC (Source) Mode: SNK (Sink) Mode: Analog 4-20 mA Analog: 0-10V DC Analog: External Pot:	Input Current = 6 mA 18-24V = On, 0-6V = Off 0-6V = On, 18-24V = Off 250 ohm input impedance 100k ohm input impedance 1-10k ohms, 2 Watt minimum
Control Output – Programmable Output (form C relay)	Resistive Rating Opto Outputs (PF 40): Analog Outputs (PF 40): Inductive Rating Opto Outputs (PF 40): Analog Outputs (PF 40):	3.0A at 30V DC, 3.0A at 125V AC, 3.0A at 240V AC 30V DC, 50 mA 10-bit, 0-10V, 1k ohm minimum 0.5A at 30V DC, 0.5A at 125V AC, 0.5A at 240V AC Non-inductive 10 bit, 4-20 mA, 525 ohm maximum
Fuses and Circuit Breakers	Recommended Fuse Type: Recommended Circuit Breakers:	UL Class J, CC, T or Type BS88; 600V (550V) or equivalent. HMCP circuit breaker or equivalent.
Protective Features	Motor Protection: Overcurrent: Control Ride Through: Faultless Power Ride Through: Over Voltage: Under Voltage:	I^2t Overload Protection, 150% for 60 sec., 200% for 3 sec. (provides Class 10 protection) 200% hardware limit, 300% instantaneous fault Minimum Ride Through is 0.5 sec. - typical value is 2 seconds 100 milliseconds 100-120V AC Input – Trip occurs at 405V DC bus voltage (= 150V AC incoming line) 200-240V AC Input – Trip occurs at 405V DC bus voltage (= 290V AC incoming line) 380-480V AC Input – Trip occurs at 810V DC bus voltage (= 575V AC incoming line) 460-600V AC Input (PF 40) – Trip occurs at 1005V DC bus voltage (= 711V AC incoming line) 100-120V AC Input – Trip occurs at 210V DC bus voltage (= 75V AC incoming line) 200-240V AC Input – Trip occurs at 210V DC bus voltage (= 150V AC incoming line) 380-480V AC Input – Trip occurs at 390V DC bus voltage (= 275V AC incoming line) 460-600V AC Input (PF 40) If P042 = 1 “High Voltage” trip occurs at 487V DC bus voltage (344V AC incoming line); If P042 = 0 “Low Voltage” trip occurs at 390V DC bus voltage (275V AC incoming line)
Dynamic Braking	Internal brake IGBT included with all ratings except No Brake drives (Cat. Nos. 22A-AxPxN103 or 22A-AxPxN113). Refer to page 11 for ordering information.	
Environment	Altitude: Ambient Operating Temperature: Cooling Method: Storage Temperature: Atmosphere: Relative Humidity: Shock (operating): Vibration (operating):	1000 m (3300 ft.) maximum without derating IP20, NEMA/UL Type Open: –10 to 50 degrees C (14 to 122 degrees F) IP30, NEMA/UL Type 1: –10 to 40 degrees C (14 to 104 degrees F) IP66, NEMA/UL Type 4X/12 (PF 40): –10 to 40 degrees C (14 to 104 degrees F) Fan, all drive ratings –40 to 85 degrees C (–40 to 185 degrees F) **Important:** Drive must not be installed in an area where the ambient atmosphere contains volatile or corrosive gas, vapors or dust. If the drive is not going to be installed for a period of time, it must be stored in an area where it will not be exposed to a corrosive atmosphere. 0 to 95% non-condensing 15G peak for 11ms duration (±1.0ms) 1G peak, 5 to 2000 Hz
Control	Carrier Frequency: Frequency Accuracy: Speed Regulation: Stop Modes: Accel/Decel: Intermittent Overload: Electronic Motor Overload Protection:	2-16 kHz. Drive rating based on 4 kHz. Digital Input: Within ±0.05% of set output frequency. Analog Input: Within 0.5% of maximum output frequency. Analog Output (PF 40): ±2% of full scale, 10-bit resolution. Open Loop with Slip Compensation: ±2% of base speed across a 40:1 speed range. (PF 40): 1% of base speed across a 60:1 speed range. Multiple programmable stop modes including - Ramp, Coast, DC-Brake, Ramp-to-Hold and S Curve. Two independently programmable accel and decel times. Each time may be programmed from 0-600 seconds in 0.1 second increments. 150% overload capability for up to 1 minute, 200% overload capability for up to 3 seconds. Class 10 protection with speed sensitive response.
Electrical	Voltage Tolerance: Frequency Tolerance: Displacement Power Factor: Maximum Short Circuit Rating:	120V, 200-240V, 380-480V, 460-600V: ±10% 48-63 Hz 0.98 across entire speed range 100,000 Amps symmetrical

Parameter Descriptions

Parameter Number	Parameter Name	Description	Factory Default
Display Group			
d001	Output Freq	Output frequency present at T1, T2 & T3 (U, V & W)	Read Only
d002	Commanded Freq	Value of the active frequency command	Read Only
d003	Output Current	Output current present at T1, T2 & T3 (U, V & W)	Read Only
d004	Output Voltage	Output voltage present at T1, T2 & T3 (U, V & W)	Read Only
d005	DC Bus Voltage	Present DC bus voltage level	Read Only
d006	Drive Status	Present operating condition of the drive	Read Only
d007-d009	Fault x Code	A code that represents a drive fault	Read Only
d010	Process Display	The output frequency scaled by parameter A099 [Process Factor]	Read Only
d012	Control Source	Displays the source of the Start Command and Speed Reference	Read Only
d013	Contrl In Status	Status of the control terminal block control inputs	Read Only
d014	Dig In Status	Status of the control terminal block digital inputs	Read Only
d015	Comm Status	Status of the communications ports	Read Only
d016	Control SW Ver	Main Control Board software version	Read Only
d017	Drive Type	Used by Rockwell Automation field service personnel	Read Only
d018	Elapsed Run Time	Accumulated time drive is outputting power	Read Only
d019	Testpoint Data	The present value of the function selected in parameter A102 [Testpoint Sel]	Read Only
d020	Analog In 0-10V	The present value of the voltage at I/O Terminal 13 (100.0% = 10 volts)	Read Only
d021	Analog In 4-20mA	The present value of the current at I/O Terminal 15 (0.0% = 4 mA, 100.0% = 20 mA)	Read Only
d022	Output Power	Output power present at T1, T2 & T3 (U, V & W)	Read Only
d023	Output Power Fctr	The angle in electrical degrees between motor voltage and motor current	Read Only
d024	Drive Temp	Present operating temperature of the drive power section	Read Only
d025	Counter Status	The current value of the counter when counter is enabled	Read Only
d026	Timer Status	The current value of the timer when timer is enabled	Read Only
d028	Stp Logic Status	When P038 [Speed Reference] is set to 6 “Stp Logic”, this parameter will display the current step logic profile as defined by parameters A140-A147 [Stp Logic x]	Read Only
d029	Torque Current	Displays the current value of the motor torque current as measured by the drive	Read Only
Basic Program Group			
P031	Motor NP Volts	20 to drive rated volts	Based on Drive Rating
P032	Motor NP Hertz	10 to 240 Hz	60 Hz
		15 to 400 Hz	60 Hz
P033	Motor OL Current	0.0 Amps to (Drive Rated Amps x 2) in units of 0.1 Amps	Based on Drive Rating
P034	Minimum Freq	0.0 to 240.0 Hz	0.0 Hz
		0.0 to 400.0 Hz	0.0 Hz
P035	Maximum Freq	0 to 240 Hz	60 Hz
		0 to 400 Hz	60 Hz
P036	Start Source	6 settings; Keypad, 3-Wire, 2-Wire, 2-Wire Level Sensitive, 2-Wire High Speed, Comm Port	Keypad
		7 settings; Keypad, 3-Wire, 2-Wire, 2-Wire Level Sensitive, 2-Wire High Speed, Comm Port, Momentary FWD/REV	Keypad
P037	Stop Mode	8 settings; Ramp-Clear Fault, Coast-Clear Fault, DC Brake-Clear Fault, DC Brake w/Shutoff-Clear Fault, Ramp, Coast, DC Brake, DC Brake w/Shutoff	Ramp, CF (Clear Fault)
		10 settings; Ramp-Clear Fault, Coast-Clear Fault, DC Brake-Clear Fault, DC Brake w/Shutoff-Clear Fault, Ramp, Coast, DC Brake, DC Brake w/Shutoff, Ramp Stop w/EM Brake Control-Clear Fault, Ramp Stop w/EM Brake Control	Ramp, CF (Clear Fault)
P038	Speed Reference	6 settings; Drive Potentiometer, Internal Freq, 0-10V Input/Remote Potentiometer, 4-20 mA Input, Preset Freq 0-3, Communications Port	Drive Pot
		8 settings; Drive Potentiometer, Internal Freq, 0-10V Input/Remote Potentiometer, 4-20 mA Input, Preset Freq 0-7, Communications Port, Step Logic, Analog In Mult	Drive Pot
P039	Accel Time 1	0.0 to 600.0 seconds	10.0 Secs
P040	Decel Time 1	0.1 to 600.0 seconds	10.0 Secs
P041	Reset To Defalts	Used to reset drive to factory default settings	Ready/Idle
P042	Voltage Class	Sets the voltage class of 600V drives, Low Voltage (460/480V) or High Voltage (575/600V)	High Voltage (575/600V)
P043	Motor OL Ret	Enables/Disables the Motor Overload Retention function.	Disabled
Advanced Program Group			
A051 A052	Digital In1 Sel Digital In2 Sel	16 settings; Not Used, Accel 2 & Decel 2, Jog, Auxiliary Fault, Preset Frequencies, Local, Comm Port, Clear Fault, Ramp Stop Clear Fault, Coast Stop Clear Fault, DC Brake Clear Fault, Jog Forward, Jog Reverse, 10V In Control, 20 mA In Control, Analog Invert	Preset Freq
		28 settings; Not Used, Accel 2 & Decel 2, Jog, Auxiliary Fault, Preset Frequencies, Local, Comm Port, Clear Fault, Ramp Stop - Clear Fault, Coast Stop - Clear Fault, DC Brake - Clear Fault, Jog Forward, Jog Reverse, 10V In Control, 20 mA In Control, PID Disable, MOP Up, MOP Down, Timer Start, Counter In, Reset Timer, Reset Counter, Reset Timer and Counter, Logic In1, Logic In2, Current Limit2, Analog Invert, EM Brake Release	

Shaded areas are applicable to PowerFlex 40 only.

Parameter Number	Parameter Name	Description	Factory Default
A053	Digital In3 Sel	28 settings; Not Used, Accel 2 & Decel 2, Jog, Auxiliary Fault, Preset Frequencies, Local, Comm Port, Clear Fault, Ramp Stop - Clear Fault, Coast Stop - Clear Fault, DC Brake - Clear Fault, Jog Forward, Jog Reverse, 10V In Control, 20 mA In Control, PID Disable, MOP Up, MOP Down, Timer Start, Counter In, Reset Timer, Reset Counter, Reset Timer and Counter, Logic In1, Logic In2, Current Limit2, Analog Invert, EM Brake Release	Local
A054	Digital In4 Sel		Jog Forward
A055	Relay Out Sel	13 different settings for a variety of drive status conditions	Ready/Fault
		24 different settings for a variety of drive status conditions	Ready/Fault
A056	Relay Out Level	0.0 to 9999	0.0
A058	Opto Out1 Sel	24 settings; Ready/Fault, At Frequency, Motor Running, Reverse, Motor Overload, Ramp Regulator, Above Frequency, Above Current, Above DC Voltage, Retries Exceeded, Above Analog Voltage, Logic In1, Logic In2, Logic 1 & 2, Logic 1 or 2, Step Logic Out, Timer Out, Counter Out, Above PF Angle, Analog Input Loss, Param Control, Non-Recoverable Fault, EM Brake Control, Above Frequency Command	MotorRunning
A059	Opto Out1 Level	0.0 to 9999	0.0
A061	Opto Out2 Sel	24 settings; Ready/Fault, At Frequency, Motor Running, Reverse, Motor Overload, Ramp Regulator, Above Frequency, Above Current, Above DC Voltage, Retries Exceeded, Above Analog Voltage, Logic In1, Logic In2, Logic 1 & 2, Logic 1 or 2, Step Logic Out, Timer Out, Counter Out, Above PF Angle, Analog Input Loss, Param Control, Non-Recoverable Fault, EM Brake Control, Above Frequency Command	At Frequency
A062	Opto Out2 Level	0.0 to 9999	0.0
A064	Opto Out Logic	Determines the logic (NO or NC) of the opto outputs, 4 settings - NO/NO, NC/NO, NO/NC, NC/NC	NO/NO
A065	Analog Out Sel	Sets the analog output signal mode, various settings	Output Freq 0-10, 0V=0Hz
A066	Analog Out High	0 to 800%	100%
A067	Accel Time 2	0.0 to 600.0 seconds	20.0 Secs
A068	Decel Time 2	0.1 to 600.0 seconds	20.0 Secs
A069	Internal Freq	0.0 to 240.0 Hz	60.0 Hz
		0.0 to 400.0 Hz	60.0 Hz
A070	Preset Freq 0	0.0 to 240.0 Hz	0.0 Hz
		0.0 to 400.0 Hz	0.0 Hz
A071	Preset Freq 1	0.0 to 240.0 Hz	5.0 Hz
		0.0 to 400.0 Hz	5.0 Hz
A072	Preset Freq 2	0.0 to 240.0 Hz	10.0 Hz
		0.0 to 400.0 Hz	10.0 Hz
A073	Preset Freq 3	0.0 to 240.0 Hz	20.0 Hz
		0.0 to 400.0 Hz	20.0 Hz
A074	Preset Freq 4	0.0 to 400.0 Hz	30.0 Hz
A075	Preset Freq 5	0.0 to 400.0 Hz	40.0 Hz
A076	Preset Freq 6	0.0 to 400.0 Hz	50.0 Hz
A077	Preset Freq 7	0.0 to 400.0 Hz	60.0 Hz
A078	Jog Frequency	0.0 to (Value set in P035 [Maximum Freq]	10.0 Hz
A079	Jog Accel/Decel	0.1 to 600.0 seconds	10.0 Secs
A080	DC Brake Time	0.0 to 90.0 seconds	0.0 Secs
		0.0 to 99.9 seconds	0.0 Secs
A081	DC Brake Level	0.0 to (Drive Rated Amps x 1.8)	Drive Rated Amps x 0.05
A082	DB Resistor Sel	Used to set percent duty cycle for external dynamic braking	Disabled
A083	S Curve %	0 to 100%	0% (Disabled)
A084	Boost Select	14 boost settings (in % of P031 [Motor NP Volts]), redefines the Volts per Hertz curve	5.0 (2.5 for 5 HP drives)
		15 boost settings (in % of P031 [Motor NP Volts]), redefines the Volts per Hertz curve	5.0, CT (2.5 CT for 5-15 HP drives)
A085	Start Boost	0.0 to 25.0%	2.5%
A086	Break Voltage	0.0 to 100.0%	25.0%
A087	Break Frequency	0.0 to 400.0 Hz	15.0 Hz
A088	Maximum Voltage	20 to Drive Rated Volts	Drive Rated Volts
A089	Current Limit 1	0.1 to (Drive Rated Amps x 1.8)	Drive Rated Amps x 1.5
A090	Motor OL Select	3 settings; No Derate, Minimum Derate, Maximum Derate	No Derate
A091	PWM Frequency	2.0 to 16.0 kHz	4.0 kHz
A092	Auto Rstrt Tries	0 to 9	0
A093	Auto Rstrt Delay	0.0 to 300.0 seconds	1.0 Secs
A094	Start At PowerUp	2 settings; Disabled, Enabled	Disabled
A095	Reverse Disable	2 settings; Reverse Enabled, Reverse Disabled	Rev Enabled

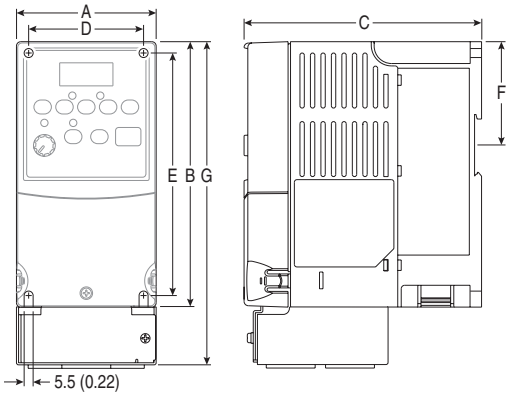
Shaded areas are applicable to PowerFlex 40 only.

Parameter Number	Parameter Name	Description	Factory Default
Advanced Program Group, Continued			
A096	Flying Start En	2 settings; Disabled, Enabled	Disabled
A097	Compensation	4 settings; Disabled, Electrical, Mechanical, Both	Electrical
A098	SW Current Trip	Software instantaneous trip, 0.0 to (Drive Rated Amps x 2)	0.0 (Disabled)
A099	Process Factor	0.1 to 999.9	30.0
A100	Fault Clear	Resets a fault and clears the fault queue	Ready/Idle
A101	Program Lock	Protects parameters against change by unauthorized personnel	Unlocked
A102	Testpoint Sel	Used by Rockwell Automation field service personnel	400
A103	Comm Data Rate	6 settings; 1200, 2400, 4800, 9600, 19.2K, 38.4K	9600
A104	Comm Node Addr	1 to 247	100
A105	Comm Loss Action	4 settings; Fault, Coast to Stop, Stop, Continue Last Speed	Fault
A106	Comm Loss Time	0.1 to 60.0 seconds	5.0 Secs
A107	Comm Format	6 settings; RTU 8-N-1, RTU 8-E-1, RTU 8-O-1, RTU 8-N-2, RTU 8-E-2, RTU 8-O-2	RTU 8-N-1
A108	Language	10 settings; English, Francais, Espanol, Italiano, Deutsch, Reserved, Portugues, Reserved, Reserved, Nederlands	English
A109	Anlg Out Setpt	0.0/100.0%	100.0%
A110	Anlg In 0-10V Lo	0.0 to 100.0%	0.0%
A111	Anlg In 0-10V Hi	0.0 to 100.0%	100.0%
A112	Anlg In4-20mA Lo	0.0 to 100.0%	0.0%
A113	Anlg In4-20mA Hi	0.0 to 100.0%	100.0%
A114	Slip Hertz @ FLA	0.0 to 10.0 Hz	2.0 Hz
A115	Process Time Lo	0.00 to 99.99	0.00
A116	Process Time Hi	0.00 to 99.99	0.00
A117	Bus Reg Mode	0/1	Enabled
A118	Current Limit 2	0.1 to (Drive Rated Amps x 1.8)	Drive Rated Amps x 1.5
A119	Skip Frequency	0 to 400 Hz	0 Hz
A120	Skip Freq Band	0.0 to 30.0 Hz	0.0 Hz
A121	Stall Fault Time	6 settings; 60 Seconds, 120 Seconds, 240 Seconds, 360 Seconds, 480 Seconds, Fit Disabled	60 Seconds
A122	Analog In Loss	7 settings; Disabled, Fault (F29), Stop, Zero Ref, Min Freq Ref, Max Freq Ref, Int Freq Ref	Disabled
A123	10V Bipolar Enbl	2 settings; Uni-Polar In, Bi-Polar In	Uni-Polar In
A124	Var PWM Disable	2 settings; Enabled, Disabled	Enabled
A125	Torque Perf Mode	2 settings; V/Hz, Sensorless Vector	Sensrls Vect
A126	Motor NP FLA	Drive Rated Amps x 0.1/2	Drive Rated Amps
A127	Autotune	3 settings; Ready/Idle, Static Tune, Rotate Tune	Ready/Idle
A128	IR Voltage Drop	0.0 to 230.0 VAC	Based on Drive Rating
A129	Flux Current Ref	0.00 to Motor NP FLA	Based on Drive Rating
A130	PID Trim Hi	0.0 to 400.0	60.0
A131	PID Trim Lo	0.0 to 400.0	0.0
A132	PID Ref Sel	9 settings; PID Disabled, PID Setpoint, 0-10V Input, 4-20mA Input, Comm Port, Setpoint - Trim, 0-10V - Trim, 4-20mA - Trim, Comm - Trim	PID Disabled
A133	PID Feedback Sel	3 settings; 0-10V Input, 4-20mA Input, Comm Port	0-10V Input
A134	PID Prop Gain	0.00 to 99.99	0.01
A135	PID Integ Time	0.0 to 999.9 Seconds	0.1 Secs
A136	PID Diff Rate	0.00 to 99.99 (1/Secs)	0.01 (1/Secs)
A137	PID Setpoint	0.0 to 100.0%	0.0%
A138	PID Deadband	0.0 to 10.0%	0.0%
A139	PID Preload	0.0 to 400.0 Hz	0.0 Hz
A140-A147	Stp Logic 0-7	0001 to bAFF	00F1
A150-157	Stp Logic Time 0-7	0.0 to 999.9 Seconds	30.0 Secs
A160	EM Brk Off Delay	0.01/10.00 Secs	2.00 Secs
A161	EM Brk On Delay	0.01/10.00 Secs	2.00 Secs
A162	MOP Reset Sel	2 settings; Zero MOP Ref, Save MOP Ref	Save MOP Ref
A163	DB Threshold	0.0 to 110.0%	100.0%
A164	Comm Write Mode	2 settings; Save, RAM Only	Save
A165	Anlg Loss Delay	0.0 to 20.0 Secs	0.0 Secs
A166	Analog In Filter	0 to 14	0

Shaded areas are applicable to PowerFlex 40 only.

Product Dimensions

Approximate Dimensions



Dimensions are in millimeters and (inches). Weights are in kilograms and (pounds).

Frame	A	B ❶	C	D	E	F	G ❷	Shipping Weight
A	80 (3.15)	152 (5.98)	136 (5.35)	67 (2.64)	140 (5.51	59.3 (2.33)	185 (7.28)	1.4 (3.1)
B	100 (3.94)	180 (7.09)	136 (5.35)	87 (3.43)	168 (6.61)	87.4 (3.44)	213 (8.39)	2.2 (4.9)
C	130 (5.1)	260 (10.2)	180 (7.1)	116 (4.57)	246 (9.7)	–	320 (12.6)	4.3 (9.5)

❶ Overall height of standard IP 20/Open Type Drive.

❷ Overall height of drive with IP 30/NEMA 1/UL Type 1 option kit installed.

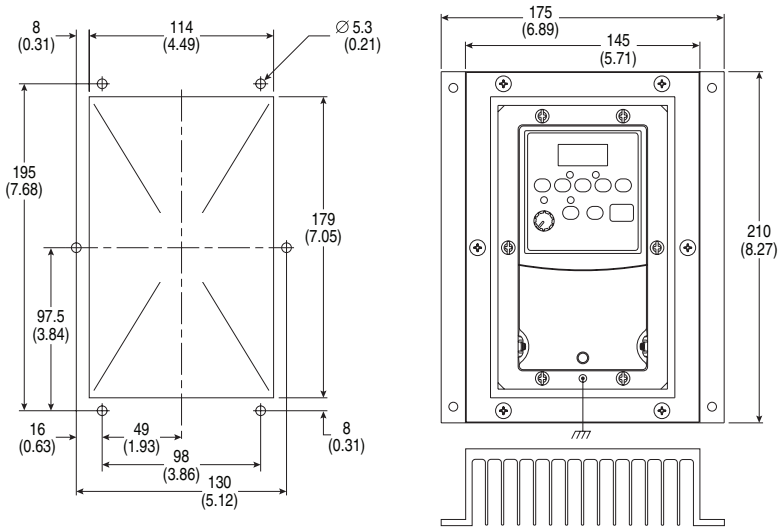
Ratings are in kW and (HP).

PowerFlex 4 — Frame	120V AC – 1-Phase	240V AC – 1-Phase	240V AC – 3-Phase	480V AC – 3-Phase
A	0.2 (0.25) 0.4(0.5)	0.2 (0.25) 0.4 (0.5) 0.75 (1.0)	0.2 (0.25) 0.4 (0.5) 0.75 (1.0) 1.5 (2.0)	0.4 (0.5) 0.75 (1.0) 1.5 (2.0)
B	0.75 (1.0) 1.1 (1.5)	1.5 (2.0)	2.2 (3.0) 3.7 (5.0)	2.2 (3.0) 3.7 (5.0)

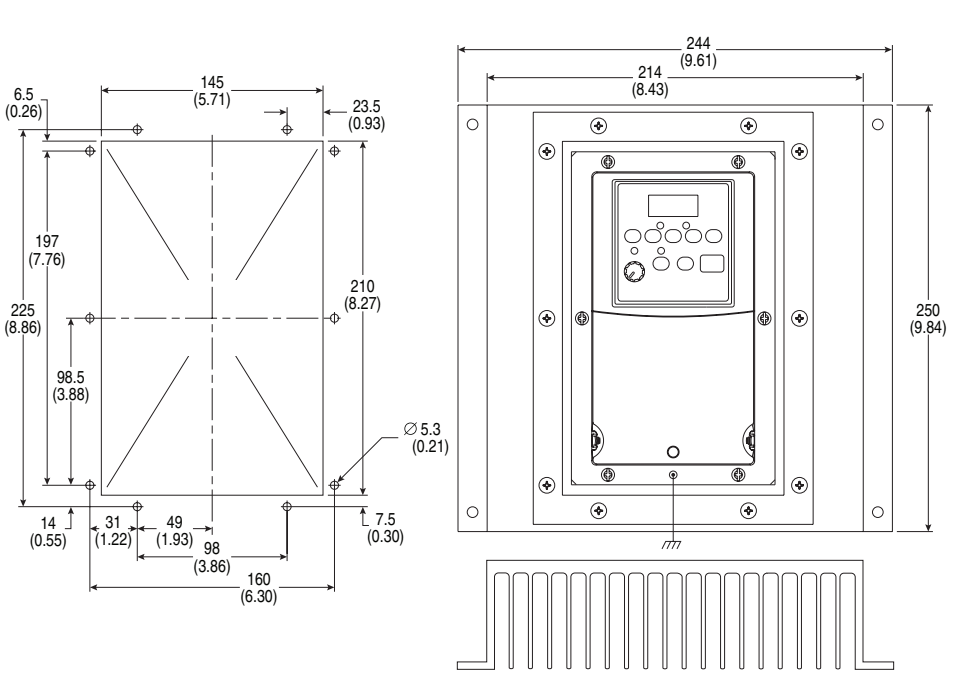
PowerFlex 40 — Frame	120V AC – 1-Phase	240V AC – 1-Phase	240V AC – 3-Phase	480V AC – 3-Phase	600V AC – 3-Phase
B	0.4 (0.5) 0.75 (1.0) 1.1 (1.5)	0.4 (0.5) 0.75 (1.0) 1.5 (2.0)	0.4 (0.5) 0.75 (1.0) 1.5 (2.0) 2.2 (3.0) 3.7 (5.0)	0.4 (0.5) 0.75 (1.0) 1.5 (2.0) 2.2 (3.0) 4.0 (5.0)	0.75 (1.0) 1.5 (2.0) 2.2 (3.0) 4.0 (5.0)
C		2.2 (3.0)	5.5 (7.5) 7.5 (10.0)	5.5 (7.5) 7.5 (10.0) 11.0 (15.0)	5.5 (7.5) 7.5 (10.0) 11.0 (15.0)

Shaded areas are applicable to PowerFlex 40 only.

Flange Mount Drive



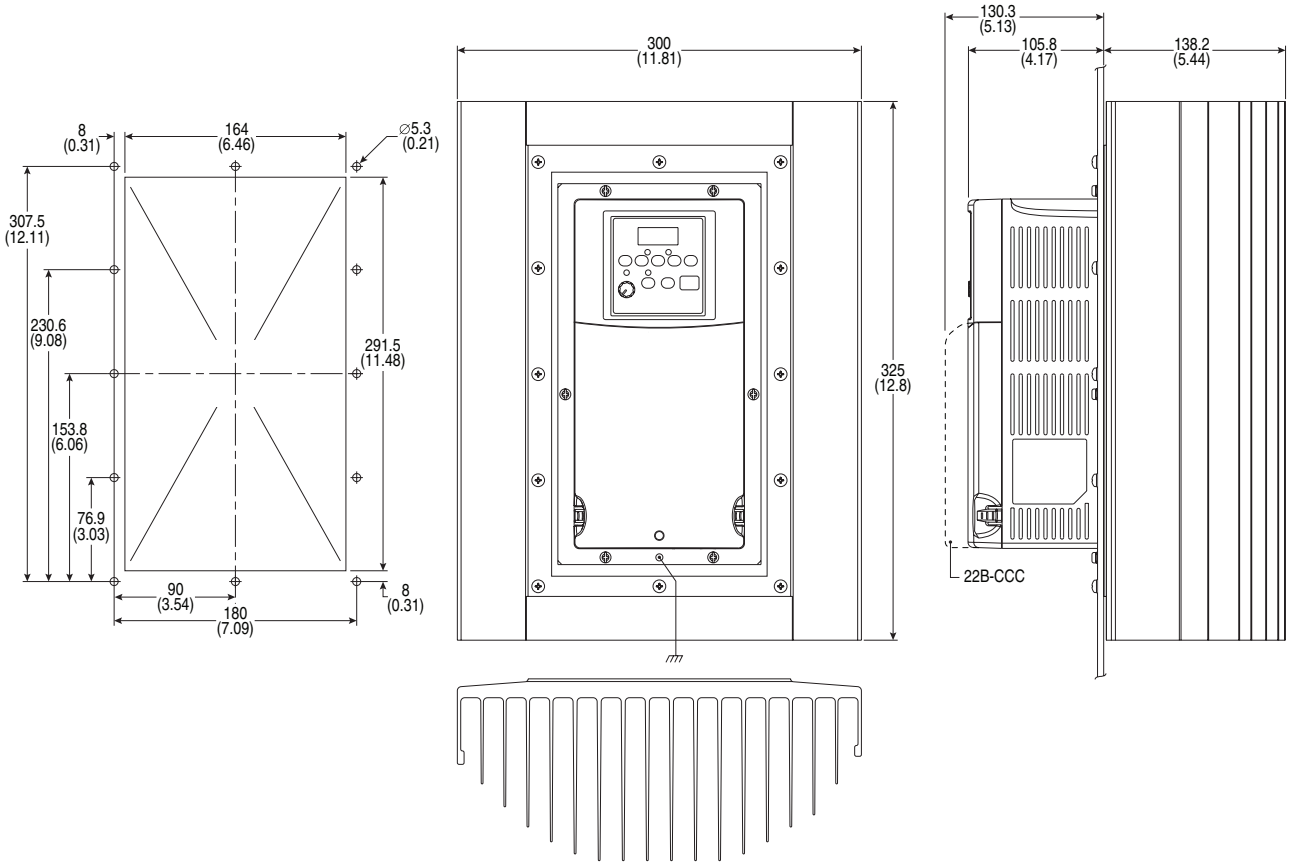
Frame A — PowerFlex 4 only



Frame B— PowerFlex 4 and PowerFlex 40

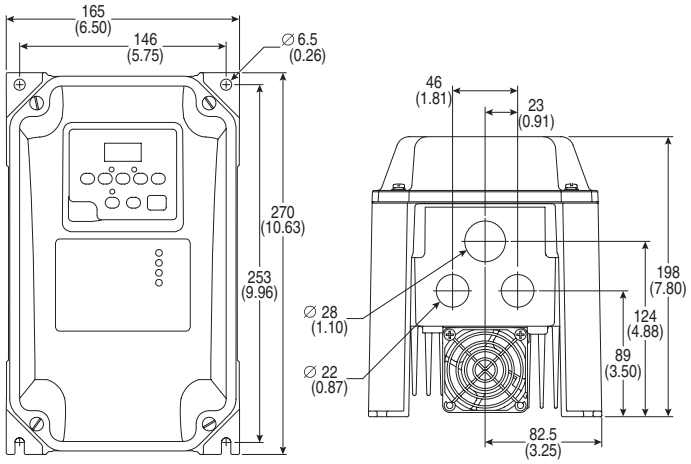
Shaded areas are applicable to PowerFlex 40 only.

Flange Mount Drive *Continued*



Frame C—PowerFlex 40 only

IP 66, NEMA/UL Type 4X/12

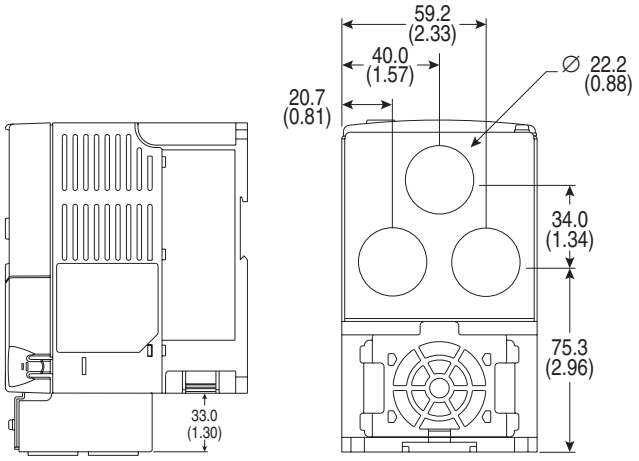


Frame B—PowerFlex 40 only

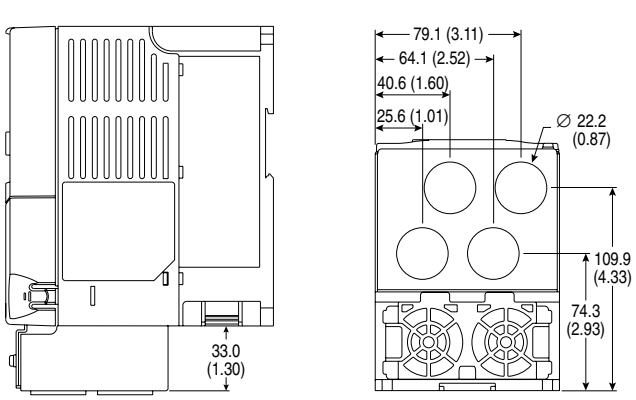
Shaded areas are applicable to PowerFlex 40 only.

IP 30, NEMA/UL Type 1 Option Kit without Communication Options

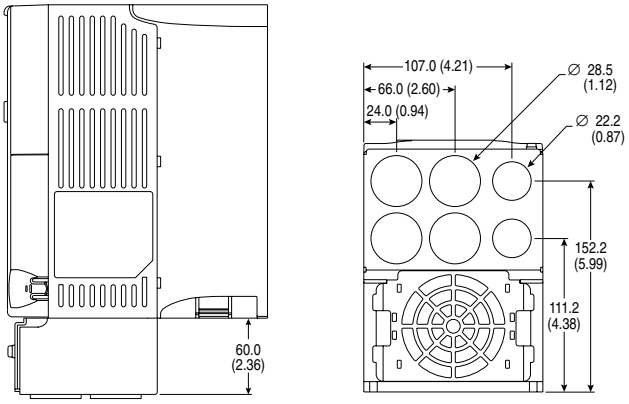
PowerFlex 4 uses Frames A & B. PowerFlex 40 uses Frames B & C.



Frame A — 22-JBAA

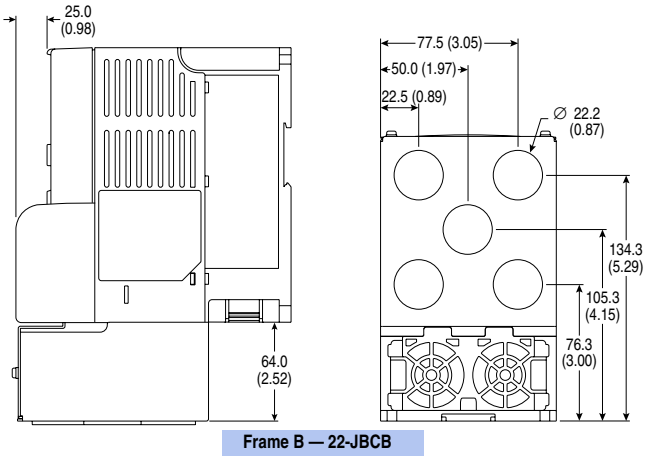


Frame B — 22-JBAB

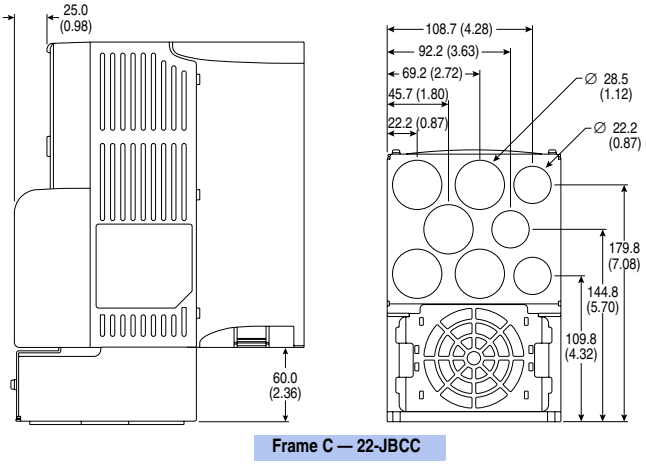


Frame C — 22-JBAC

PowerFlex 40 IP 30/NEMA 1/UL Type 1 Option Kit with Communication Option



Frame B — 22-JBCB

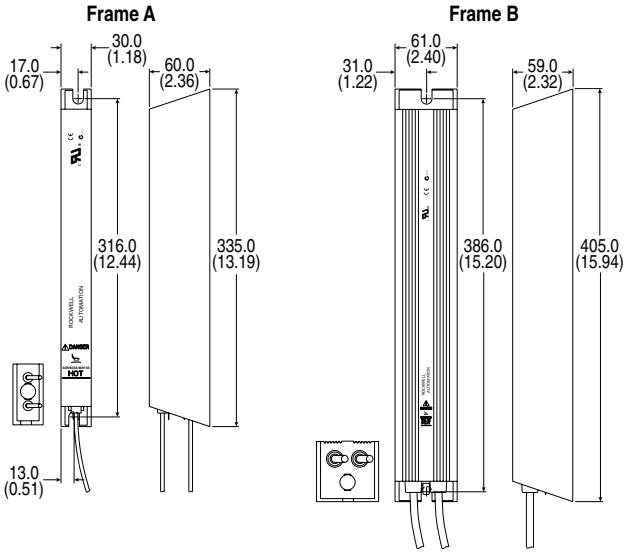


Frame C — 22-JBCC

Shaded areas are applicable to PowerFlex 40 only.

Dynamic Brake Resistors

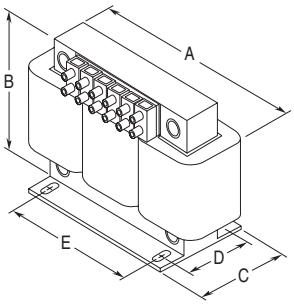
Dimensions are in millimeters and (inches)



Frame	Catalog Number
A	AK-R2-091P500, AK-R2-047P500, AK-R2-360P500
B	AK-R2-030P1K2, AK-R2-120P1K2

Bulletin 1321-3R Series Line Reactors

Dimensions are in millimeters and (inches). Weights are in kilograms and (pounds).

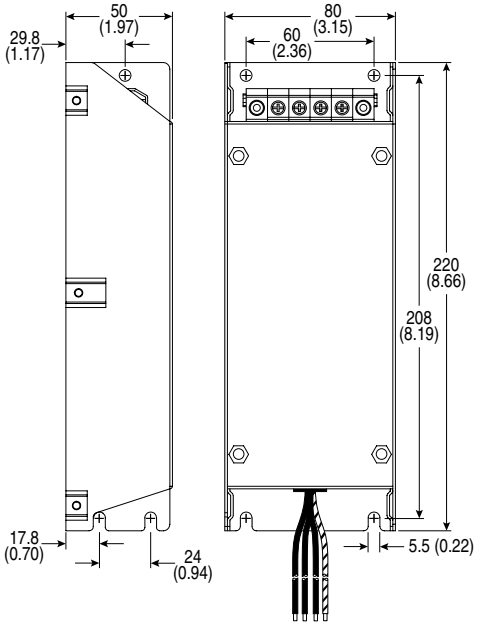


Catalog Number	A	B	C	D	E	Weight
1321-3R2-A	112 (4.40)	104 (4.10)	70 (2.75)	50 (1.98)	37 (1.44)	1.8 (4)
1321-3R2-B	112 (4.40)	104 (4.10)	70 (2.75)	50 (1.98)	37 (1.44)	1.8 (4)
1321-3R4-A	112 (4.40)	104 (4.10)	76 (3.00)	50 (1.98)	37 (1.44)	1.8 (4)
1321-3R4-B	112 (4.40)	104 (4.10)	76 (3.00)	50 (1.98)	37 (1.44)	1.8 (4)
1321-3R4-C	112 (4.40)	104 (4.10)	86 (3.38)	60 (2.35)	37 (1.44)	2.3 (5)
1321-3R8-A	152 (6.00)	127 (5.00)	76 (3.00)	53 (2.10)	51 (2.00)	3.1 (7)
1321-3R8-B	152 (6.00)	127 (5.00)	76 (3.00)	53 (2.10)	51 (2.00)	3.6 (8)
1321-3R8-C	152 (6.00)	127 (5.00)	85 (3.35)	63 (2.48)	51 (2.00)	4.9 (11)
1321-3R12-A	152 (6.00)	127 (5.00)	76 (3.00)	53 (2.10)	51 (2.00)	4.1 (9)
1321-3R12-B	152 (6.00)	127 (5.00)	76 (3.00)	53 (2.10)	51 (2.00)	4.5 (10)
1321-3R18-A	152 (6.00)	133 (5.25)	79 (3.10)	54 (2.13)	51 (2.00)	4.1 (9)
1321-3R18-B	152 (6.00)	133 (5.25)	86 (3.40)	63 (2.48)	51 (2.00)	5.4 (12)
1321-3R25-A	183 (7.20)	146 (5.76)	85 (3.35)	60 (2.35)	76 (3.00)	4.9 (11)
1321-3R35-A	193 (7.60)	146 (5.76)	91 (3.60)	66 (2.60)	76 (3.00)	6.3 (14)

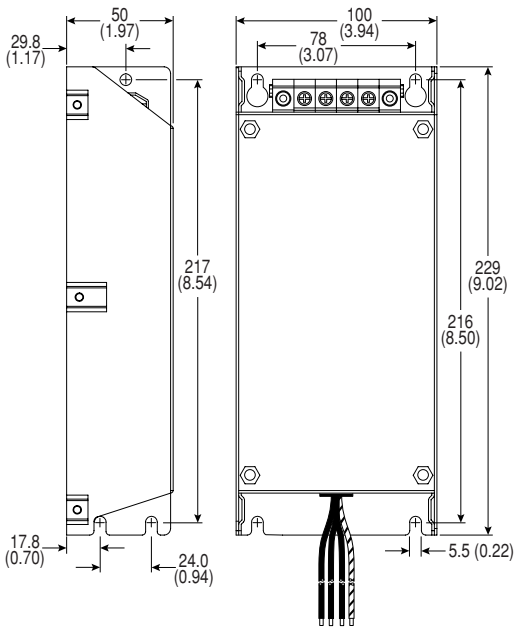
Shaded areas are applicable to PowerFlex 40 only.

EMC Line Filters

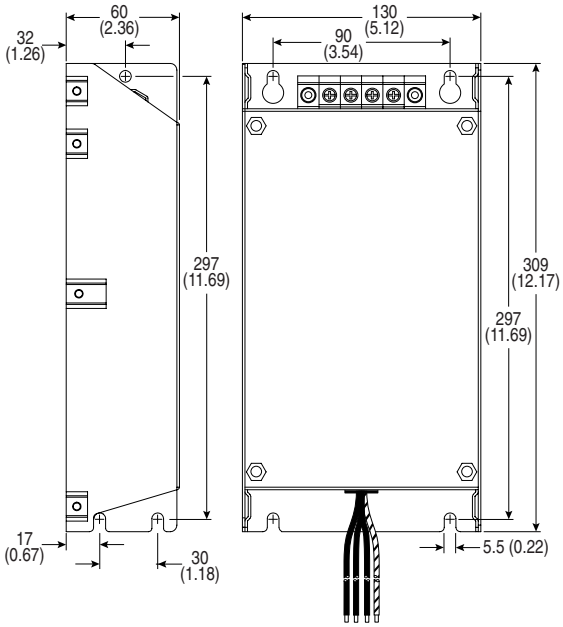
Frame A EMC Line Filters – Dimensions are in millimeters and (inches)
Catalog Numbers: 22-RF5P7-AS, -AL; 22-RF9P5-AS, -AL; 22-RF010-AL



Frame B EMC Line Filters – Dimensions are in millimeters and (inches)
Catalog Numbers: 22-RF8P0-BL, 22-RF012-BS, -BL; 22-RF018-BL; 22-RF021-BS, -BL



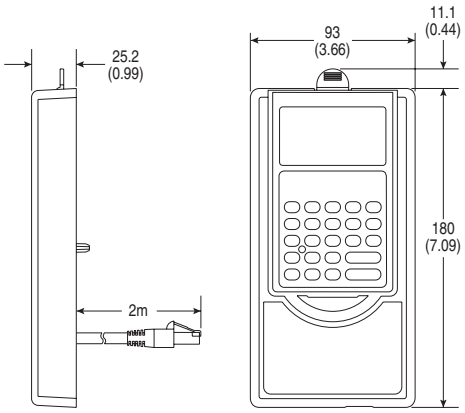
Frame C EMC Line Filters – Dimensions are in millimeters and (inches)
Catalog Numbers: 22-RF015-CL; 22-RF018-CS, -CL; 22-RF024-CL; 22-RF025-CL; 22-RF026-CS, -CL; 22RF034-CS, -CL

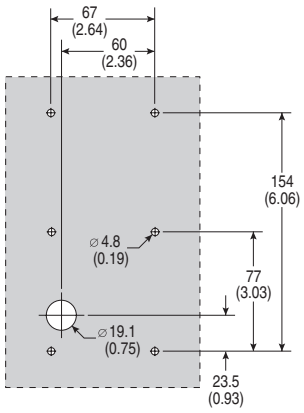


Shaded areas are applicable to PowerFlex 40 only.

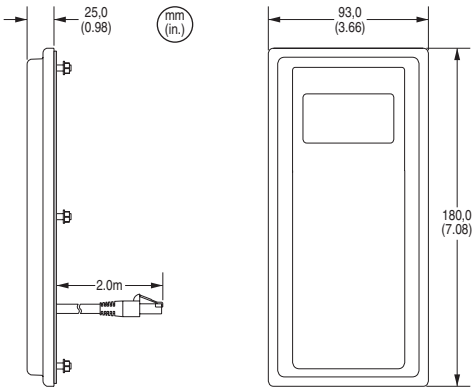
Human Interface Module (HIM) Dimensions

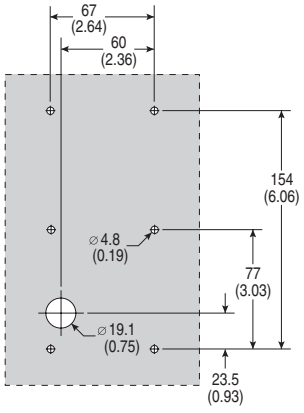
NEMA Type 1 Bezel – Dimensions are in millimeters and (inches)
Catalog Number: 22-HIM-B1





NEMA Type 4X/12 Remote (Panel Mount) HIM
– Dimensions are in millimeters and (inches)
Catalog Number: 22-HIM-C2S





PowerFlex 4 and 40 Configured Drives

The heart of every Configured Drive is an Allen-Bradley standard drive. These world class products help to provide a single solution for virtually all of your motor speed control requirements.

Configured Drive programs provide you with an offering of factory mounted options enhancing the Standard Drive program. The options defined within the programs are pre-engineered for consistency of design. This translates to time and money savings in set-up, integration and maintenance of your automation systems.

Catalog Number Explanation

					Position						
1-3	4	5	6-8	9	10	11	12	13	14	15	16+
23B	–	D	4P0	D	1	0	4	N	N	–	P6
a		*b*	*c*	*d*	*e*	*f*	*g*	*h*	*i*		*j*

a

Drive	
Code	Type
23B	PowerFlex 40

b

Voltage Rating		
Code	Voltage	Ph.
D	480V ac	3

c

Amp Rating		
480V 60Hz Input		
Code	Amps	kW (Hp)
1P4	1.4	0.4 (0.5)
2P3	2.3	0.75 (1.0)
4P0	4.0	1.5 (2.0)
6P0	6.0	2.2 (3.0)
010	10.5	4.0 (5.0)
012	12	5.5 (7.5)
017	17	7.5 (10)
024	24	11 (15)

d

Enclosure	
Code	Enclosure
C	NEMA/UL Type 4X ‡
D	NEMA/UL Type 4 ‡

‡ The design of the PowerFlex 40 Standard Configured Drive supports indoor and outdoor applications that are not in direct sunlight.

e

HIM	
Code	Interface Module
1	Fixed Keypad on Drive
F ❄	Fixed Keypad on Drive and LCD Display with Digital Speed Control HIM on Enclosure Door (22-HIM-C2S)

❄ This option changes the enclosure rating to indoor only.

f

Emission Class	
Code	Rating
0	Not Filtered

g

Version	
Code	Version
4	RS485 (Standard)
C	ControlNet
D	DeviceNet
E	EtherNet/IP
P	PROFIBUS DP

h

Code	Rating
N	Reserved

i

Code	Rating
N	Reserved

j

Options	
Code	Description
-E22	DeviceNet Quick Disconnect (Bottom)
-E23	DeviceNet Quick Disconnect (Left Side)
-P3	Motor Circuit Protector
-P3T	Motor Circuit Protector (Customer wiring into top of device)
-P6	Disconnect Switch - Fused
-P6T	Disconnect Switch - Fused (Customer wiring into top of device)
-R3	DeviceNet I/O (4 In/2 Out) w/Spring Return HOA and Power Disconnect Aux. Contact
-R4	DeviceNet Point I/O w/IB4 (4 Inputs)
-R5	-R3 plus 4 I/O Quick Disconnects and (1) 24V DC Receptacle
-S1	Hand/Off/Auto S.S. (Start/Stop/Speed Ref.)
-S4	Auto/Manual S.S. (Speed Ref.)
-S7	Start and Stop P.B.
-S8	Forward/Reverse S.S.
-S18	Door Mounted Local Speed Pot (1-Turn)
-S20	Local/Remote and Local Control Off/Run Forward Selector Switches
-S21	Local/Off/Remote with 1 N.O. Interposing Relay
-S22	Spring Return Hand/Off Auto S.S. (Start/Stop/Speed Ref.)
-S23	Clear Fault P.B.

Product Description

PowerFlex 40 Configured AC drives are ideal for OEM's and end-users with special installation needs. Designed to meet your customer demand for space savings, applications flexibility and reliability, the PowerFlex 40 Configured AC drive options have been pre-engineered to ensure superior reliability.

Standard Features

- This package integrates the PowerFlex 40 Standard Drive as the base power/control component.
- Enclosure features include…
  - NEMA Type 4/12 and 4X (IP66) indoor and outdoor applications ❶
  - Heat out the back design reduces enclosure size
  - Viewing window-drive display and all indicators are visible.
  - Mounting feet-orientation is adjustable per customer requirements
- The drive can be removed from the front of the enclosure for ease of assembly or repair.
- Low cost, highly configurable I/O inputs and/or 0-10V/4-20mA outputs that are not used by program standard features and options are available for customer use.

❶ Supports indoor and outdoor applications other than direct sunlight.

Program Options

- Communication Options
  - ControlNet
  - DeviceNet
  - EtherNet/IP
  - LonWorks
  - PROFIBUS DP
- Power Disconnect Options
  - Drive Input Fused Disconnect Switch – 100kA short circuit withstand rating
  - Motor Circuit Protector – 65kA short circuit withstand rating
- Door Mounted Operator Devices
  - Hand/Off/Auto Selector Switch
  - Auto/Manual Selector Switch
  - Start and Stop Pushbuttons
  - Forward/Reverse Selector Switch
  - Local Control Off/Run Forward and Local/Remote – Selector Switches
  - Local/Off/Remote Selector Switch with One – Normally Open Interposing Relay–(Panel)
  - Clear Fault Pushbutton
- Quick Disconnect
  - DeviceNet Quick Disconnect–Bottom or left side mounted
- I/O Options
  - DeviceNet I/O with Hand/Off auto selector switch and power disconnect auxiliary contact. (4 in / 2 out) I/O quick disconnect optional.
  - DeviceNet Point I/O with IB4 (4 in)

For option specific detail, refer to the PowerFlex 40 Adjustable Frequency AC Configured Drives Installation Instructions, publication 23B-IN001….

Drive Ratings — PowerFlex 40 Configured Drives

Catalog Number	kW (HP)	Input Ratings		Output Ratings	
		Voltage	Amps	Voltage	Amps
23B-D1P4	0.4 (0.5)	480	1.8	460	1.4
23B-D2P3	0.75 (1.0)	480	3.2	460	2.3
23B-D4P0	1.5 (2.0)	480	5.7	460	4.0
23B-D6P0	2.2 (3.0)	480	7.5	460	6.0
23B-D010	4.0 (5.0)	480	13.0	460	10.5
23B-D012	5.5 (7.5)	480	14.2	460	12.0
23B-D017	7.5 (10.0)	480	18.4	460	17.0
23B-D024	11.0 (15.0)	480	26.0	460	24.0

Specifications for Configured Drive Products

Input/Output Ratings	Output Frequency:	0-400 Hz (Programmable)
	Efficiency:	97.5% (Typical)
Approvals	UL508C, CSA C 22.2 No. 14, EN 61800-3, CE LV Directive 73/23/EEC LV: EN 50178, EN 60204 EMC Directive 89/336/EEC EMC: EN 61800-3	
Fuses and Power Disconnecting Means	140M Motor Circuit Protector:	Provides branch circuit protection, 65 kA short circuit withstand
	194R Fused Disconnect:	Provides branch circuit protection, 100 kA short circuit withstand, Class J fuses
Protective Features	Over Voltage:	480V AC Input – Trip occurs at 810V DC bus voltage (equivalent to 575V AC incoming line)
	Under Voltage:	480V AC Input – Trip occurs at 390V DC bus voltage (equivalent to 275V AC incoming line)
Environment	Ambient Operating Temperature:	NEMA 4/12, 4X (IP66), –10 to 40 degrees C (14 to 104 degrees F) ❶
	Cooling Method:	Fan, all drive ratings
Control	Carrier Frequency:	2-4 kHz. Drive rating and heat calculations are based on 4 kHz.

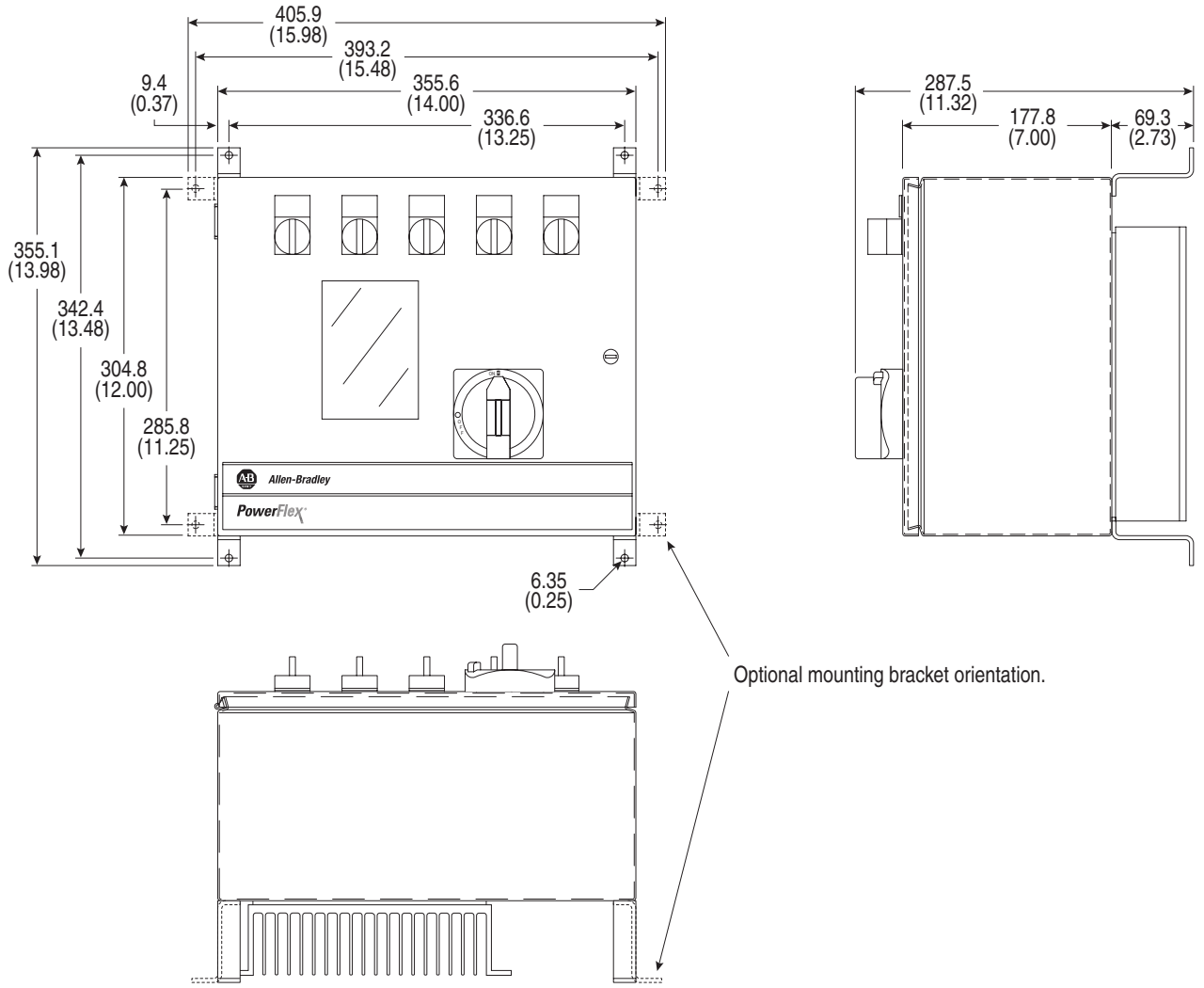
❶ The design of the PowerFlex 40 Configured Drive supports indoor and outdoor applications that are not in direct sunlight.

Specifications for Standard PowerFlex 40 Drives

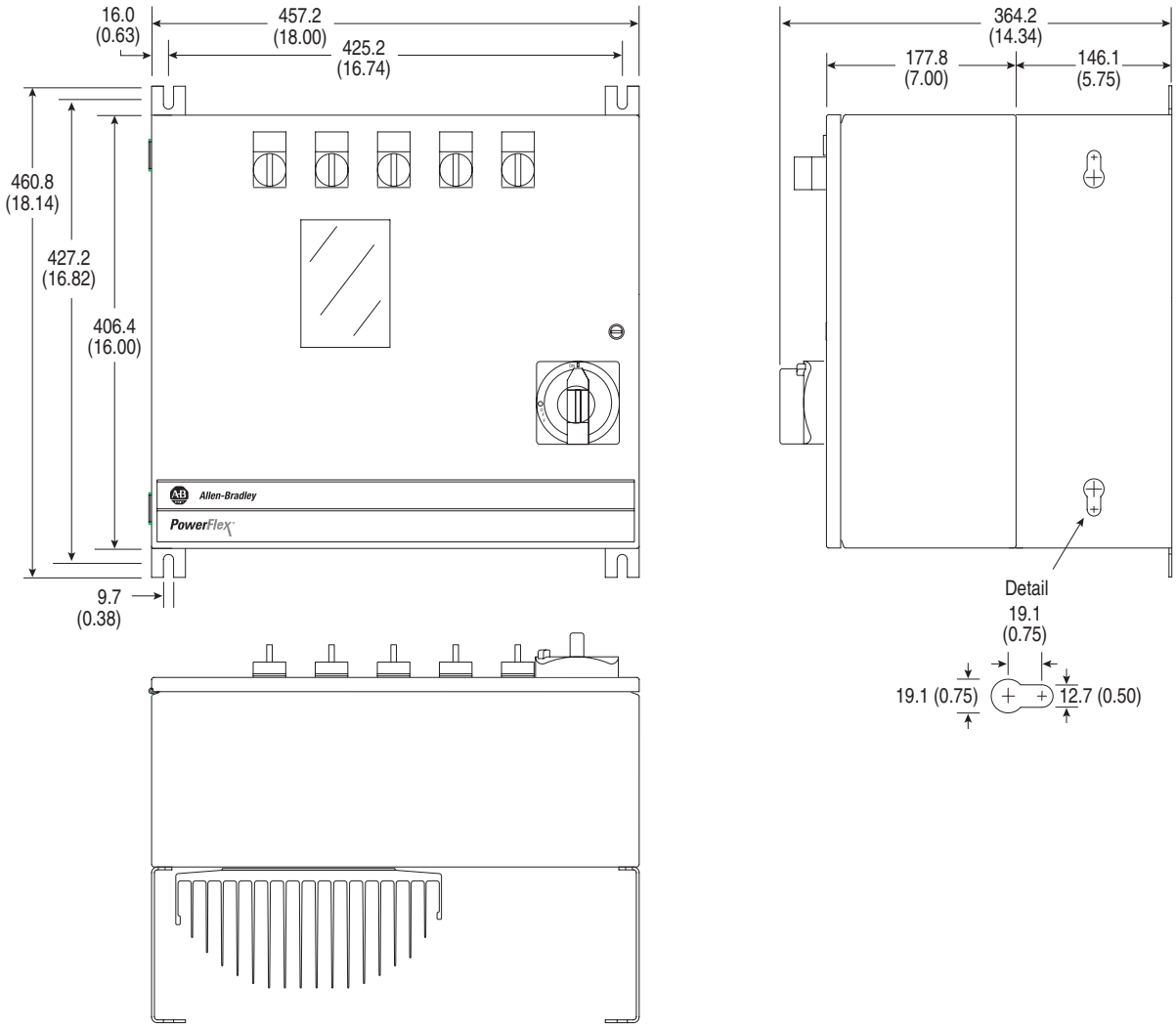
Electrical	Voltage Tolerance:	120V, 200-240V, 380-480V, 460-600V: ±10%
	Frequency Tolerance:	48-63 Hz
	Displacement Power Factor:	0.98 across entire speed range
	Maximum Short Circuit Rating:	100,000 Amps symmetrical
Control Inputs	Digital SRC (Source) Mode: SNK (Sink) Mode:	Input Current = 6 mA 18-24V = On, 0-6V = Off 0-6V = On, 18-24V = Off
	Analog 4-20 mA Analog: 0-10V DC Analog: External Pot:	 250 ohm input impedance 100k ohm input impedance 1-10k ohms, 2 Watt minimum
Control Output – Programmable Outputs (form C relay)	Resistive Rating Opto Outputs: Analog Outputs:	3.0A at 30V DC, 3.0A at 125V AC, 3.0A at 240V AC 30V DC, 50 mA 10-bit, 0-10V, 1k ohm minimum
	Inductive Rating Opto Outputs: Analog Outputs:	0.5A at 30V DC, 0.5A at 125V AC, 0.5A at 240V AC Non-inductive 10 bit, 4-20 mA, 525 ohm maximum
Fuses and Circuit Breakers	Recommended Fuse Type:	UL Class J, CC, T or Type BS88; 600V (550V) or equivalent.
	Recommended Circuit Breakers:	HMCP circuit breaker or equivalent.
Protective Features	Motor Protection:	I^2t Overload Protection, 150% for 60 sec., 200% for 3 sec. (provides Class 10 protection)
	Overcurrent:	200% hardware limit, 300% instantaneous fault
	Control Ride Through:	Minimum Ride Through is 0.5 sec. - typical value is 2 seconds
	Faultless Power Ride Through:	100 milliseconds
Dynamic Braking	Internal brake IGBT included with all ratings.	
Environment	Altitude:	1000 m (3300 ft.) maximum without derating
	Storage Temperature:	–40 to 85 degrees C (–40 to 185 degrees F)
	Atmosphere:	**Important:** Drive must not be installed in an area where the ambient atmosphere contains volatile or corrosive gas, vapors or dust. If the drive is not going to be installed for a period of time, it must be stored in an area where it will not be exposed to a corrosive atmosphere.
	Relative Humidity:	0 to 95% non-condensing
	Shock (operating):	15G peak for 11ms duration (±1.0ms)
	Vibration (operating):	1G peak, 5 to 2000 Hz
Control	Frequency Accuracy:	Digital Input: Within ±0.05% of set output frequency. Analog Input: Within 0.5% of maximum output frequency. Analog Output: ±2% of full scale, 10-bit resolution.
	Speed Regulation:	Open Loop with Slip Compensation: ±2% of base speed across a 40:1 speed range. 1% of base speed across a 60:1 speed range.
	Stop Modes:	Multiple programmable stop modes including - Ramp, Coast, DC-Brake, Ramp-to-Hold and S Curve.
	Accel/Decel:	Two independently programmable accel and decel times. Each time may be programmed from 0-600 seconds in 0.1 second increments.
	Intermittent Overload:	150% overload capability for up to 1 minute, 200% overload capability for up to 3 seconds.
	Electronic Motor Overload Protection:	Class 10 protection with speed sensitive response.

Enclosure Options and Approximate Dimensions

Frame B Dimensions



Frame C Dimensions



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HMI, Allen Bradley Panelview 12” 2711P-T12C4A2

LISTEN. THINK. SOLVE.®

PRODUCT PROFILE

PanelView Plus 400 & 600 Family

Operator Interface

Advantages

- Provides maximum flexibility, inventory reduction, and easy upgrades
- Able to communicate with complete Logix suite of controllers
- Integrated with FactoryTalk View Machine Edition for advanced functionality including trending, expressions, data logging, advanced graphics, and direct browsing of Logix addresses
- Includes keypad, touch screen, or keypad/touch screen combination terminals for convenient and flexible operator input choices
- Includes CompactFlash card slot for transferring files, logging data, or system upgrades
- Includes complete package for immediate startup
- Offers unit level immediate exchange program to reduce downtime
- Powerful graphics providing clear and crisp visuals

Overview

PanelView Plus gives operators a clear view into monitoring and controlling applications. With FactoryTalk View Machine Edition already installed and activated, development time is greatly reduced. The PanelView Plus family of products provides a broad range of rugged terminals that offer premier integration with Integrated Architecture and common development software.

PanelView Plus 400 and 600 terminals combine a 4 or 6-inch display, logic module, memory, and power (AC or DC) together in the base unit. Powerful grahics are displayed via 18 bit color or 32 level grayscale displays. Flexible operator input is available through keypad, touch screen, or a keypad/touch screen combination.

All terminals offer an RS232 and USB port, plus an optional Ethernet port. Additional communication options allow you to take advantage of Remote I/O, DH485, DH+, DeviceNet, ControlNet and Isolated RS232.

Take advantage of these additional features on all units:

- Unique mounting mechanism requiring only a single die-cut and no special tools for installation
- Replaceable bezel ID labels for custom terminal or system identification
- Function key legend kit and software for customizing the function key legends of the PanelView Plus 600 keypad terminal

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PRODUCT SPECIFICATIONS

	PanelView Plus 400 Grayscale	PanelView Plus 400 Color	PanelView Plus 600 Grayscale	PanelView Plus 600 Color
Display Type	Monochrome Passive Matrix, Film Compensated Super-Twist Nematic (FSTN)	Color Active Matrix Thin Film Transistor (TFT)	Monochrome Passive Matrix, Film Compensated Super-Twist Nematic (FSTN)	Color Active Matrix Thin Film Transistor (TFT)
Display Size	77 x 58 mm (3.7 in.)	71 x 53 mm (3.5 in.)	112 x 84 mm (5.5 in.)	112 x 84 mm (5.5 in.)
Resolution	320 x 240, 32 level grayscale	320 x 240, 18 bit color graphics	320 x 240, 32 level grayscale	320 x 240, 18 bit color graphics
Operator Input	Keypad	Keypad or Keypad/Touch Screen Combination	Keypad, Touch Screen, or Keypad/Touch Screen Combination	
Function Keys	8 (F1 - F8)	8 (F1 - F8)	10 (F1 - F10)	
Real Time Clock	Battery-backed time clock timestamps critical data. Accuracy +/- 2 minutes per month			
Memory Options Available Flash / RAM	Standard 64 MB / 64 MB, Not Expandable			
Electrical Communciation Port	RS232 and (1) USB Only or Ethernet, RS232, (1) USB, plus optional DH485, DH+, or Remote I/O modules, ControlNet and DeviceNet modules			
Power Requirements	18-30V dc or 85-264V ac @ 47-63 Hz			
Power Consumption	dc Power: 25 Watts max. (1.0A @ 24V dc) ac Power: 60 VA max.			
Programming	FactoryTalk View Studio for Machine Edition or FactoryTalk View Studio Enterprise Series			
Environmental Operating Temperature	0-55° C (32-131° F)			
Storage Temperature	-25 - 70° C (-13 - 158° F)			
Humidity	5-95%, noncondensing @ 0-55° C			
Ratings	NEMA 12, 13, 4X, IP54, IP65			
Certifications	cUL certified; UL listed; Class I, Div 2, Groups A,B,C,D; Class II, Div 2, Groups F, G, Class III, T4, Class I Zone 2 Group IIC			
Mechanical Weight Keypad or Key / Touch	.563 kg (1.24 lb)	.635 kg(1.40lb)	.930 kg (2.05 lb)	.930 kg (2.05 lb)
Weight Touch only	N/A	N/A	.789 kg (1.74 lb)	.789 kg (1.74 lb)
Dimensions Overall (H x W x D)	Keypad: 152 x 185 x 90 mm (6.0 x 7.28 x. 3.54 in)	Keypad or Keypad/Touch: 152 x 185 x 90 mm (6.0 x 7.28 x. 3.54 in)	Keypad or Keypad/Touch: 167 x 266 x 98 mm (6.58 x 10.47 x 3.86 in) Touch only: 152 x 185 x 98 mm (6.0 x 7.28 x 3.86 in)	
Cutout Dimensions	Keypad: 123 x 156 mm (4.86 x 6.15 in)	Keypad or Keypad/Touch: 123 x 156 mm (4.86 x 6.15 in)	Keypad or Keypad/Touch: 142 x 241 mm (5.61 x 9.50 in); Touch Only: 123 x 156 mm (4.86 x 6.15 in)	

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PanelView Plus Terminals

Allen-Bradley

Catalog Number 2711P
400, 600, 700, 1000, 1250, 1500 Terminals

User Manual

Allen-Bradley Rockwell Software

Rockwell Automation

Important User Information

Solid state equipment has operational characteristics differing from those of electromechanical equipment. Safety Guidelines for the Application, Installation and Maintenance of Solid State Controls (publication SGI-1.1 available from your local Rockwell Automation sales office or online at http://www.rockwellautomation.com/literature/) describes some important differences between solid state equipment and hard-wired electromechanical devices. Because of this difference, and also because of the wide variety of uses for solid state equipment, all persons responsible for applying this equipment must satisfy themselves that each intended application of this equipment is acceptable.

In no event will Rockwell Automation, Inc. be responsible or liable for indirect or consequential damages resulting from the use or application of this equipment.

The examples and diagrams in this manual are included solely for illustrative purposes. Because of the many variables and requirements associated with any particular installation, Rockwell Automation, Inc. cannot assume responsibility or liability for actual use based on the examples and diagrams.

No patent liability is assumed by Rockwell Automation, Inc. with respect to use of information, circuits, equipment, or software described in this manual.

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Throughout this manual, when necessary, we use notes to make you aware of safety considerations.

WARNING	Identifies information about practices or circumstances that can cause an explosion in a hazardous environment, which may lead to personal injury or death, property damage, or economic loss.
IMPORTANT	Identifies information that is critical for successful application and understanding of the product.
ATTENTION	Identifies information about practices or circumstances that can lead to personal injury or death, property damage, or economic loss. Attentions help you identify a hazard, avoid a hazard, and recognize the consequence
SHOCK HAZARD	Labels may be on or inside the equipment, for example, a drive or motor, to alert people that dangerous voltage may be present.
BURN HAZARD	Labels may be on or inside the equipment, for example, a drive or motor, to alert people that surfaces may reach dangerous temperatures.

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The information below summarizes the changes to this manual since the last revision.

Revision bars, as shown in the margin, identify updated information. This document includes the following changes.

Topic	Page
Added information on new web-enabled ViewPoint software	11
Corrected touchscreen stylus tip radius	15, 16, 21, 22, 88
Removed referenced to Remote I/O and DeviceNet communication modules for the 400 and 600 terminals	14
Removed referenced to Remote I/O and DeviceNet communication modules for the 700 to 1500 terminals	19
Updated catalog number configuration	23
Updated catalog number table for logic modules	24
Updated catalog number table for communication modules	25
Updated component compatibility tables	142
Updated information on configuration mode access	218
Updated controller cable charts	166, 167, 168

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Objectives

This preface provides information on these topics.

- Intended audience
- Parts list
- Additional resources
- Software and firmware upgrades

Intended Audience

Use this manual if you are responsible for installing, operating, or troubleshooting the PanelView Plus or PanelView Plus CE terminals.

No special knowledge is required to understand this manual or operate the terminal. However, you must understand the functions and operations of FactoryTalk View Machine Edition (ME) applications that will run on the terminal. Consult the application designer for this information.

Equipment installers must be familiar with standard panel installation techniques.

Parts List

The PanelView Plus terminals are shipped with these items.

- Power terminal block
- FactoryTalk View ME runtime software, preloaded
- Mounting levers for 400 and 600 terminals, quantity eight
- Mounting clips for 700 to 1500 terminals, quantity four to eight
- Installation instructions
- Panel cutout template

Additional items are shipped with the PanelView Plus CE terminals.

- Windows CE .NET operating system preloaded with Terminal Services and Internet Explorer
- PanelView Plus CE Accessory CD with utilities and software development kit for C++
- Microsoft Windows CE license agreement

Additional Resources

For additional information, refer to these publications, that you can download from http://literature.rockwellautomation.com.

Resource	Description
DeviceNet Communications for PanelView Plus Terminals User Manual, publication 2711P-UM004	Provides procedures for creating a DeviceNet application to run on a PanelView Plus terminal.
ControlNet Communications for PanelView Plus Terminals User Manual, publication 2711P-UM003	Provides procedures for creating a ControlNet application to run on a PanelView Plus terminal.
Modbus Applications for PanelView Plus Terminals User Manual, publication 2711P-UM002	Provides procedures for creating a Modbus application to run on a PanelView Plus terminal.
Wiring and Grounding Guidelines for PanelView Plus Devices Technical Data, publication 2711P-TD001	Provides grounding and wiring guidelines for PanelView Plus terminals.
Software Development Kit for PanelView Plus CE Terminals User Manual, publication 2711P-UM005	Provides information for programmers to develop CE applications for PanelView Plus CE terminals.

You may also want to refer to:

- online help for FactoryTalk View Studio or RSLinx software.
- documentation for your controller.

Software and Firmware Upgrades

To receive software updates (software serial number required) and firmware upgrades for your terminal:

- call your local Rockwell Automation sales office or distributor.
- access http://support.rockwellautomation.com

Overview

Chapter Objectives

This chapter gives an overview of the PanelView Plus terminals.

- Software support
- PanelView Plus 400 and 600 features
- PanelView Plus 700 to 1500 features
- Catalog number configuration
- Product components

Software Support

Each PanelView Plus and PanelView Plus CE terminal is preloaded with FactoryTalk View Machine Edition runtime and terminal configuration software that does not require activation. Machine Edition applications for the terminals are created using FactoryTalk View Studio software.

Users, other than equipment operators, can view a running Machine Edition application in read-only mode within a Web browser using ViewPoint software. This software is an add-on capability provided with FactoryTalk View Studio.

IMPORTANT ViewPoint software requires terminals with a Series E or later logic module and a minimum of 128 MB RAM. You can also order an internal CompactFlash card with FactoryTalk View software, catalog number 2711P-RW*x* , to support any series logic module, catalog number 2711P-RP*xx*.

The open Windows CE.NET environment of the PanelView Plus CE terminals provides:

- familiar Windows desktop and user interface.
- terminal server-client support to configured servers
- Internet Explorer web browser.
- software development kit to support custom C++ applications for Windows CE.NET operating system.
- third-party device support for Windows CE.NET operating system.
- Windows CE.NET operating system provides these programs:
  - File viewers for MS Office: Excel, Word, PowerPoint
  - PDF file viewer
  - WordPad text editor
  - WebServer application
  - FTP server

  - Support for the .NET compact framework

Some of the above software applications are included on the PanelView Plus CE Accessory CD.

PanelView Plus 400 and 600 Terminals

The PanelView Plus 400 and 600 terminals offer:

- base-configured units.
- communication modules.
- power supply, AC or DC.
- grayscale and color displays.

The PanelView Plus 400 and 600 terminals are HMI devices that provide these features:

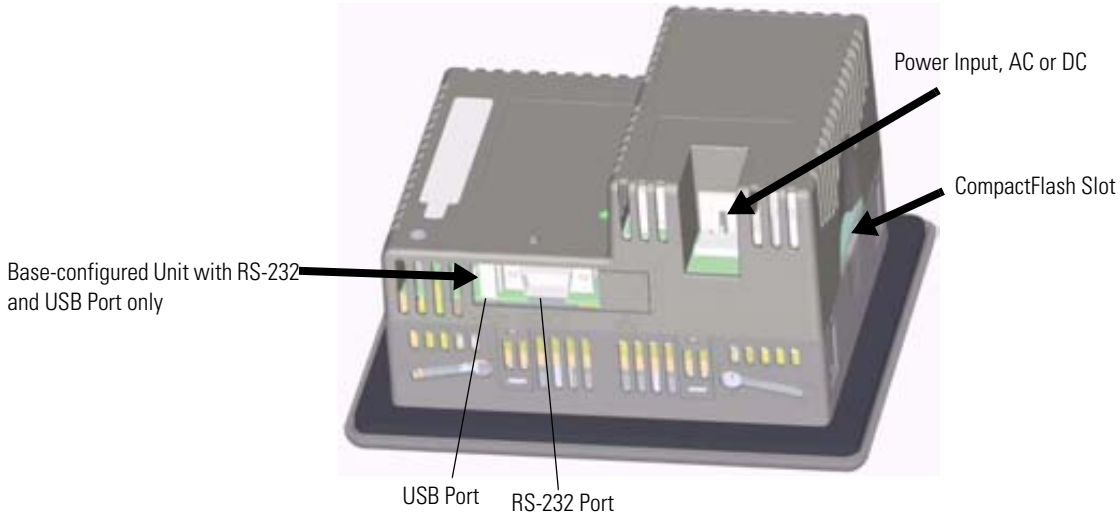
- PanelView Plus 400 terminals
  - Color or grayscale graphic displays
  - Keypad or keypad and touch screen input support
- PanelView Plus 600 terminals
  - Color or grayscale graphic displays
  - Keypad, touch screen, or keypad and touch screen input
- Base-configured unit
  - RS-232 only
  - RS-232, Ethernet, and modular communications interface
- Communication modules provide add-on capability to base-configured units with a modular communications interface
- Power input, AC (85…264V) or DC (18…30V)
- CompactFlash card slot supports Type 1 CompactFlash cards
- USB port for attaching mouse, keyboard, printer, bar code scanner, and other devices
- Same panel cutouts as the PanelView Standard 550 terminals

Base-configured Units

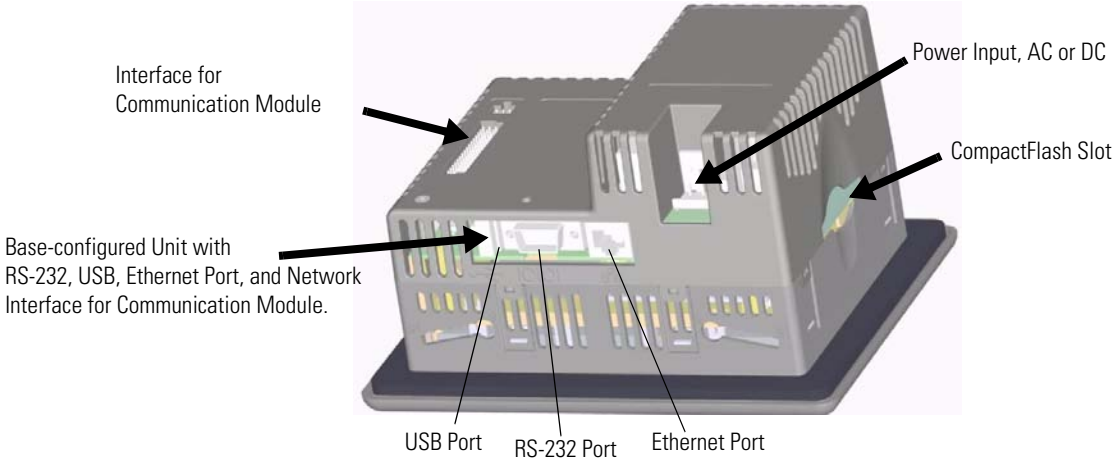
The base-configured unit of the 400 and 600 terminals is available in two versions.

- Base unit with RS-232 port and one USB port
- Base unit with RS-232 port, 10/100BaseT Ethernet port, one USB port, and a network interface for a communication module

Base Unit with RS-232 Only



Base Unit with RS-232, Ethernet Port, and Modular Communications Interface

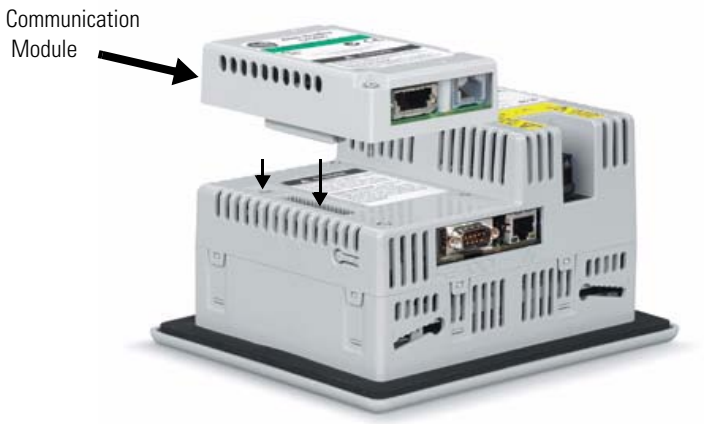


Communication Modules

You can attach a communication module with a network interface to the base-configured unit of the PanelView Plus 400 and 600 terminals to increase your communication capability with these networks:

- DH-485
- DH+
- Isolated RS-232
- ControlNet

The communication module installs easily on the back of the unit.



Power Options

The base-configured unit of the PanelView Plus 400 and 600 terminals is available with either AC (85…264V) or DC (18…30V) power input providing application flexibility.

Display and Input Options

PanelView Plus 400 and 600 terminals are available with these display and operator input options:

- 400 terminals: 3.8 in. grayscale (320 x 240) graphics display with keypad or 3.5 in. (320 x 240) color with keypad or keypad and touch support
- 600 terminals: 5.5 in. color or grayscale (320 x 240) graphics display with keypad, touch screen, or keypad and touch support

Touch Screen

The PanelView Plus 600 terminals offer an analog resistive touch screen for touch input.

600 Touch Grayscale or Color Terminal

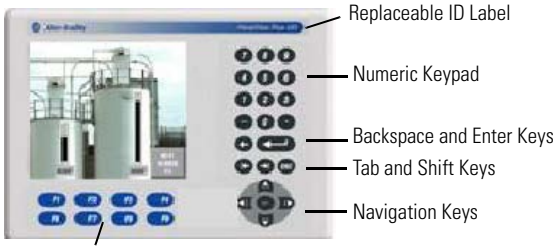
IMPORTANT The touch screen may be operated with a finger, gloved finger, or plastic stylus device with a minimum tip radius of 1.3 mm (0.051 in.) to prevent damage to the touch screen. Using any other object or tool may damage the touch screen.

Keypad or Keypad and Touch

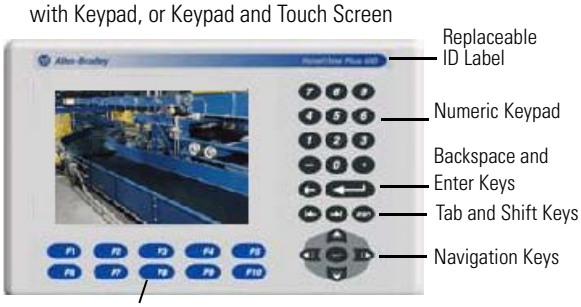
The keypad versions of the PanelView Plus 400 and 600 terminals are available with these options:

- 400 terminals: grayscale display with keypad or color display with keypad or keypad and touch input
- 400 and 600 terminals offer an analog resistive touch screen for touch input.
- 600 terminals: color or grayscale displays with either keypad, or keypad and touch input

400 Grayscale with Keypad, or 400 Color with Keypad or Keypad and Touch



600 Grayscale or Color Terminal with Keypad, or Keypad and Touch Screen



Keys		Description
400 600	F1 through F8 F1 through F10	Programmable keys that initiate functions on terminal display. Replaceable legends are available for the 600 terminals allowing for custom function key labels.
Numeric Keypad		0…9, ., -, Backspace, Enter, Left and Right Tab keys, Shift keys
Navigation Keys		Use the arrow keys for navigation. Use the Alt+arrow keys to activate home, end, page up, and page down functions.

IMPORTANT The keypad is designed for finger or gloved finger operation. The touch screen may be operated with a finger, gloved finger, or plastic touch screen stylus with a minimum tip radius of 1.3 mm (0.051 in.) to prevent damage to the touch screen. Using any other object or tool may damage the touch screen or keypad.

PanelView Plus 700 to 1500 Terminals

This section gives an overview of the PanelView Plus 700, 1000, 1250, 1250H, and 1500 terminals.

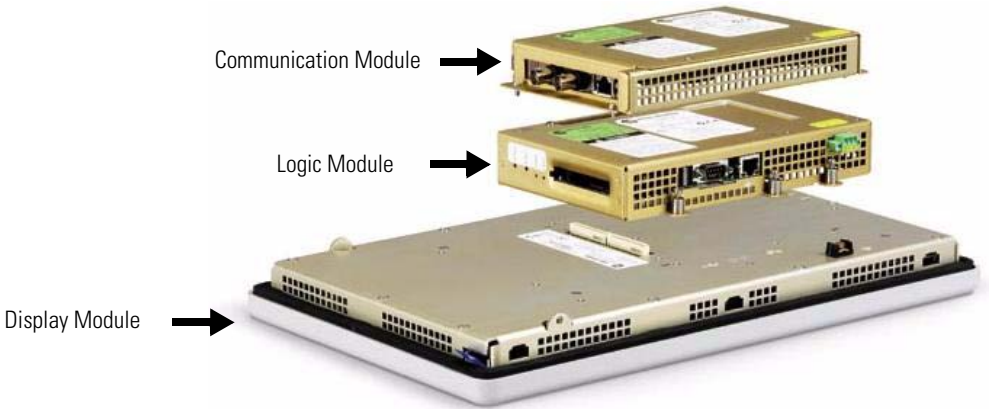
- Modular components
- Base-configured unit
- Communication modules
- Logic module, standard or CE
- Power supply, AC or DC
- Display modules

The PanelView Plus 700 to 1500 terminals are HMI devices that offer these features:

- Graphic color-display modules with keypad, touch screen, or keypad and touch screen support
- Analog resistive touch screen
- Ethernet and serial communications
- Modular communication interface for easy add-on capability
- Memory expansion modules for field upgrades to 256 MB RAM and 512 MB CompactFlash
- Power input, AC (85…264V AC) or DC (18…32V DC)
- CompactFlash card slot supports Type 1 CompactFlash cards
- USB ports provide connections for keyboard, mouse, and printer
- Field replaceable bezels
- Same panel cutouts as the PanelView Standard and PanelView Enhanced terminals
- Standard or CE logic module

Modular Components

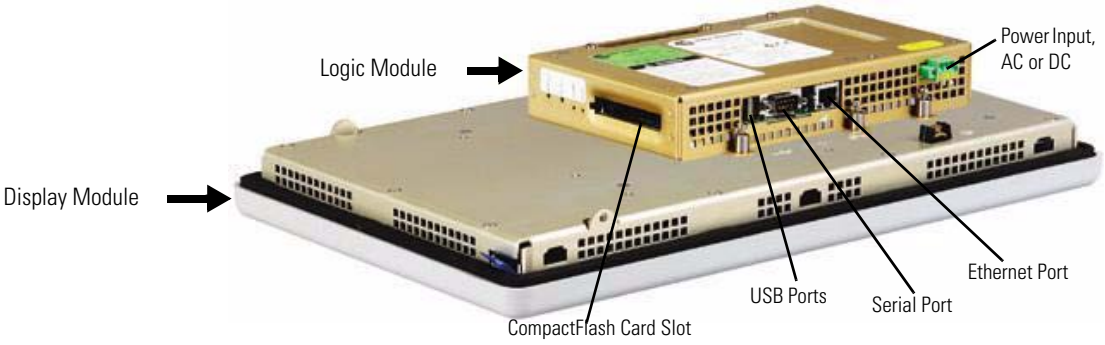
The terminals use modular components allowing for flexible configuration, installation, and upgrades. You can order items as separate components or factory assembled per your configuration.



Base-configured Unit

The base-configured unit of the terminal consists of:

- display module (700, 1000, 1250, 1500) with keypad, touch, or keypad and touch input.
- logic module.



The logic module contains:

- 24V DC input (18…32V) or AC input (85…264V).
- SDRAM and flash memory, various sizes.
- 10/100 BaseT Ethernet port.
- serial RS-232 port for file transfers, printing, and logic controller communications.
- two USB ports for attaching mouse, keyboard, or printer.
- card slot for Type I CompactFlash cards.
- battery-backed real-time clock.

Logic Modules and CompactFlash

The logic module is available with or without internal CompactFlash. The contents of the internal CompactFlash is what differentiates a PanelView Plus device from a PanelView Plus CE device.

- For the PanelView Plus terminals, the internal CompactFlash contains FactoryTalk View ME software and flash memory.
- For the PanelView Plus CE terminals, the internal CompactFlash contains the open Windows CE operating system, FactoryTalk View ME software, and flash memory.

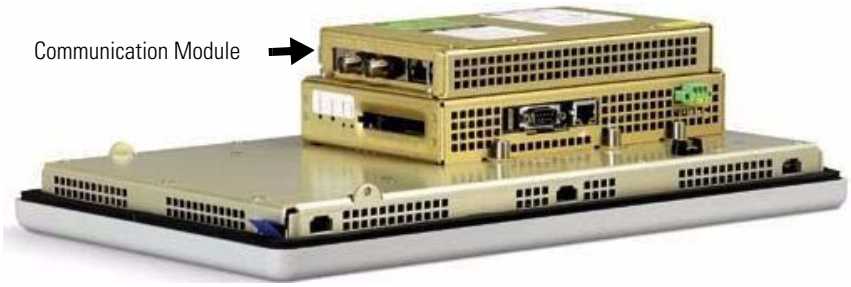
The internal CompactFlash is available in different sizes and can be ordered separately or bundled with the logic module.

Communication Modules

You can attach a communication module with a network interface to the base-configured unit of the terminal to increase your communication capability with these networks:

- DH+/DH-485
- ControlNet

The communication module installs easily on top of the logic module on the back of the unit.



Power Options

The basic configured units of the 700 to 1500 PanelView Plus terminals provide application flexibility with three available power power options:

- AC (85...264V)
- unisolated DC (18...32V)
- isolated DC (18...32V)

For DC applications using AC power, a remote AC-to-DC power supply, cat. no. 2711P-RSACDIN, is available for DIN-rail mounting.

Display Modules

The terminals offer a range of TFT color graphic displays with either keypad, touch screen, or keypad and touch screen support.

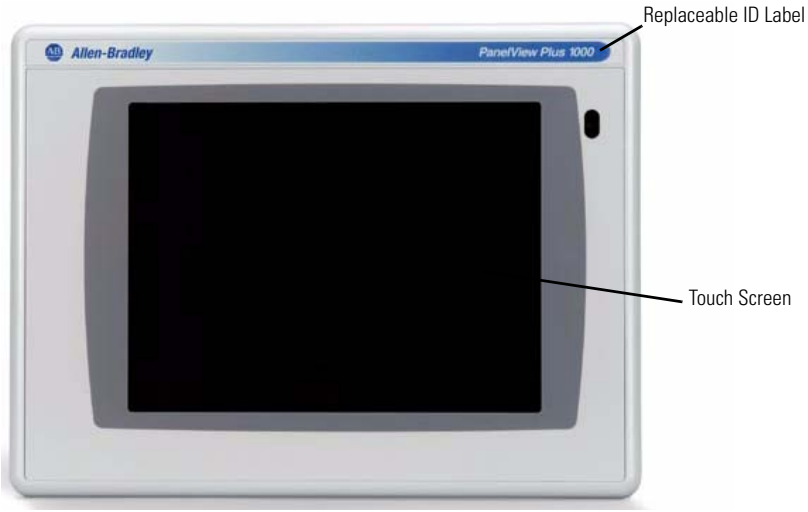
- 700 (6.5 in.)
- 1000 (10.4 in.)
- 1250 (12.1 in.)
- 1500 (15 in.)

The 700 and 1250 touch displays are available in conformal-coated options. A 1250 high-bright, touch display module is available for outdoor installations. Plus the 1250 and 1500 touch displays offer an integral antiglare overlay.

All displays have common features and firmware providing for easy migration to a larger display. Field-replaceable bezels are also available.

Touch Screen

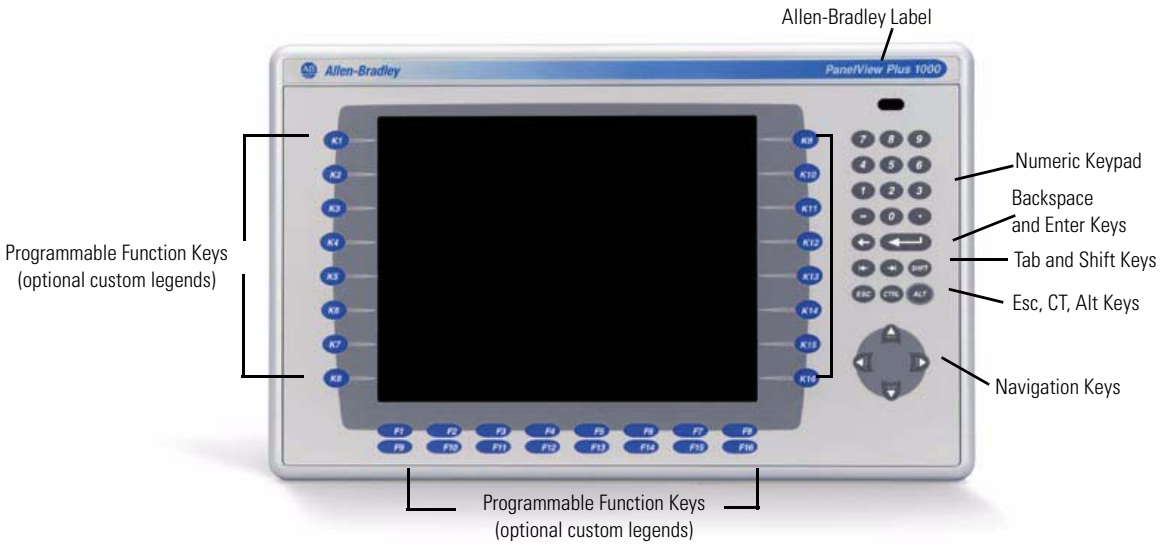
Touch-screen displays are analog resistive and similar except for size.



IMPORTANT The touch screen may be operated with a finger, gloved finger, or plastic stylus device with a minimum tip radius of 1.3 mm (0.051 in.) to prevent damage to the touch screen. Using any other object or tool may damage the touch screen.

Keypad or Keypad and Touch

All displays are similar except for size and the number of function keys available.



IMPORTANT The keypad is designed for finger or gloved finger operation. The touch screen may be operated with a finger, gloved finger, or plastic stylus device with a minimum tip radius of 1.3 mm (0.051 in.) to prevent damage to the touch screen. Using any other object or tool may damage the touch screen or keypad.

The K*xx* and F*xx* function keys on the keypad terminals are programmable.

Function Keys	Description
Function Keys 700 (F1 through F10, K1 through K12) 1000 (F1 through F16, K1 through K16) 1250 (F1 through F20, K1 through K20) 1500 (F1 through F20, K1 through K20)	Programmable keys that initiate functions on terminal display. Replaceable legends are available for the terminals allowing for custom function key labels.
Numeric Keypad	0…9, ., -, Backspace, Enter, Left and Right tab, Shift, Esc, Ctrl, Alt keys.
Navigation Keys	Use the arrow keys to move cursor in lists and select objects. Alt+arrow key activates home, end, page up, page down functions.

Catalog Number Configuration

The table shows the catalog number explanation for configured versions of the PanelView Plus and PanelView Plus CE terminals. Not all combinations of options are available for sale.

	Input Type	Display Size	Display Type	Communication [1]	Power	Logic Module with Flash and RAM Memory [2]	Special Option[2]
2711P-	**K** = Keypad	**4** = 3.5 in.	**C** = Color	**PanelView Plus 400 and 600**	**A** = AC	**1**= Logic Module 64 MB	**K** = Conformal-Coated[3]
	T = Touch	**6** = 5.5 in.	**M**=Grayscale	**5** = RS-232 & USB	**D** = DC	**2** = Logic Module 128 MB	**M** = Marine Certified
	B = Keypad/Touch	**7** = 6.5 in.		**20** = Ethernet, RS-232 & USB plus Communication Module Interface		**6** = CE Logic Module with 128 MB	
		10 = 10.4 in.				**7** = CE Logic Module with 256 MB	
		12 = 12.1 in.		**PanelView Plus 700 to 1500**			
		15 = 15 in.		**4** = Ethernet, RS-232 & (2) USB			

(1) Additional communication options are available and listed on page 25 in the following section.

(2) Applies to PanelView Plus 700 to 1500 terminals only.

(3) Applies to PanelView Plus 700 and 1250 terminals only.

PanelView Plus Product Components

Components are available as separate catalog numbers for field installation or replacement.

Display Modules (700 to 1500 only)

Cat. No.	Description
2711P-RDK7C	700 keypad color display
2711P-RDT7C	700 touch color display
2711P-RDT7CM	700 touch color display, marine certified
2711P-RDB7C	700 keypad and touch color display
2711P-RDB7CM	700 keypad and touch color display, marine certified
2711P-RDT7CK	Conformal-coated 700 touch color display
2711P-RDK10C	1000 keypad color display
2711P-RDT10C	1000 touch color display
2711P-RDT10CM	1000 touch display, marine certified
2711P-RDB10C	1000 keypad and touch color display
2711P-RDB10CM	1000 keypad and touch display, marine certified
2711P-RDK12C	1250 keypad color display
2711P-RDT12C	1250 touch color display
2711P-RDT12AG	1250 touch color display with antiglare overlay
2711P-RDT12CK	Conformal-coated 1250 touch color display
2711P-RDT12H	1250 high-bright touch color display
2711P-RDB12C	1250 keypad and touch color display

Display Modules (700 to 1500 only)

Cat. No.	Description
2711P-RDK15C	1500 keypad color display
2711P-RDT15C	1500 touch color display
2711P-RDT15AG	1500 touch color display with antiglare overlay
2711P-RDB15C	1500 keypad and touch color display

Logic Modules (700 to 1500 only)

Cat. No.	Description
Standard Logic Modules for PanelView Plus Terminals	
2711P-RP	Logic module without flash/RAM memory, DC input
2711P-RPD	Logic module, without memory, isolated DC input, marine certified
2711P-RPA	Logic module without flash/RAM memory, AC input, marine certified
2711P-RP1	Logic module with 64 MB flash/64 MB RAM, DC input
2711P-RP1A	Logic module with 64 MB flash/64 MB RAM, AC input, marine certified
2711P-RP1D	Logic module with 64MB, isolated DC input, marine certified
2711P-RP2	Logic module with 128 MB flash/128 MB RAM, DC input (1)
2711P-RP2A	Logic module with 128 MB flash/128 MB RAM, AC input, marine certified (1)
2711P-RP2D	Logic module with 128MB, isolated DC input, marine certified (1)
2711P-RP2DK	Conformal-coated logic module with 128MB, isolated DC input (1)
2711P-RP2K	Conformal-coated logic module with 128 MB flash/128 MB RAM, DC input (1)
2711P-RP3	Logic module with 256 MB flash/256 MB RAM, DC input (1)
2711P-RP3A	Logic module with 256 MB flash/256 MB RAM, AC input, marine certified (1)
2711P-RP3D	Logic module with 256MB, isolated DC input, marine certified (1)
CE Logic Modules for PanelView Plus CE Terminals	
2711P-RP6	CE logic module with 128 MB flash/128 MB RAM, DC input (1)
2711P-RP6A	CE logic module with 128 MB flash/128 MB RAM, AC input, marine certified (1)
2711P-RP6D	CE logic module with 128MB, isolated DC input, marine certified(1)
2711P-RP6DK	CE conformal-coated logic module with 128MB, isolated DC input(1)
2711P-RP6K	CE conformal-coated logic module with 128 MB flash/128 MB RAM, DC input (1)

Logic Modules (700 to 1500 only)

Cat. No.	Description
2711P-RP7	CE logic module with 256 MB flash/256 MB RAM, DC input [1]
2711P-RP7A	CE logic module with 256 MB flash/256 MB RAM, AC input, marine certified [1]
2711P-RP7D	CE logic module with 256 MB, isolated DC input, marine certified[1]

[1] Compatible with ViewPoint Software.

Communication Modules

Terminal Type	Cat. No.	Description
400 and 600	2711P-RN3	DH-485 communication module
	2711P-RN8	DH+ communication module
	2711P-RN15C	ControlNet communication module
	2711P-RN22C	RS-232 isolated communication module
700 to 1500	2711P-RN6	DH+/DH-485 communication module
	2711P-RN6K	Conformal-coated DH+/DH-485 communication module
	2711P-RN15S	ControlNet communication module, marine certified
	2711P-RN15SK	Conformal-coated ControlNet communication module

Internal Compact Flash

Cat. No.	Description
Internal CompactFlash for Standard Logic Modules	
2711P-RW1	64 MB CompactFlash with FactoryTalk View ME software
2711P-RW2	128 MB CompactFlash with FactoryTalk View ME software
2711P-RW3	256 MB CompactFlash with FactoryTalk View ME software

Internal Compact Flash

Cat. No.	Description
Internal CompactFlash for CE Logic Modules	
2711P-RW6	128 MB CompactFlash with FactoryTalk View ME software and the open Windows CE operating system for the CE logic module
2711P-RW7	256 MB CompactFlash with FactoryTalk View ME software and the open Windows CE operating system for the CE logic module
2711P-RW8	512 MB CompactFlash with FactoryTalk View ME software and the open Windows CE operating system for the CE logic module

RAM Memory (700 to 1500 only)

Cat. No.	Description
2711P-RR64	64 MB SODIMM memory
2711P-RR128	128 MB SODIMM memory
2711P-RR256	256 MB SODIMM memory

Compact Flash Cards (Blank)

Cat. No.	Description
2711P-RC2	128 MB blank CompactFlash card
2711P-RC3	256 MB blank CompactFlash card
2711P-RC4	512 MB blank CompactFlash card
2711P-RCH	CompactFlash to PCMCIA adapter

Legend Kits

Cat. No.	Description
2711P-RFK6	Replacement legends strips for 600 keypad terminal
2711P-RFK7	Replacement legends strips for 700 keypad terminal
2711P-RFK10	Replacement legends strips for 1000 keypad terminal
2711P-RFK12	Replacement legends strips for 1250 keypad terminal
2711P-RFK15	Replacement legends strips for 1500 keypad terminal

Backlights (700 to 1500 only)

Cat. No.	Description
2711P-RL7C	Replacement color backlight for 700 series A and B display modules
2711P-RL7C2	Replacement color backlight for 700 series C and D display modules
2711P-RL10C	Replacement color backlight for 1000 series A display modules
2711P-RL10C2	Replacement color backlight for 1000 series B display modules
2711P-RL12C	Replacement color backlight for 1250 series A and B display modules
2711P-RL12C2	Replacement color backlight for 1250 series C display modules
2711P-RL15C	Replacement color backlight for 1500 series B display modules

Replacement Bezels

Cat. No.	Description
2711P-RBK7	Replacement bezel for 700 keypad terminal
2711P-RBT7	Replacement bezel for 700 touch terminal
2711P-RBB7	Replacement bezel for 700 keypad or keypad/touch terminal
2711P-RBK10	Replacement bezel for 1000 keypad terminal
2711P-RBT10	Replacement bezel for 1000 touch terminal
2711P-RBB10	Replacement bezel for 1000 keypad or keypad/touch terminal
2711P-RBK12	Replacement bezel for 1250 keypad terminal
2711P-RBT12	Replacement bezel for 1250 touch terminal
2711P-RBT12H	Replacement bezel for 1250 high-bright touch terminal
2711P-RBB12	Replacement bezel for 1250 keypad or keypad/touch terminal
2711P-RBK15	Replacement bezel for 1500 keypad terminal
2711P-RBT15	Replacement bezel for 1500 touch terminal
2711P-RBB15	Replacement bezel for 1500 keypad or keypad/touch terminal

Protective Antiglare Overlays

Cat. No.[(1)]	Description
2711P-RGK4	Antiglare overlay for PanelView Plus 400 grayscale terminal
2711P-RGB4	Antiglare overlay for PanelView Plus 400 color keypad/touch terminal
2711P-RGK6	Antiglare overlay for PanelView Plus 600 keypad or keypad/touch terminal
2711P-RGT6	Antiglare overlay for PanelView Plus 600 touch terminal
2711P-RGK7	Antiglare overlay for PanelView Plus 700 keypad or keypad/touch terminal
2711P-RGT7	Antiglare overlay for PanelView Plus 700 touch terminal
2711P-RGK10	Antiglare overlay for PanelView Plus 1000 keypad or keypad/touch terminal
2711P-RGT10	Antiglare overlay for PanelView Plus 1000 touch terminal
2711-RGK12	Antiglare overlay for PanelView Plus 1250 keypad or keypad/touch terminal
2711P-RGT12	Antiglare overlay for PanelView Plus 1250 touch and high-bright touch terminal
2711P-RGK15	Antiglare overlay for PanelView Plus 1500 keypad or keypad/touch terminal
2711P-RGT15	Antiglare overlay for PanelView Plus 1500 touch terminal

(1) All catalog numbers ship with a quantity of three overlays.

Adapter Plates

Cat. No.	Description
2711P-RAK4	Adapts a PanelView Plus 400 keypad terminal to a PanelView Standard 550 keypad cutout
2711P-RAK6	Adapts a PanelView Plus 600 keypad terminal to a PanelView Standard 600 keypad cutout
2711P-RAK7	Adapts a PanelView Plus 700 keypad terminal to a PanelView Standard 900 keypad cutout
2711P-RAT7	Adapts a PanelView Plus 700 touch terminal to a PanelView Standard 900 touch cutout
2711P-RAK10	Adapts a PanelView Plus 1000 keypad terminal to a PanelView 1000/1000E keypad cutout
2711P-RAT10	Adapts a PanelView Plus 1000 touch terminal to a PanelView 1000/1000E touch cutout
2711P-RAK12E	Adapts a PanelView Plus 1250 (or PV1000/1000E) keypad terminal to a PanelView 1200/1400E keypad cutout
2711P-RAT12E2	Adapts a PanelView Plus 1250 (or PV1000/1000E) touch terminal to a PanelView 1200E touch cutout
2711P-RAT12E	Adapts a PanelView Plus 1250 (or PV1000/1000E) touch terminal to a PanelView 1400E touch cutout
2711P-RAK12S	Adapts a PanelView Plus 1250 (or PV1000/1000E) keypad terminal to a PanelView Standard 1400 keypad cutout
2711P-RAT12S	Adapts a PanelView Plus 1250 (or PV1000/1000E) touch terminal to a PanelView Standard 1400 touch cutout
2711P-RAK15	Adapts a PanelView Plus 1500 keypad or keypad/touch terminal to a PanelView 1200E/1400E keypad terminal
2711P-RAT15	Adapts a PanelView Plus 1500 touch terminal to a PanelView 1400E touch cutout

Cables

Cat. No.	Description
2711-NC13	RS-232 operating/programming cable (9-pin D-shell to 9-pin D-shell), 5 m (16.4 ft)
2711-NC14	RS-232 operating/programming cable (9-pin D-shell to 9-pin D-shell), 10 m (32.7 ft)
2711-NC17	Remote RS-232 serial cable (9-pin D-shell to 9-pin D-shell)
2711-NC21	RS-232 operating cable (9-pin D-shell to 8-pin mini DIN), 5 m (16.4 ft)
2711-NC22	RS-232 operating cable (9-pin D-shell to 8-pin mini DIN), 10 m (32.7 ft)
1761-CBL-AS03	DH-485 operating cable (6-pin Phoenix to RJ45), 3 m (10 ft)
1761-CBL-AS09	DH-485 operating cable (6-pin Phoenix to RJ45), 9 m (30 ft)
1746-C10	DH-485 network interface cable (SDL AMP to RJ45), 1.83 m (6 ft)
1746-C11	DH-485 network interface cable (SDL AMP to RJ45), .3 m (1 ft.)
1784-CP14	DH-485 network interface cable (5-pin Phoenix to RJ45)
2711P-CBL-EX04	Ethernet CAT5 crossover cable, industrial grade, 4.3 m (14 ft)

Communication Adapters

Cat. No.	Description
1761-NET-AIC	AIC+ advanced interface converter
1747-AIC	DH-485 isolated link coupler for use with DH-485 communication modules (2711P-RN3, 2711P-RN6)

Remote AC Power Supply (700 to 1500 only)

Cat. No.	Description
2711P-RSACDIN	DIN-rail power supply, AC-to-DC, 85…265V AC, 47…63 Hz

Miscellaneous

Cat. No.	Description
2711P-RVT12	Solar visor for outdoor high-bright 1250 touch screen display modules
2711P-RY2032	Replacement battery for 700 to 1500 terminals
2711P-RTMC	Replacement mounting clips for 700 to 1500 terminals, quantity of 8
2711P-RTFC	Replacement mounting levers for 400 and 600 terminals, quantity of 8
2711P-RVAC	Replacement AC power terminal block for 400 and 600 terminals
2711-TBDC	Replacement DC power terminal block for 400 and 600 terminals
2711P-RTBDC3 (1)	Three-position terminal block for DC logic modules, series A to D
2711P-RTBDC2 (1)	Two-position terminal block for DC logic modules, series E or later
2711P-RTBAC3(1)	Three-position terminal block for all AC logic modules

(1) Catalog numbers ship with a quantity of ten.

Firmware Upgrade Kits

Cat. No.	Description
2711P-RU310	PanelView Plus media kit includes firmware upgrade wizard, one firmware license, certificate of authenticity, end user license agreement.
2711P-RUA3 10	PanelView Plus advanced media kit includes the 2711P-RU310 media kit, PCMCIA to compact flash adapter, and 32 MB CompactFlash card.
2711P-RUL01	Firmware upgrade license kit with one PanelView Plus firmware license.(1)
2711P-RUL05	Firmware upgrade license kit with five PanelView Plus firmware licenses.(1)
2711P-RUL10	Firmware upgrade license kit with 10 PanelView Plus firmware licenses.(1)
2711P-RUL25	Firmware upgrade license kit with 25 PanelView Plus firmware licenses.(1)
2711P-RUL50	Firmware upgrade license kit with 50 PanelView Plus firmware licenses.(1)

(1) Also includes certificate of authenticity, end user license agreement, installation instructions.

Installation

Chapter Objectives

This chapter provides pre-installation information and procedures on how to install the terminals.

- Hazardous locations
- Environment and enclosure
- Outdoor installation for 1250 high-bright display module
- Required tools
- Clearances
- Panel cutout dimensions
- Mount the 400 or 600 terminal in a panel
- Mount the 700 to 1500 terminals in a panel
- Product dimensions

Hazardous Locations

When marked, this equipment is suitable for use in these locations:

- Class I, Division 2, Groups A, B, C, D
- Class I, Zone 2, Group IIC
- Class II, Division 2, Groups F, G
- Class III
- ordinary, nonhazardous locations

The following statement applies to use in hazardous locations.

WARNING

Explosion Hazard

- Do not disconnect equipment unless power has been removed and area is known to be nonhazardous.
- Do not disconnect connections to this equipment unless power has been removed and the area is known to be nonhazardous.
- Substitution of components may impair suitability for Class 1, Division 2.
- Peripheral equipment must be suitable for the location it is used in.
- The battery or realtime clock module in this product must only be changed in an area known to be nonhazardous.
- All wiring must be in accordance with Class I, Division 2, Class II, Division 2, or Class III, Division 2 wiring methods of Articles 501, 502 or 503, as appropriate, of the National Electrical Code and/or in accordance with Section 18-1J2 of the Canadian Electrical Code, and in accordance with the authority having jurisdiction.

The terminals have a temperature code of T4 when operating in a 55 °C (131 °F) maximum ambient temperature. Do not install the terminals in environments where atmospheric gases have ignition temperatures **less** than 135 °C (275 °F).

USB Ports

The terminals contain universal serial bus (USB) ports that comply with hazardous location environments. This section details the field-wiring compliance requirements and is provided in accordance with the National Electrical Code, article 500.

PanelView Plus 400, 600, and 700 to 1500 Terminals Control Drawing

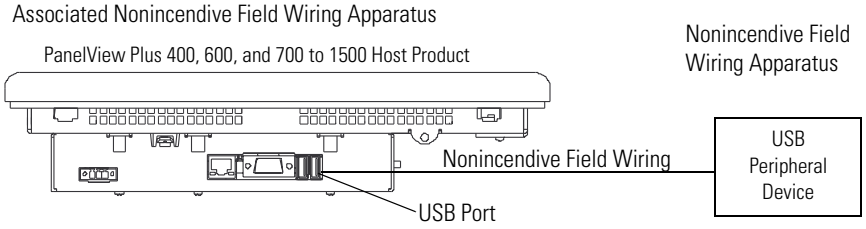


Table 1 - PanelView Plus 400, 600, and 700 to 1500 USB Port Circuit Parameters

Display Size	V_{oc}	I_{sc}	C_a		L_a	
			Groups A and B	Groups C and D	Groups A and B	Groups C and D
400 and 600 Series A and B	5.25V DC	1.68 A	10 µF	10 µF	15 µH	15 µH
400 and 600 Series C or later	5.25V DC	1.68 A	10 µF	10 µF	3.5 µH	15 µH
700 to 1500	5.25V DC	1.68 A	10 µF	10 µF	15 µH	15 µH

Selected nonincendive field wiring apparatus must have nonincendive circuit parameters conforming with Table 2.

Table 2 - Required Circuit Parameters for the USB Peripheral Device

V_{max}	≥	V_{oc}
I_{max}	≥	I_{sc}
$C_i + C_{cable}$	≤	C_a
$L_i + L_{cable}$	≤	L_a

Application Information

Per the National Electrical Code the circuit parameters of nonincendive field wiring apparatus for use in hazardous locations shall be coordinated with the associated nonincendive field wiring apparatus such that their combination remains nonincendive. The PanelView Plus terminal and the USB peripheral device shall be treated in this manner.

The circuit parameters of the PanelView Plus terminal USB port are given in Table 1. The USB peripheral device and its associated cabling shall have circuit parameters with the limits given in Table 2 for them to remain nonincendive when used with the PanelView Plus terminal USB port. If cable capacitance and inductance are not known the following values from ANSI/ISA-RP 12.06.01-2003 may be used:

C_{cable} = 197pF/m (60 pF/ft)
L_{cable} = 0.7 µH/m (0.20 µH/ft)

Nonincendive field wiring must be wired and separated in accordance with 501.10(B)(3) of the National Electrical Code (NEC) ANSI/NFPA 70 or other local codes as applicable.

This associated nonincendive field wiring apparatus has not been evaluated for use in combination with another associated nonincendive field wiring apparatus.

Symbol Definitions

V_{oc}	Open circuit voltage of the host USB port.
I_{sc}	Maximum output current of the host USB port.
V_{max}	Maximum applied voltage rating of the USB peripheral device. V_{max} shall be greater than or equal to V_{oc} in Table 1. ($V_{max} \geq V_{oc}$).
I_{max}	Maximum current to which the USB peripheral device can be subjected. I_{max} shall be greater than or equal to I_{sc} in Table 1. ($I_{max} \geq I_{sc}$).
C_i	Maximum internal capacitance of the USB peripheral device.
C_a	Maximum allowed capacitance of the USB peripheral device and its associated cable. The sum of C_i of the USB peripheral device and C_{cable} of the associated cable shall be less than or equal to C_a . ($C_i + C_{cable} \leq C_a$).
L_i	Maximum internal inductance of the USB peripheral device.
L_a	Maximum allowed inductance of the USB peripheral device and its associated cable. The sum of L_i of the USB peripheral device and L_{cable} of the associated cable shall be less than or equal to L_a . ($L_i + L_{cable} \leq L_a$).

Environment and Enclosure

ATTENTION

This equipment is intended for use in a Pollution Degree 2 industrial environment, in overvoltage Category II applications (as defined in IEC 60664-1), at altitudes up to 2000 m (6561 ft) without derating.

The terminals are intended for use with programmable logic controllers. Terminals that are AC powered must be connected to the secondary of an isolating transformer. Terminals that are DC Class 2 powered may be supplied from an isolated DC source when used with the indicated fuse kit.

This equipment is considered Group 1, Class A industrial equipment according to IEC/CISPR 11. Without appropriate precautions, there may be difficulties ensuring electromagnetic compatibility in residential and other environments due to conducted or radiated disturbances.

This equipment is supplied as open-type equipment. It must be mounted within an enclosure that is suitably designed for those specific environmental conditions that will be present and appropriately designed to prevent personal injury resulting from accessibility to live parts. The interior of the enclosure must be accessible only by the use of a tool. The terminals meet specified NEMA Type and IEC ratings only when mounted in a panel or enclosure with the equivalent rating. Subsequent sections of this publication may contain additional information regarding specific enclosure type ratings that are required to comply with certain product safety certifications.

In addition to this publication, see:

- Industrial Automation Wiring and Grounding Guidelines, publication 1770-4.1, for additional installation requirements.
- NEMA Standards 250 and IEC 60529, as applicable, for explanations of the degrees of protection provided by different types of enclosure.

For more enclosure and certification information, refer to the PanelView Plus/PanelView Plus CE Outdoor High-bright Display Modules Installation Instructions, publication 2711P-IN026.

Outdoor Installation for High-bright Displays

When using the high-bright display module, cat. no. 2711P-RDT12H, outdoors, considerations in maximizing the field life of the front bezel and display are:

- selecting the proper enclosure.
- orientation of the terminal.

Both ultraviolet and infrared radiation can reduce the field life of any electronic device. While the materials used in the terminal bezels provide long field life, that life can be extended by proper installation.

Ultraviolet radiation from the sun causes all plastics to fade or yellow and become brittle over time. Using an antiglare overlay, cat. no. 2711P-RGT12, will protect the front of the terminal from direct exposure to UV radiation and greatly increase its field life.

When installing the high-bright display module in an environment where the front of the terminal will be in direct sunlight during the hottest part of the day and the external ambient temperature can exceed 40 °C (104 °F), use the visor kit, cat. no. 2711P-RVT12. The visor reduces the solar load on the front of the display and helps to maintain internal temperatures within specification.

The high-bright display module has a built-in temperature sensor that automatically reduces the backlight intensity if the temperature inside the cabinet exceeds 55 °C (131 °F). This reduces the risk of damage to the display.

The paint color, size, and power dissipated by the internal components of an enclosure affect the temperature rise inside the cabinet. Hoffman, a Rockwell Automation Encompass Partner, has information to assist you with enclosure selection and heating/cooling accessories to meet the temperature requirements of the installed equipment. See website http://www.hoffmanonline.com.

Stirring fans or active cooling may be required in high altitude and high ambient temperature locations to keep the internal enclosure temperature below 55 °C (131 °F). Use a heater in installations where the ambient temperature is below 0 °C (32 °F).

The backlight of the high-bright display generates a significant amount of heat when set to full intensity. To minimize the amount of heat generated and extend the life of the backlight, decrease the display intensity by using the screen saver with a 5…10 minute delay.

Avoid placing the terminal on the south (north in the southern hemisphere) or west side of the cabinet, if possible. This will reduce the heat rise due to solar loading during the hottest part of the day.

Mount the terminal vertically to minimize solar loading on the display. Do not mount the terminal in a sloped enclosure if it will be exposed to direct sunlight.

Required Tools

These tools are required for panel installation:

- Panel cutout tools
- Small, slotted screwdriver
- Torque wrench (lb•in) for tightening the mounting clips on the PanelView Plus 700 to 1500 and PanelView Plus CE terminals

Clearances

Allow adequate clearance around the terminal, inside the enclosure, for adequate ventilation. Consider heat produced by other devices in the enclosure. The ambient temperature around the terminals must be between 0…55 °C (32…131 °F).

Clearance Area	400 and 600 Terminals	700 to 1500 Terminals
Top	51 mm (2 in.)	51 mm (2 in.)
Bottom	102 mm (4 in.)	51 mm (2 in.)
Side[1]	25 mm (1 in.)	25 mm (1 in.)
Back	None	25 mm (1 in.)

(1) Minimum side clearance for insertion of memory card and cable wiring is 102 mm (4 in.).

Cutout Dimensions

Use the full size template shipped with your terminal to mark the cutout dimensions.

Terminal Type	Height mm (in.)	Width mm (in.)
PanelView Plus 400 and 600 Terminals		
400 Keypad or Keypad and Touch	123 (4.86)	156 (6.15)
600 Keypad or Keypad and Touch	142 (5.61)	241 (9.50)
600 Touch	123 (4.86)	156 (6.15)
PanelView Plus and PanelView Plus CE 700 to 1500 Terminals		
700 Keypad or Keypad and Touch	167 (6.57)	264 (10.39)
700 Touch	154 (6.08)	220 (8.67)
1000 Keypad or Keypad and Touch	224 (8.8)	375 (14.75)
1000 Touch	224 (8.8)	305 (12.00)
1250 Keypad or Keypad and Touch	257 (10.11)	390 (15.35)
1250 Touch and 1250 High-bright Touch	257 (10.11)	338 (13.29)
1500 Keypad or Keypad and Touch	305 (12.00)	419 (16.50)
1500 Touch	305 (12.00)	391 (15.40)

Mount the 400 or 600 Terminal in a Panel

Mounting levers secure the terminal to the panel. The number of levers you use (4 or 6) varies by terminal type.

ATTENTION

Disconnect all electrical power from the panel before making the panel cutout.

Make sure the area around the panel cutout is clear.

Take precautions so metal cuttings do not enter any components already installed in the panel.

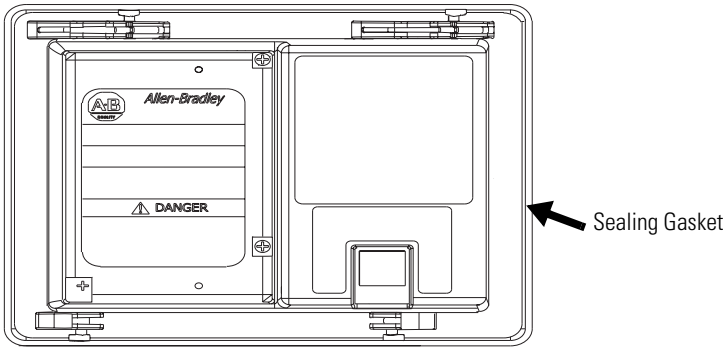
Failure to follow these warnings may result in personal injury or damage to panel components.

Follow these steps to mount the 400 or 600 terminals in a panel.

1. Cut an opening in the panel by using the panel cutout shipped with the terminal.
2. If a communication module is ordered separately, attach the module to the base unit before panel installation.

   Refer to the instructions shipped with module.
3. Make sure the terminal sealing gasket is properly positioned on the terminal.

   This gasket forms a compression-type seal. Do not use sealing compounds.



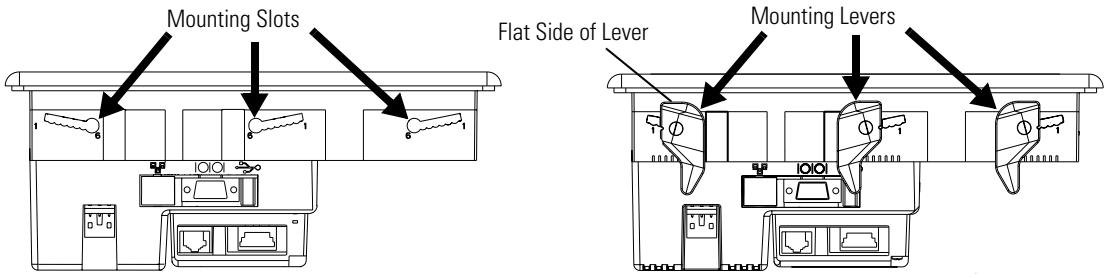
4. Install legend strips before installing the terminal if you are using keypad legend strips on a 600 keypad terminal.

   Be careful not to pinch legend strip during installation.
5. Place the terminal in the panel cutout.

   If installing the terminal in an existing 550 panel cutout, align the terminal with the center of the cutout for best gasket sealing.

6. Insert all mounting levers into the mounting slots on the terminal.

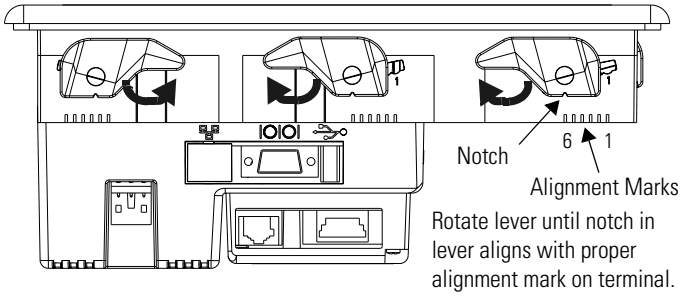
Slide each lever until the flat side of the lever touches the surface of the panel.

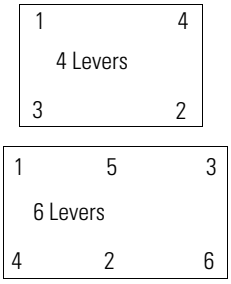


7. When all levers are in place, slide each lever an additional notch or two until you hear a click.

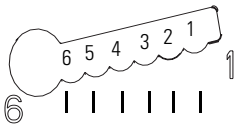
8. Rotate each lever in the direction indicated until it is in the final latch position.

Follow the latching sequence for the optimum terminal fit.





Use this table as a guide to provide an adequate gasket seal between the terminal and the panel.

	Lever Position	Panel Thickness Range	Typical Gauge
 Terminal Markings	1	1.5…2.01 mm (0.060…0.079 in.)	16
	2	2.03…2.64 mm (0.08…0.104 in.)	14
	3	2.67…3.15 mm (0.105…0.124 in.)	12
	4	3.17…3.66 mm (0.125…0.144 in.)	10
	5	3.68…4.16 mm (0.145…0.164 in.)	8/9
	6	4.19…4.75 mm (0.165…0.187 in.)	7

ATTENTION

Follow instructions to provide a proper seal and to prevent potential damage to the product. Rockwell Automation assumes no responsibility for water or chemical damage to the terminal or other equipment within the enclosure because of improper installation.

Mount the 700 to 1500 Terminal in a Panel

Mounting clips secure the terminal to the panel. The number of clips you use (4, 6, or 8) varies by terminal type.

ATTENTION

Disconnect all electrical power from the panel before making the panel cutout.

Make sure the area around the panel cutout is clear.

Take precautions so metal cuttings do not enter any components already installed in the panel.

Failure to follow these warnings may result in personal injury or damage to panel components.

Follow these steps to mount a 700 to 1500 terminal in a panel.

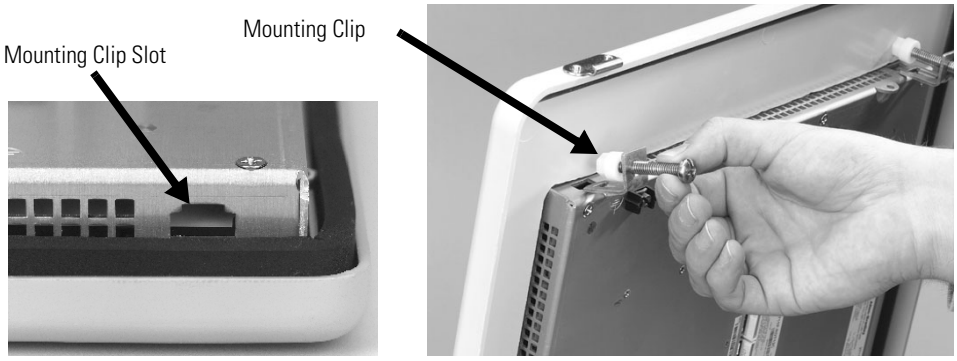
1. Cut an opening in the panel by using the panel cutout shipped with the terminal.
2. Make sure the terminal sealing gasket is properly positioned on the terminal.

   This gasket forms a compression-type seal. Do not use sealing compounds.

3. Install the legend strips before installing the terminal if you are using keypad legend strips on keypad terminals.

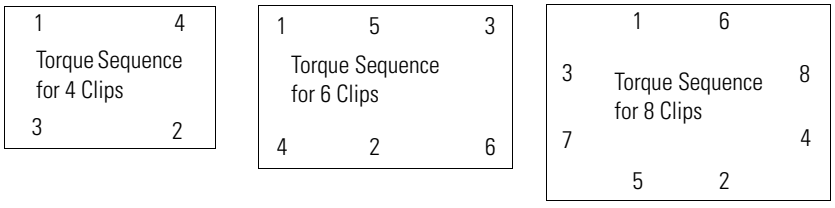
   Be careful not to pinch the legend strip during installation.
4. Place the terminal in the panel cutout.

5. Slide the ends of the mounting clips into the slots on the terminal.



6. Tighten the mounting clip screws by hand until the gasket seal contacts the mounting surface uniformly.

7. Tighten the mounting clips screws to a torque of 0.90…1.1 Nm (8…10 lb•in) by using the specified sequence, making sure not to overtighten.



ATTENTION

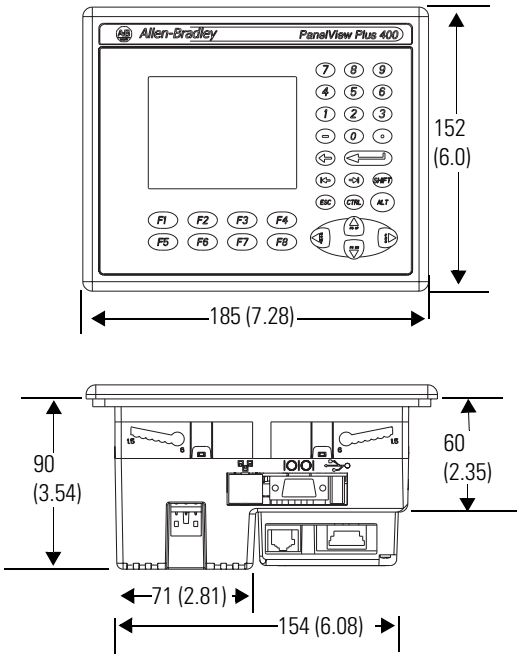
Tighten the mounting clips to the specified torque to provide a proper seal and to prevent damage to the product. Allen-Bradley assumes no responsibility for water or chemical damage to the product or other equipment within the enclosure because of improper installation.

Product Dimensions

Product dimensions for each terminal are in mm (in.).

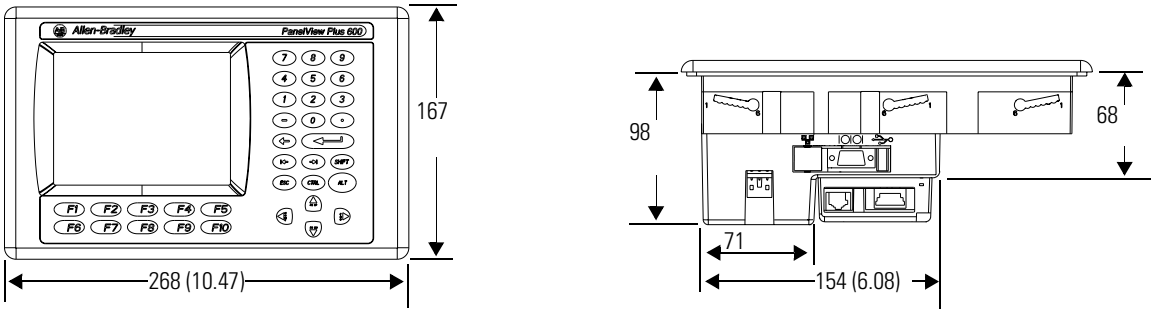
PanelView Plus 400 Dimensions

400 Keypad or Keypad/Touch Terminal

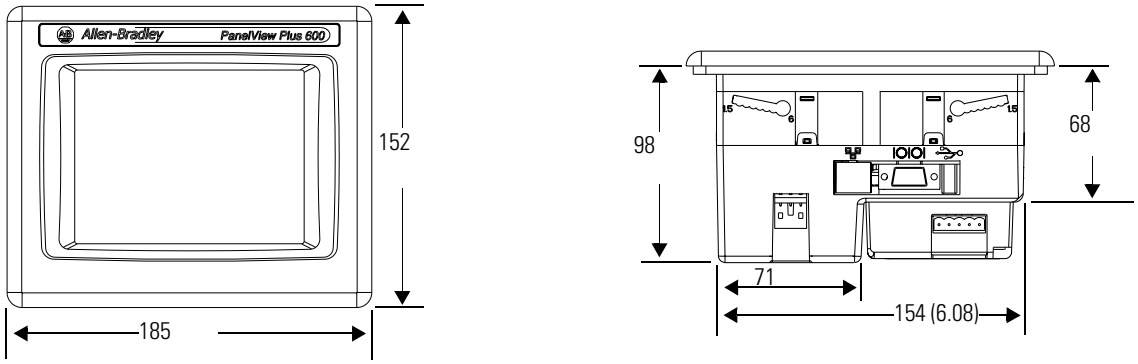


PanelView Plus 600 Dimensions

600 Keypad or Keypad/Touch Terminal



600 Touch Terminal

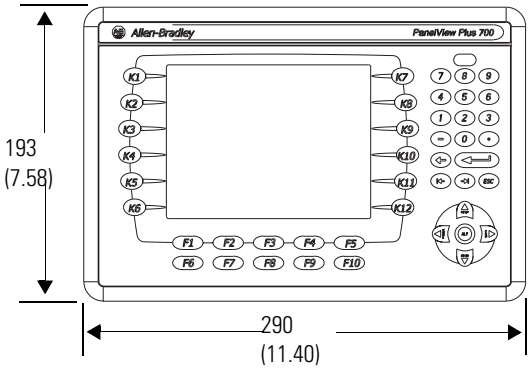


The depth dimensions are shown for:

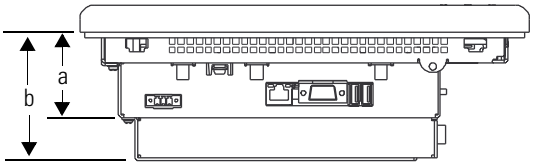
- base-configured unit (display module and logic module).
- base-configured unit with communication module.

PanelView Plus and PanelView Plus CE 700 Dimensions

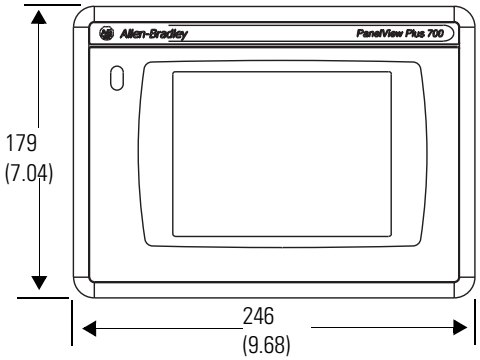
700 Keypad or Keypad/Touch Terminal



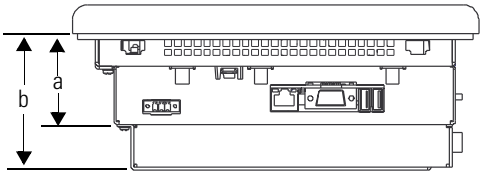
a 55 (2.18) Display to Logic Module



700 Touch Screen Terminal



a 55 (2.18) Display to Logic Module
b 83 (3.27) Display to Communication Module

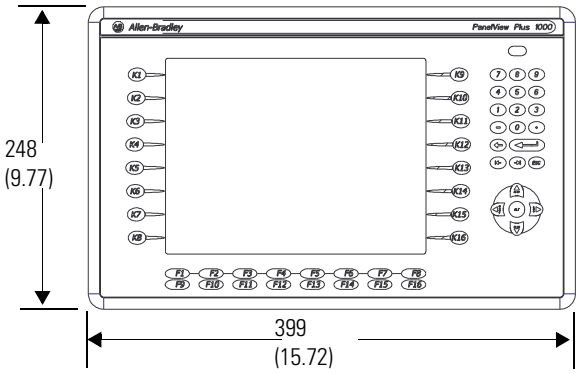


The depth dimensions are shown for:

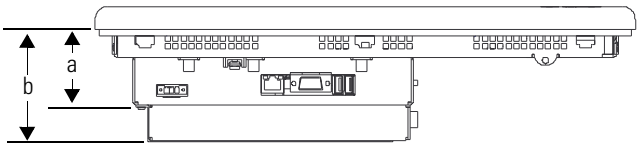
- base-configured unit (display module and logic module).
- base-configured unit with communication module.

PanelView Plus and PanelView Plus CE 1000 Dimensions

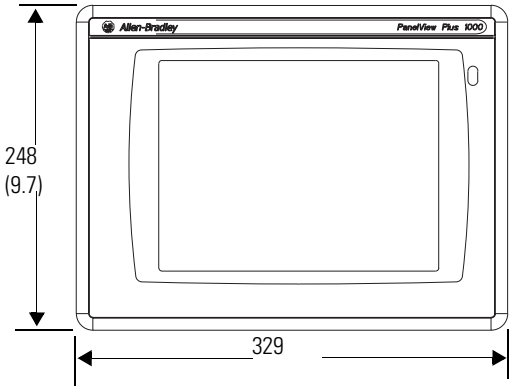
1000 Keypad or Keypad/Touch Terminal



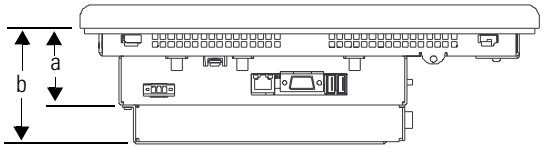
a 55 (2.18) Display to Logic Module
b 83 (3.27) Display to Communication Module



1000 Touch Screen Terminal



a 55 (2.18) Display to Logic Module
b 83 (3.27) Display to Communication Module

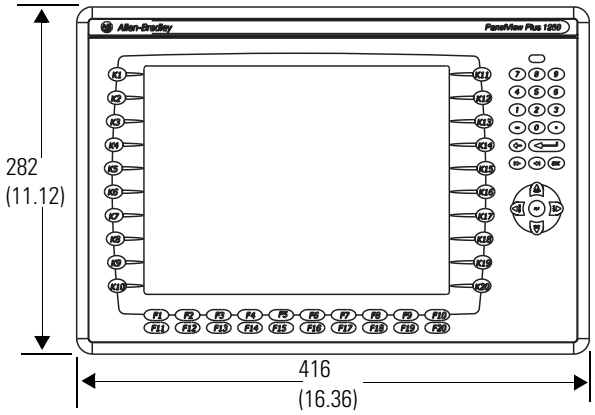


The depth dimensions are shown for:

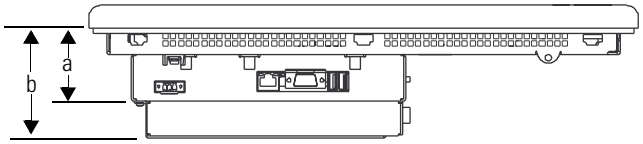
- base-configured unit (display module and logic module).
- base-configured unit with communication module.

PanelView Plus and PanelView Plus CE 1250 Dimensions

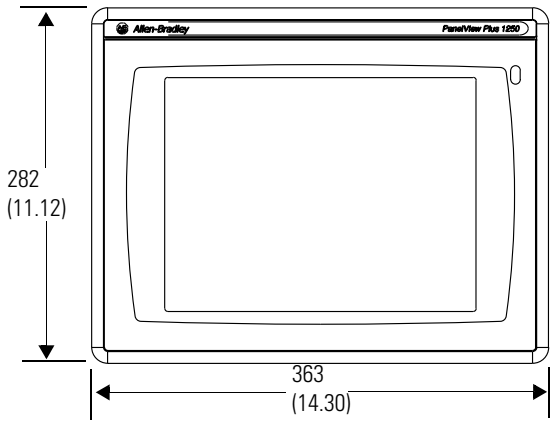
1250 Keypad or Keypad/Touch Terminal



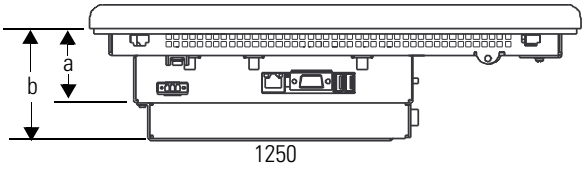
a 55 (2.18) Display to Logic Module
b 83 (3.27) Display to Communication Module



1250 Touch Screen Terminal

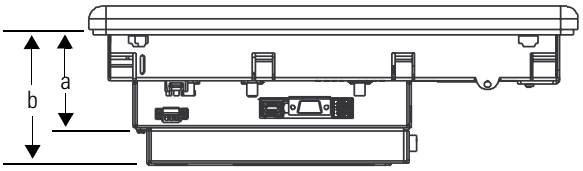


a 55 (2.18) Display to Logic Module
b 83 (3.27) Display to Communication Module



1250

a 74 (2.90) Display to Logic Module
b 101 (3.99) Display to Communication Module



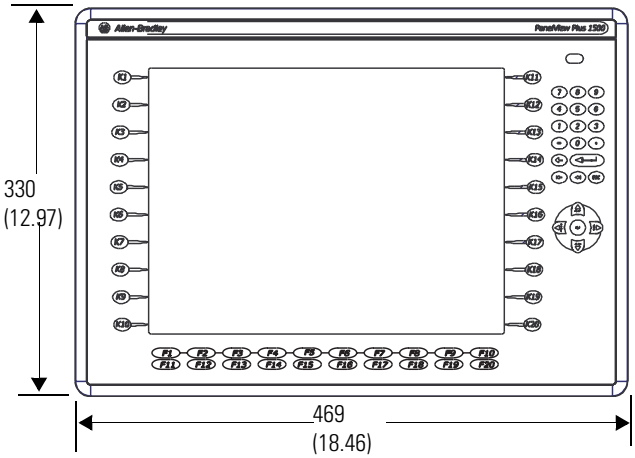
1250 High-bright

The depth dimensions are shown for:

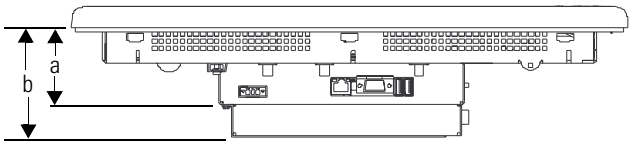
- base-configured unit (display module and logic module).
- base-configured unit with communication module.

PanelView Plus and PanelView Plus CE 1500 Dimensions

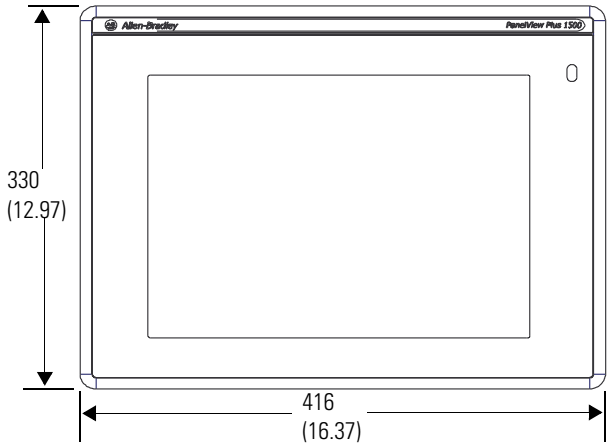
1500 Keypad or Keypad/Touch Terminal



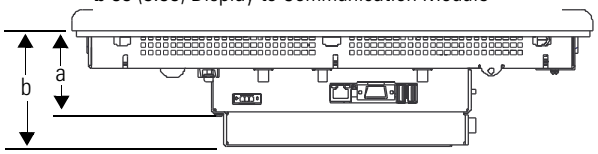
a 65 (2.55) Display to Logic Module
b 93 (3.65) Display to Communication Module



1500 Touch Screen Terminal



a 65 (2.55) Display to Logic Module
b 93 (3.65) Display to Communication Module



Power Connections

Chapter Objectives

This chapter covers wiring and safety guidelines, and provides procedures to:

- remove and install the power terminal block.
- connect DC power.
- connect AC power.
- reset the terminal.

Wiring and Safety Guidelines

Use publication NFPA 70E Electrical Safety Requirements for Employee Workplaces, IEC 60364 Electrical Installations in Buildings, or other applicable wiring safety requirements for the country of installation when wiring the devices. In addition to the NFPA guidelines:

- connect the device and other similar electronic equipment to its own branch circuit.
- protect the input power by a fuse or circuit breaker rated at no more than 15 A.
- route incoming power to the device by a separate path from the communication lines.
- cross power and communication lines at right angles if they must cross.
- Communication lines can be installed in the same conduit as low-level DC I/O lines (less than 10V).
- shield and ground cables appropriately to avoid electromagnetic interference (EMI).
- Grounding minimizes noise from EMI and is a safety measure in electrical installations.

For more information on grounding recommendations, refer to the National Electrical Code published by the National Fire Protection Association.

For more information, refer to Wiring and Grounding Guidelines for PanelView Plus Devices, publication 2711P-TD001. You can locate this publication in the literature library at this website http://literature.rockwellautomation.com.

Remove and Install the Power Terminal Block

The terminals are shipped with the power terminal block installed. You can remove the terminal block for ease of installation, wiring, and maintenance.

WARNING

Explosion Hazard

Substitution of components may impair suitability for hazardous locations.

Do not disconnect equipment unless power has been switched off and area is known to be nonhazardous.

Do not connect or disconnect components unless power has been switched off.

All wiring must comply with N.E.C. articles 501, 502, 503, and/or C.E.C. section 18-1J2 as appropriate.

Peripheral equipment must be suitable for the location in which it is used.

ATTENTION

Disconnect all power before installing or replacing components. Failure to disconnect power may result in electrical shock or damage to the terminal.

400 and 600 Terminals

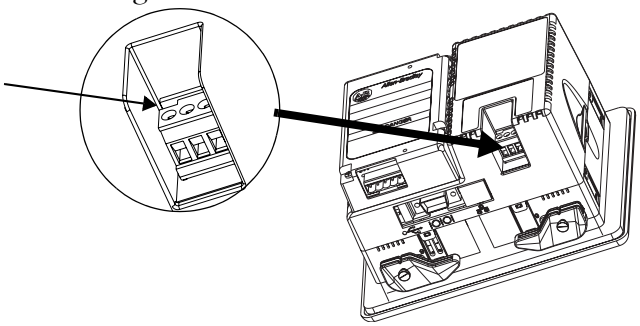
ATTENTION

The AC and DC terminal blocks are keyed and marked differently so be sure to follow markings. Do not force terminal blocks into connectors to prevent potential damage to terminal.

Follows these steps to remove the terminal block in the PanelView 400 and 600 terminals.

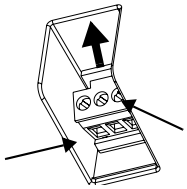
1. Insert the tip of small, flat-blade, screwdriver into the terminal block access slot.

2. Gently pry the terminal block away from terminal to release the locking mechanism.



Follow these steps to replace the terminal block.

1. Press terminal block base in first with block leaning outward.



2. Gently push the top of the terminal block back to the vertical position to snap in locking tab.

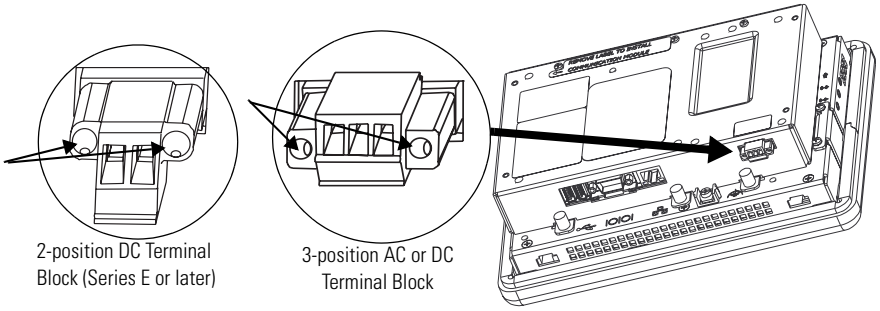
700 to 1500 Terminals

The terminal block used by the 700 to 1500 terminals depends on the series of the logic module and the power input type.

- Series A to D, DC logic modules use a 3-position terminal block.
- Series E or later, DC logic modules use a 2-position terminal block.
- All logic modules with an AC power input use a 3-position terminal block.

Follow these steps to remove the terminal block.

1. Loosen the two screws that secure the terminal block.
2. Gently pull the terminal block away from the connector.



Follow these steps to install the terminal block.

1. Reattach the terminal block to the connector until seated.
2. Tighten the two screws that secure the terminal block to the connector.

DC Power Connections

PanelView Plus terminals with an integrated, 24V DC power supply have these power ratings

Power Type	Terminal	Input Range
DC	400 and 600	24V DC nom (18…30 V DC) 25 W max (1.0 A at 24V DC)
	700 to 1500	24V DC nom (18…32 V DC) 70 W max (2.9 A at 24V DC)

The power supply is internally protected against reverse polarity of the DC+ and DC- connections. Connecting DC+ or DC- to the earth terminal may damage the device.

The input power terminal block is removeable and supports these wire sizes.

Wire Specifications for DC Power Terminal Block

Terminal	Wire Type		Dual-wire Gauge[1]	Single-wire Gauge	Terminal Screw Torque
400 and 600	Stranded or solid	Cu 90 °C (194 °F)	22…16 AWG	22…14 AWG	0.45…0.56 Nm (4…5 lb•in)
700 to 1500 logic module series A to D					0.23…0.34 Nm (2…3 lb•in)
700 to 1500 logic module series E and later					0.56 Nm (5 lb•in)

(1) Two-wire max. per terminal.

External Power Supply For Non-insolated DC Terminals

TIP To identify non-isolated DC logic modules refer to the Logic Modules (700 to 1500 only) table on page 24.

TIP All 400 and 600 DC terminals contain non-isolated DC power supplies.

Use a single, 24V DC power supply to power each PanelView Plus device, such as cat. no. 2711P-RSACDIN. Using a separate, isolated and ungrounded source to power each terminal prevents ground loop currents from damaging the terminals.

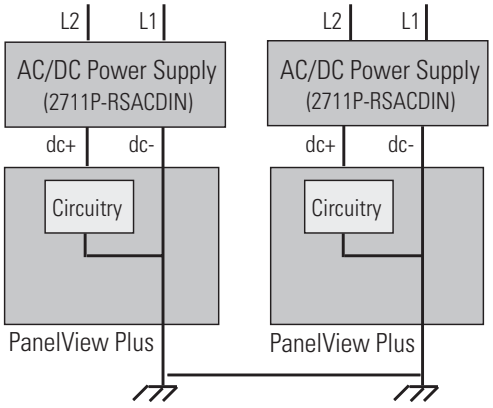
The output on the power supply must be isolated from the input and not connected to earth/ground.

The non-isolated power supply does not provide galvanic isolation. A Class 2 or Safety Extra-Low Voltage (SELV) isolated power supply with a 24V DC nominal output voltage is required to power the terminal.

ATTENTION

Use a Class 2 or SELV supply as required by local wiring codes for your installation. The Class 2 and SELV power sources provide protection so that under normal and single-fault conditions, the voltage between the conductors, and between the conductors and functional earth or protective earth does not exceed a safe value.

Multiple AC Power Supplies to Power Multiple DC Terminals



External Power for 700 to 1500 Isolated DC Terminals (2711P-R*xx*D*x* Logic Modules)

Use an SELV or PELV 24V DC power supply, such as cat. no. 2711P-RSACDIN, to power the isolated DC PanelView Plus terminal.

The isolated DC terminals may be powered by the same power source as other equipment, by a DC power bus.

ATTENTION

Use an SELV or PELV supply as required by local wiring codes for your installation. The SELV and PELV power sources provide protection so that under normal and single fault conditions, the voltage between conductors and earth/ground does not exceed a safe value.

Earth/Ground Connection

PanelView Plus devices with a DC power input have an earth/ground terminal that you must connect to a low-impedance earth/ground.

IMPORTANT The earth/ground connection to ground is mandatory. This connection is required for noise immunity, reliability, and Electromagnetic Compliance (EMC) with the European Union (EU) EMC directive for CE-mark conformance and is required for safety by Underwriters Laboratory.

- The 700 to 1500 terminals have the earth/ground connection on the rear of the display module.
- The 400 and 600 terminals have the functional earth/ground connection on the power input terminal block.

The earth terminal requires a minimum wire gauge.

Earth Wire Specifications for DC Power

Terminal	Symbol	Wire Type		Wire Gauge	Terminal Screw Torque
400 and 600	⏚	Stranded or solid	Cu 90 °C (194 °F)	14…12 AWG	0.45…0.56 Nm (4…5 lb•in)
700 to1500	⏚ GND			14…10 AWG	1.13…1.36 Nm (10…12 lb•in)

On most PanelView Plus DC terminals, the earth/ground terminal is internally connected to the DC- terminal within the product.

ATTENTION

Damage or malfunction can occur when a voltage potential exists between two separate ground points. Make sure the terminal does not serve as a conductive path between ground points at different potentials.

The PanelView Plus terminals have isolated and nonisolated communication ports. Refer to Communication Port Isolation on page 169 for details.

IMPORTANT For more information, refer to Wiring and Grounding Guidelines for PanelView Plus Devices, publication 2711P-TD001.

Connect DC Power

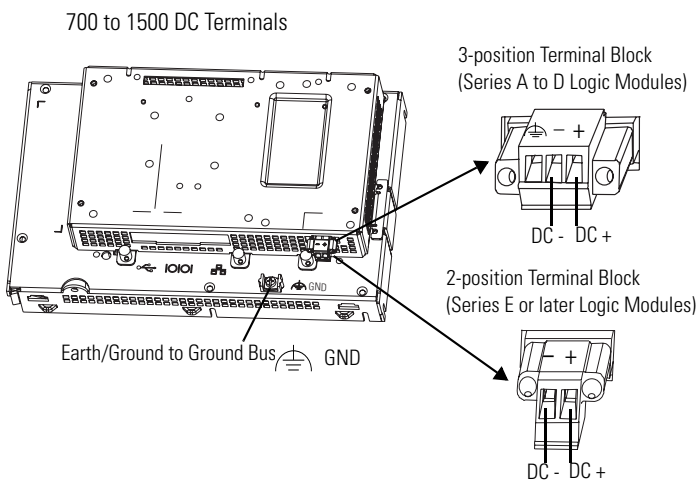
WARNING

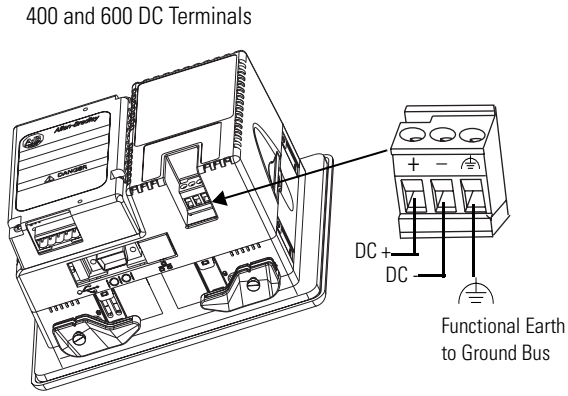
Explosion Hazard - Do not disconnect equipment unless power has been switched off and area is known to be nonhazardous.

Disconnect all power before installing or replacing components. Failure to disconnect power may result in electrical shock or damage to the terminal.

Follow these steps to connect the terminal to DC power.

1. Verify that the terminal is not connected to a power source.
2. Secure the DC power wires to the terminal block.
   Follow the markings on terminal blocks and terminal for proper connections.
3. Secure the earth/ground wire.
   - On the 400 and 600 terminals, secure the earth/ground wire to the functional earth/ground terminal on the input power terminal block.
   - On the 700 to 1500 terminals, secure the earth/ground wire to the earth/ground terminal screw at the bottom of the display.





4. Apply 24V DC power to the terminal.

AC Power Connections

PanelView Plus devices with an integrated AC power supply have these power ratings.

Terminal	Voltage Range	Frequency	V A
400 and 600	85…264V AC	47…63 Hz	60V A max
700 to 1500	85…264V AC	47…63 Hz	160V A max

The input power terminal block supports these wire sizes.

Wire Specifications for AC Power Terminal Block

Terminal	Wire Type		Dual-wire Gauge[1]	Single-wire Gauge	Terminal Screw Torque
400 and 600	Stranded or solid	Cu 90 °C (194 °F)	22…16 AWG	22…14 AWG	0.45…0.56 Nm (4…5 lb•in)
700 to 1500			22…16 AWG	22…14 AWG	0.56 Nm (5 lb•in)

(1) Two-wire max. per terminal

Protective Earth Connection

PanelView Plus devices with an AC power input have a protective earth/ground terminal that you must connect to a low-impedance earth/ground.

ATTENTION

The protective earth connection is required for both electrical safety and Electromagnetic Compliance (EMC) with the European Union (EU) EMC directive for CE-mark conformance.

The protective earth/ground connection is on the power input terminal block. The protective earth terminal requires a minimum wire gauge.

Protective Earth Wire Specifications for AC Power

Terminal	PE Symbol	Wire Type		Wire Gauge	Terminal Screw Torque
400 and 600	⏚	Stranded or solid	Cu 90 °C (194 °F)	14…12 AWG	0.45…0.56 Nm (4…5 lb•in)
700 to 1500				14…12 AWG	0.56 Nm (5 lb•in)

Functional Earth Connection

The PanelView Plus 700 to 1500 devices with an AC power input also have a functional earth connection on the back of the display.

IMPORTANT On 700 to 1500 devices, you must connect both protective earth and functional earth to ground.

The functional earth terminal requires a minimum wire gauge.

Functional Earth Wire Specifications for AC Power

Terminal	FE Symbol	Wire Type		Wire Gauge	Terminal Screw Torque
700 to 1500	GND	Stranded or solid	Cu 90 °C (194 °F)	14…10 AWG	1.13…1.36 Nm (10…12 lb•in)

ATTENTION

The functional earth and protective earth connections to ground are mandatory. The functional earth is required for Electromagnetic Compliance (EMC) with the European Union (EU) EMC directive for CE-mark conformance. The protective earth/ground connection is required for safety and regulatory compliance.

Connect AC Power

WARNING

Explosion Hazard - Do not disconnect equipment unless power has been switched off and area is known to be nonhazardous.

Disconnect all power before installing or replacing components. Failure to disconnect power may result in electrical shock or damage to the terminal.

ATTENTION

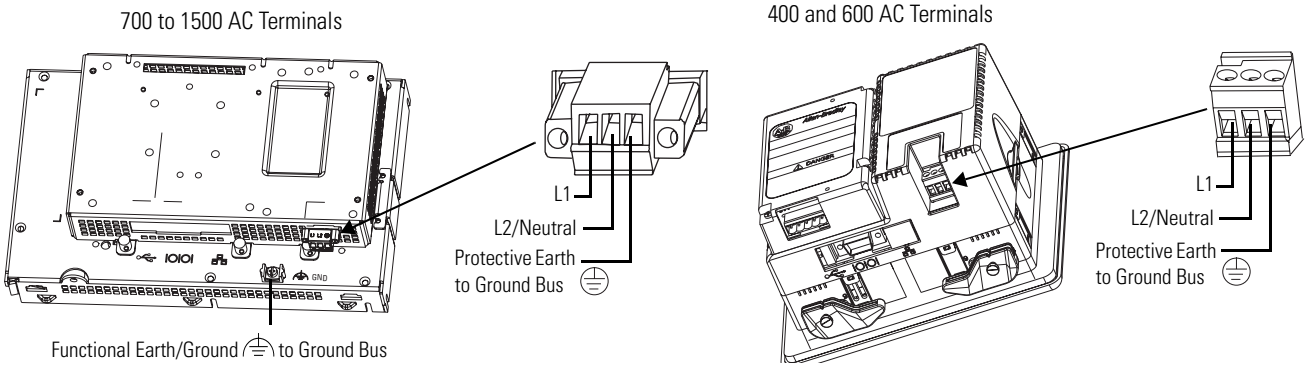
Improper wiring of the power terminals may result in voltage at the communication connector shells.

Do not apply power to the terminal until all wiring connections have been made. Failure to do so may result in electrical shock.

Follow these steps to connect the terminal to AC power.

1. Verify that the terminal is not connected to a power source.
2. Secure the AC power wires to the terminal block.

   Follow the markings on terminal blocks and terminal for proper connections.
3. Secure the protective earth/ground wire to the marked position of the power input terminal block.
4. On the 700 to 1500 devices, also secure the functional earth/ground wire to the functional earth terminal screw on the back of the display to ground bus.



5. Apply AC power to the terminal.

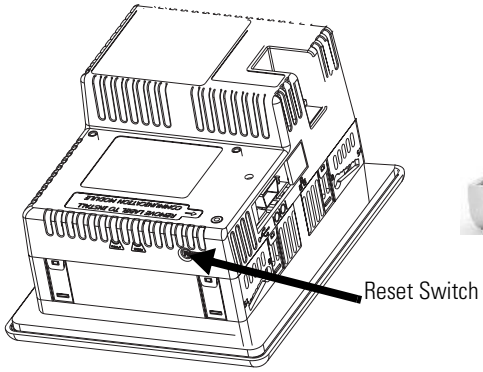
Reset the Terminals

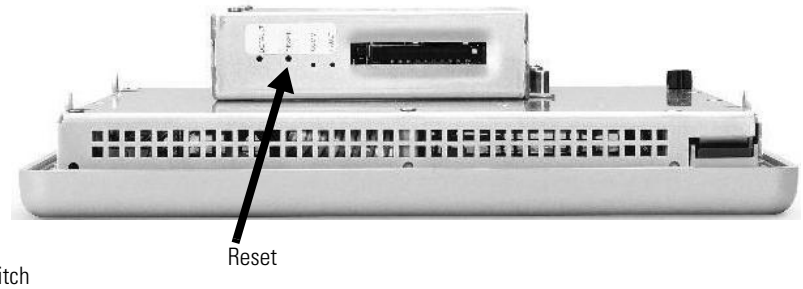
Use the reset switch to restart a terminal without having to disconnect and reapply power. After a reset, the terminal performs a series of startup tests and then either:

- runs the .MER application loaded in the terminal.
- opens the desktop on CE terminals only.
- enters Configuration mode.

The action that occurs depends on the startup options configured for your terminal.

Refer to Chapter 9, Troubleshoot the System, for a list of startup information and error messages.





- On 400 to 600 terminals, press the reset switch with your finger or a nonconductive object.
- On 700 to 1500 terminals, insert a thin, nonconductive probe into the hole marked reset and press the switch.

ATTENTION

Use a nonconductive object to press the reset or default switch. Do not use a conducting object such as a paper clip or you may damage the terminal. Do not use the tip of a pencil; graphite may damage the terminal.

Configuration Mode

Chapter Objectives

This chapter shows how to use the Configuration mode of your PanelView Plus terminal to:

- perform data entry and navigation.
- load an application.
- run an application.
- modify application settings.
- modify terminal settings.
- configure startup shortcuts for PanelView Plus CE devices.

Access Configuration Mode

Your PanelView Plus device has onboard software, FactoryTalk View ME Station, to perform and configure terminal operations. When you reset or start the terminal, you automatically enter Configuration mode, unless your .MER application is automatically set to run on startup.

To access Configuration mode from a running application, press the Goto Configuration Mode button. This button is added to the application screen in FactoryTalk View Studio. The application stops running but is still loaded.

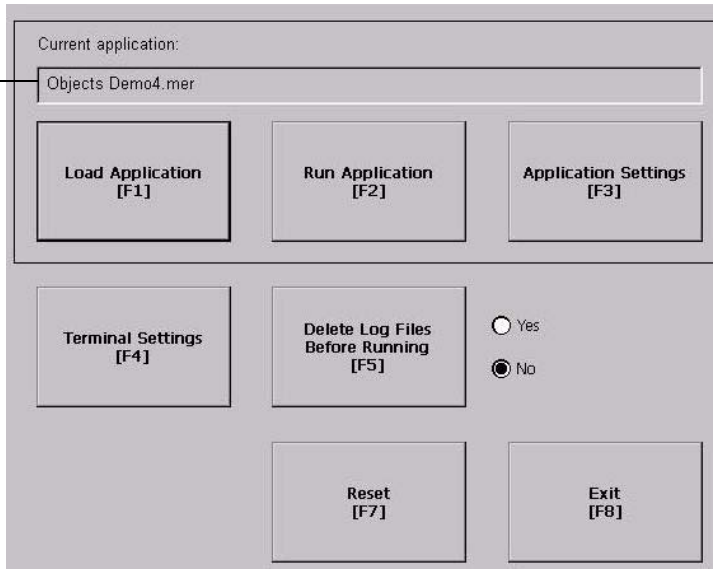
IMPORTANT To access Configuration mode from a running application, you must add a Goto Configuration Mode button to an application screen.

On PanelView Plus CE devices, you can enter Configuration mode from the Start menu or the desktop.

- Select Start>Programs>Rockwell Software>FactoryTalk View>FactoryTalkView ME Station.
- Select the FactoryTalk View ME Station icon on the desktop.

Configuration Mode Main Screen

Name of application that is currently loaded. Only appears if application is loaded.



Terminal Operation	Description
Load Application (F1)	Opens another screen where you can select an application to load. Once loaded, the application name will appear under Current Application.
Run Application (F2)	Runs the .mer application displayed under Current Application. An application must be loaded before you can run it.
Application Settings (F3)	Opens a menu of application-specific configuration settings.
Terminal Settings (F4)	Opens a menu of options to configure non-application, specific terminal settings for the PanelView Plus device.
Delete Log Files Before Running (F5)	Toggles between Yes and No. If you select Yes, all data log files, alarm history and alarm status file will be deleted before the application is run. If you select No, log files are not deleted first.
Reset (F7)	Resets the terminal. The action that occurs on startup for PanelView Plus CE devices depends on whether you defined shortcut paths in the Windows Startup folder. On other PanelView Plus devices, the action on startup depends on configured startup options.
Exit (F8)	Exits Configuration mode.

Navigation Buttons

Screen buttons are used for data entry and navigation.

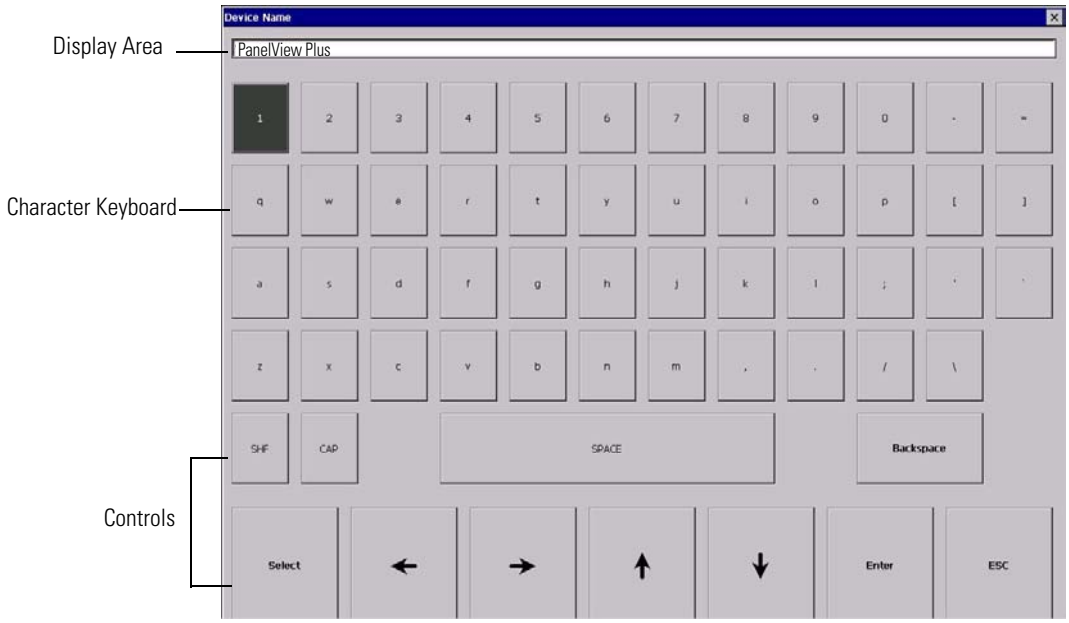
- On touch-screen terminals, tap the button with your finger or stylus.
- On keypad terminals, select the function key listed on the button, or in some cases, the corresponding key on the keypad.
- If a mouse is attached, click a button.

In addition to operation specific buttons, most screens have a combination of these buttons.

Navigation Buttons	Description
Close [F8]	Returns to the previous screen.
OK [F7]	Accepts modified values and returns to previous screen.
Cancel [F8]	Cancels the current operation without saving any changes.
▲ ▼	Moves highlight up or down a list.
↵	Selects a highlighted screen or item from a list.

Enter or Edit Data

Many screens have buttons that access fields where you must enter or edit data. When you press the button or function key, the input panel opens ready for you to enter data. If a field is restricted to a numeric value, only the 0…9 keys will be enabled. If the value is an IP address, the 0…9 and decimal point keys will be enabled. All other buttons will be disabled.



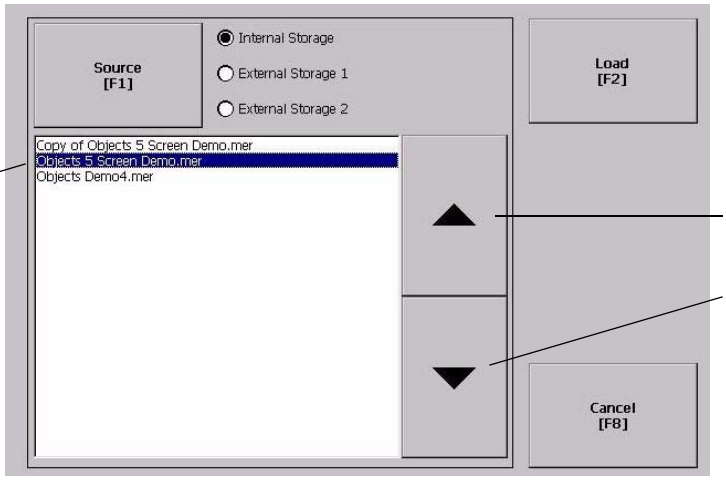
Input Panel Controls	Function
SHF	Switches keys between their shifted and unshifted state. The initial default is shifted.
CAPS	Switches keys between lowercase and uppercase characters. The initial default is lowercase.
SPACE	Enters a space between characters in the Display Area.
Backspace	Deletes the previous character (to the left of the cursor) in the Display Area.
Select	Selects a character and enters it in the Display Area.
Right, Left, Up, Down Arrow Keys	Selects the character to the right, left, above or below the currently selected character.
Enter	Accepts the entered characters and returns to the previous screen
ESC	Cancels the current operation and returns to the previous screen.

Follow these steps to enter characters in the display area.

1. Select a character on the character keyboard.
   - On a touch-screen terminal, tap or press a key.
   - On a keypad terminal, use the arrow keys on the keypad to select a key.
   - If a mouse is attached, click a key.
2. Press the Select button to copy the character to the display area.
3. Press Enter when done to exit the input panel.

Load an Application

You can load a FactoryTalk View ME .MER application from the internal CompactFlash in the terminal or an external CompactFlash card.



Follows these steps to load an application.

1. Select Load Application from the main screen.
2. Press the Source button to select the storage location of the application file you want to load.
   - Internal Storage - the internal CompactFlash in the terminal.
   - External Storage 1 - the external CompactFlash card loaded in the card slot of the terminal.
   - External Storage 2 - for future use.

   TIP FactoryTalk View ME software only recognizes files in the \Rockwell Software\RSViewME\Runtime\ folder.
3. Select an .MER file from the list by using the up and down cursor keys.
4. Press the Load button to load the selected application.

   You will be asked if you want to replace the terminal's communication configuration with the configuration in the application.
5. Select Yes or No.

   If you select Yes, any changes to the device addresses or driver properties in the RSLinx Communications screen will be lost.

The name of the currently loaded application will appear at the top of the main configuration screen.

Run an Application

After loading an .MER application, you can run the application. To load an application, select the Run Application button on the main screen.

Log files are generated by the application. To delete the log files before running an application, select the Delete Log Files Before Running button on the main screen.

Application Settings

You can show device shortcuts defined for the loaded .MER application. For example, your .MER application might have SLC defined as a device shortcut name for the SLC 5/05 controller. Device shortcuts are read-only and cannot be edited. To view device shortcuts, select the Application Settings button from the main screen.

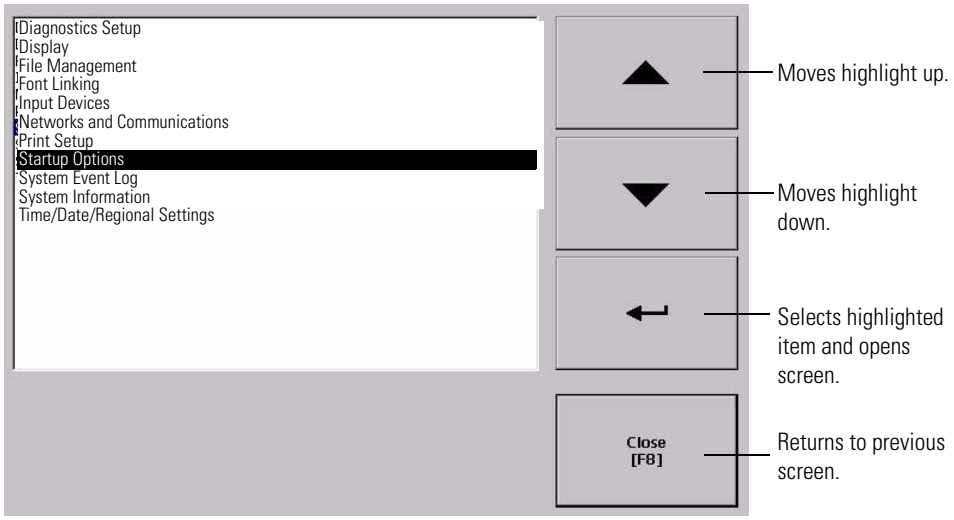
Terminal Settings

You can modify settings on the terminal that are not specific to the application.

Terminal Settings	Description
Diagnostic	Forwards diagnostic messages form a remote log destination to a computer running diagnostics.
Display	Shows the temperature of the display, sets the intensity of the backlight, and enables/disables the screen saver.
File Management	Copies or deletes application files or font files from a storage location.
Font Linking	Links a font file to a base font loaded on the terminal.
Input Devices	Configures settings for the keypad, touch screen, or attached keyboard and mouse.
Networks and Communications	Configures network connections and communication settings specific to the application (DHPlus, DH-485, remote I/O, ControlNet, DeviceNet, serial).
Print Setup	Configures settings for printing displays, alarm messages, and diagnostics messages generated by the application.
Startup Options	Specifies whether the terminal starts up in configure or run mode. Also lets you enable/disable tests to run on the terminal at startup.
System Event Log	Displays a list of system events currently logged by the terminal.
System Information	Displays power, temperature, battery and memory details for the terminal. Also shows the firmware number for FactoryTalk View ME software and technical support information.
Time/Date/Regional Settings	Sets the date, time, language, and numeric format used by the terminal and applications.

Follow these steps to access terminal settings and select a function.

1. Select Terminal Settings from the main screen.



2. Highlight an option by using the up and down cursor buttons.
   - On touch screen terminals, press the buttons.
   - On keypad terminals, press a key on the keypad or the corresponding function key.
3. Press the Enter key to access the highlighted function.

Configure Communication

You configure communication for your application and controller by using RSLinx Enterprise software.

- Access KEPServer Serial Port ID's.
- Edit or view the driver settings for the communication protocol used by your .MER application.
- Edit the device address of the controller on the network.

KEPServer Serial Port ID's

To access the KEPServer Serial Port ID's screen, you must have KEPServer Enterprise installed on your terminal. Otherwise, you will get an error message when accessing this screen. If you plan on using KEPServer Enterprise and serial communication, you must specify which COM port to use.

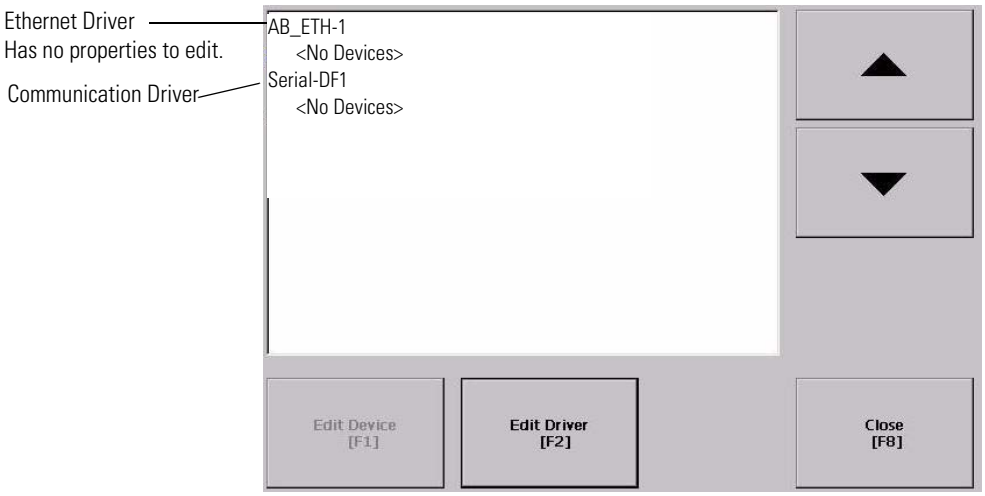
To access the KEPServer Serial Port ID screen, select Terminal Settings>Networks and Communications>KEPServer Serial Port ID's.

Configure Communication Properties

Follow these steps to configure driver settings for the communication protocol used by your application.

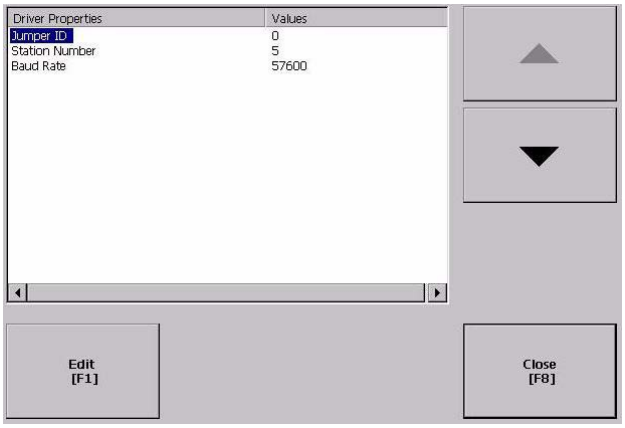
1. Select Terminal Settings>Networks and Communications>RSLinx Enterprise Communications.

   You see a tree view of installed communication cards and network configurations.



2. Select the communication card installed on your terminal.

3. Press the Edit Driver button to view the current properties for the communication driver.



4. Select the property you want to modify, then press the Edit button.

5. Modify the setting and then press the Enter button.

   You return to the previous screen with the newly entered data.

DHPlus Properties

Field	Description	Valid Values
Jumper ID	Identifies the communication card if multiple cards are installed on terminal.	0…3
Station Number	The unique address of the terminal on the DHPlus network.	0…77 (octal)
Baud Rate	The communication rate of the DHPlus network.	57,600 (default) 115,200 230,400

DH-485 Properties

Field	Description	Valid Values
Jumper ID	Identifies the communication card if multiple cards are installed on terminal.	0…3
Station Number	The unique station number of the terminal on the DH-485 network.	0…31 (decimal)
Baud Rate	The communication rate of the DH-485 network.	9600 19,200
MaxStationNumber	The maximum station number on the DH-485 network. The value must be greater than or equal to the Station Number.	0…31 (decimal)

Remote I/O Properties

Field	Description	Valid Values
Jumper ID	Identifies the communication card if multiple cards are installed on terminal.	0…3
Baud Rate	The communication rate of the remote I/O network.	57,600 (default) 115,200 230,400

ControlNet Properties

Field	Description	Valid Values
Device ID	Unique address of the PanelView Plus terminal on the ControlNet network.	1…99

DeviceNet Properties

Field	Description	Valid Values
MacID	Unique address of the terminal on the DeviceNet network.	0…63
Baud Rate	The communication rate at which the DeviceNet driver communicates.	125 Kbps (default) 250 Kbps 500 Kbps

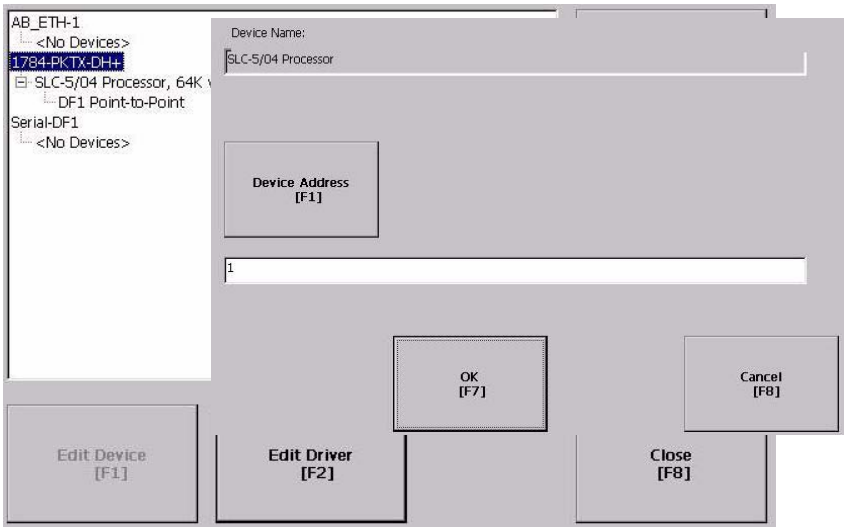
Serial Properties

Field	Description	Valid Values
Device	The serial device your terminal is connected to.	PLC_CH0 KF2 SLC_CH0 KF3 KFC KFC15 AC_CH0
Error Check	Type of error checking used. Error checking is automatically configured if Use Auto Config is set to Yes.	BCC, CRC
Parity	Type of parity used. The parity is automatically configured if Use Auto Config is set to Yes.	None, Odd, Even
Stop Bits	Number of stop bits used.	1 or 2
Ack Timeout	Ack/Poll timeout value in ms.	20…60,000 ms
Max Retries	Maximum number of retries before the serial driver fails.	0…255
Station	Station number based on a specific device.	PLC_CH0 0…77 (octal) KF2 0…77 (octal) SLC_CH0 0…31 KF3 0…31 KFC 1…99 KFC15 1…99 AC_CH0 0…255
Baud Rate	Data rate at which serial driver communicates. The baud rate is automatically configured if Use Auto Config is set to Yes.	110 300 600 1200 4800 9600 19,200 38,400 115,200
Use Auto Config	Automatically or manually configures the baud rate, parity, and error checking parameters.	Yes (auto configure) No (manual configure)
Com Port	Communication port used on the terminal.	1 (COM1) 2 (COM2)

Configure the Controller Address

Follow these steps to edit the device address of the logic controller.

1. From the RSLinx Configuration screen, select a device node.
2. Press the Edit Device button to view the device name and current address of the logic controller.



3. Press the Device Address button to modify the address.

   The input panel opens with the current address.

4. Use the Input Panel to modify the address and then press the Enter button.

   You return to the previous screen with the new address.

5. Press OK.

IMPORTANT Modified settings do not take effect until the terminal is restarted.

Configure Network Information

You can configure network information for your terminal.

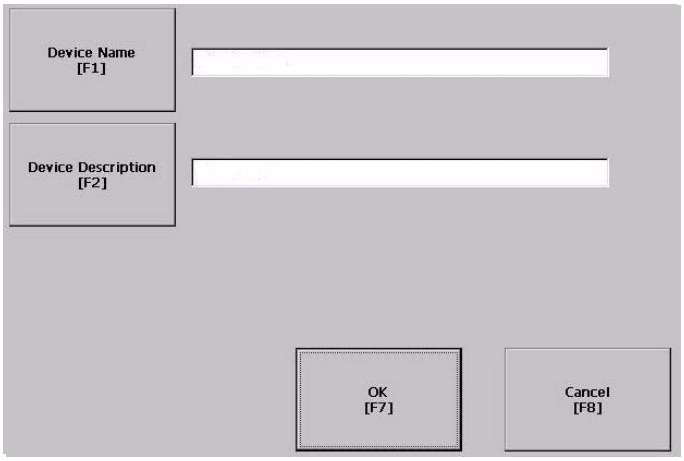
- Device name to identify terminal on network
- IP address of terminal on network
- Username and password to access network resources

Define a Device Name for the Terminal

You can configure a device name and description to identify your your terminal on the network.

Follow these steps to enter a device name and description for your terminal.

1. Select Terminal Settings>Networks and Communications>Network Connections>Device Name.



2. Press the Device Name button to enter or edit the device name.

3. Press the Device Description button to enter or edit the description for the device.

Field	Description	Valid Values
Device Name (1)	Name that identifies the terminal to other computers on the network.	1…15 characters A leading character in the range of a through z or A through Z. Remaining characters in the range of a through z, A through Z, 0…9, or - (hyphen)
Device Description	Provides a description of the terminal.	50 characters max

(1) Check with your network administrator to determine a valid device name.

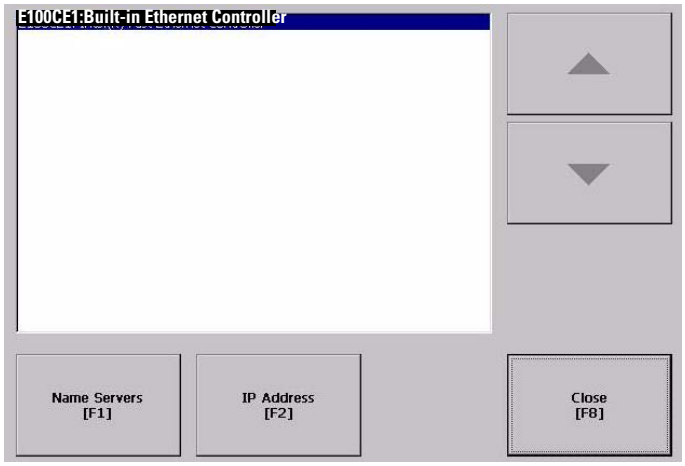
4. Press OK.

Define an Ethernet IP Address

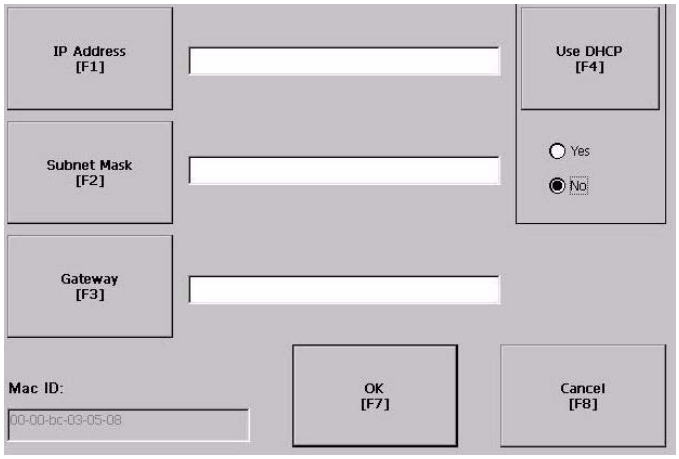
Some networks automatically assign IP addresses to Ethernet devices if DHCP is enabled. If DHCP is not enabled, you can manually enter an IP address for the terminal.

Follow these steps to view or enter an IP address for your terminal.

1. Select Terminal Settings>Networks and Communications>Network Connections>Network Adapters.



2. Press the IP Address button to view or modify the IP address.



3. Press the DHCP button to enable or disable DHCP assignment of addresses.

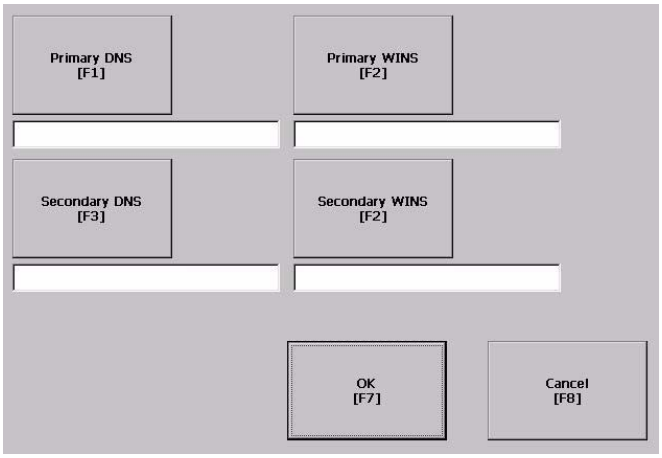
4. Press the IP address, Subnet Mask, and Gateway buttons, then enter the appropriate information.

5. Press OK when done.

Field	Description	Valid Values
Use DHCP	Enables or disables Dynamic Host Configuration Protocol (DHCP) settings. DHCP automatically allocates network devices and configurations to newly attached devices on the network. If DHCP is set to Yes, the terminal is automatically assigned an IP address, Subnet Mask, and Gateway. The fields are disabled. If DHCP is set to No, you can enter the IP address, Subnet Mask, and Gateway address.	Yes (default) No
IP Address	A unique address identifying the terminal on the Ethernet network.	xxx.xxx.xxx.xxx 000.000.000.000 (default) Range of values for the first set of decimal numbers is 1…255 unless all fields are set to 000. The range of values for the last three sets of decimal numbers is 0…255.
Subnet Mask	Address must be identical to the server subnet mask.	xxx.xxx.xxx.xxx
Gateway	Optional Gateway address.	xxx.xxx.xxx.xxx
Mac ID	Read-only field.	

Define Name Server Addresses

You can define name server addresses for the EtherNet/IP network adapter. These addresses are automatically assigned if DHCP is enabled for the network adapter.



Follow these steps to define name server address.

1. Select Terminal Settings>Networks and Communications>Network Connections>Network Adapters.
2. Press a button to enter a name server address.

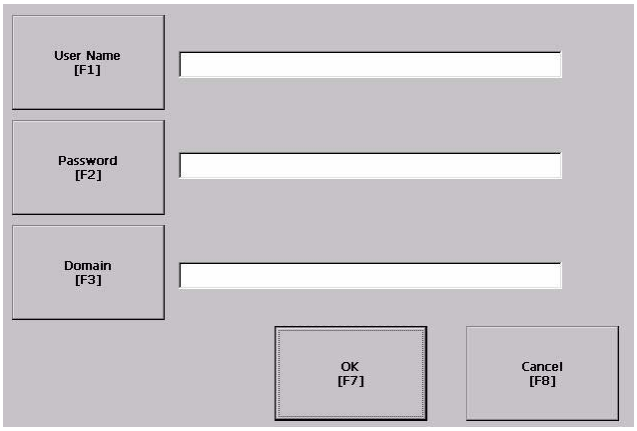
Field	Description	Valid Values
Primary DNS	The address of the primary DNS resolver.	xxx.xxx.xxx.xxx
Secondary DNS	The address of the secondary DNS resolver.	xxx.xxx.xxx.xxx
Primary WINS	The address of the primary WINS resolver.	xxx.xxx.xxx.xxx
Secondary WINS	The address of the secondary WINS resolver.	xxx.xxx.xxx.xxx

3. Press OK when done.

Authorize Terminal to Access Network Resources

The terminal can access network resources with proper identification. A user name, password, and domain must be provided by your network administrator.

1. Select Terminal Settings>Network and Communications>Network Connections>Network Identification.



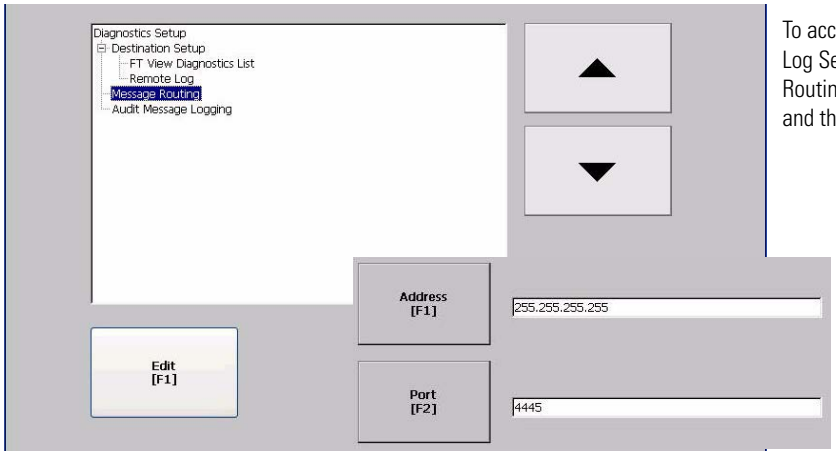
2. Press the user name, password and domain buttons and enter the information provided by your network administrator.

Field	Description	Valid Values
User Name	Identifies the user to the network.	70 characters max
Password	Characters that gain access to network along with the user name.	No character limitation
Domain Name	Provided by network administrator.	15 characters max

3. Press OK when done.

Configure Diagnostics

You can configure diagnostics for the current computer. To access the diagnostic screen, select Terminal Settings>Diagnostic Setup from the main screen. The screen shows a tree view of diagnostic nodes.



To access the Remote Log Setup or Message Routing, select the node and then the Edit button.

Remote Log Destination

The Remote Log Destination forwards messages that it receives to a Windows 2000/XP computer running diagnostics. The location is determined by the IP address and port number.

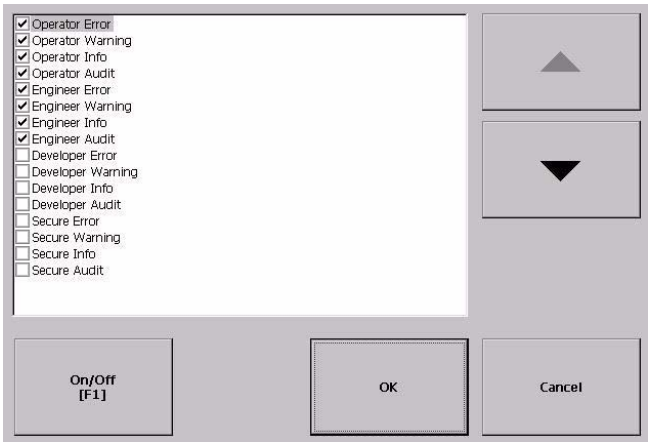
Field	Description	Valid Values
Address	Address of the remote Windows 2000/XP computer.	xxx.xxx.xxx.xxx
Port	The port used to communicate with the remote Windows 2000/XP computer.	4445 (default)

Message Routing

The Message Routing screen lets you access these screens:

- Remote Log
- FactoryTalk View Diagnostics List

Each of the above screens shows a list of messages that can be sent to that destination. The list shows the On/Off status of each message type. Use the On/Off button to turn a message type on or off. A message type is enabled if it has a checked box.



Manage Files on the Terminal

The terminal provides operations for managing files that are stored on the terminal.

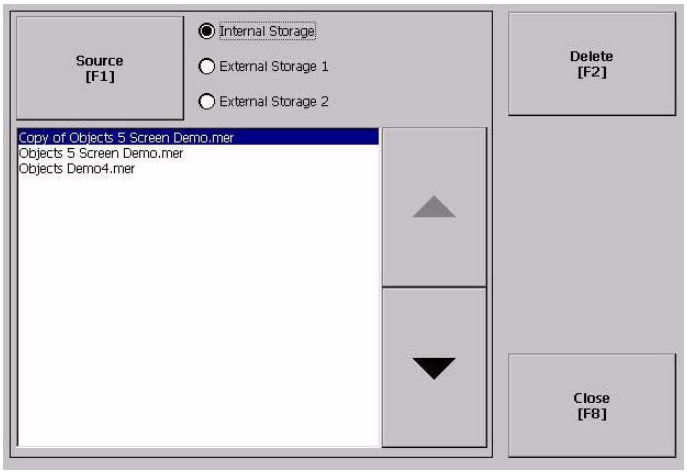
- Delete application .MER files, font files, or log files that reside in a storage location on the terminal.
- Copy application .MER files or font files from one storage location to another.

Delete an Application File or a Font File

The procedure for deleting an application file or a font file from the terminal is the same except for the type of file you are deleting.

1. Select Terminal Settings>File Management>Delete Files>Delete Applications or Delete Fonts.

2. Press the Source button to choose the storage location of the application or font file you want to delete.
   - Internal Storage - the internal CompactFlash in the terminal.
   - External Storage 1 - the external CompactFlash card loaded in the card slot of the terminal.
   - External Storage 2 - for future use.



3. Select a file from the list.
4. Press the Delete button.
5. Select Yes or No when asked if you want to delete the selected application or font file from the storage location.

Delete Log Files from Terminal

You can delete log files, alarm history files, and alarm status files from the System Default location on the terminal.

1. Select Terminal Settings>File Management>Delete Files>Delete Log Files.

   You are asked to confirm the deletion of the files.

   Do you want to delete all of the FactoryTalk View ME Station Log Files?

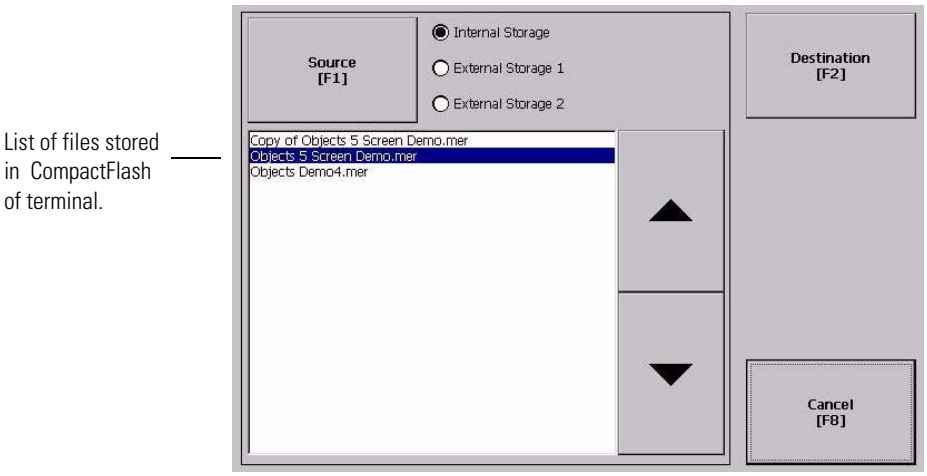
2. Select Yes or No.

   Log files not located in the System Default location will not be deleted.

Copy an Application File or Font File

The procedure for copying an application .MER file or a font file from one storage location on the terminal to another is the same.

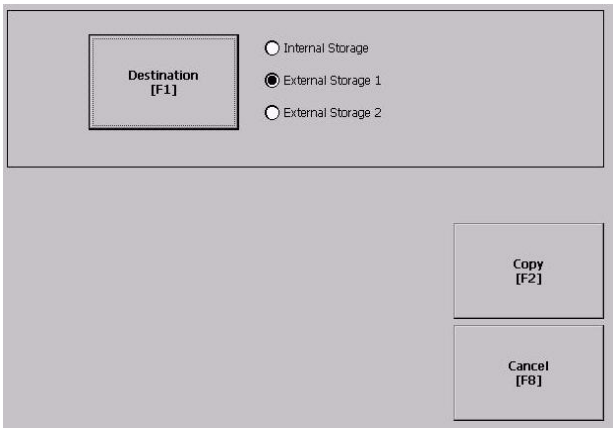
1. Select Terminal Settings>File Management>Copy Files>Copy Applications or Copy Fonts.



2. Press the Source button to choose the location of the application or font file you want to copy.
   - Internal Storage - the internal CompactFlash in the terminal.
   - External Storage 1 - the external CompactFlash card loaded in the card slot of the terminal.
   - External Storage 2 - for future use.

3. Select a file from the storage location.

4. Press the Destination button on the same screen.



5. Press the Destination button to choose the storage location where you want to copy the application or font file.

   The destination must be different than the source location.

   - Internal Storage - the internal CompactFlash in the terminal.
   - External Storage 1 - the external CompactFlash card loaded in the card slot of the terminal.
   - External Storage 2 - for future use.

6. Press the Copy button to copy the selected application or font file to the selected destination.

   If the file exists, you will receive a warning and will be asked if you want to overwrite the existing application.

7. Select Yes or No.

TIP FactoryTalk View ME software looks for .MER files in the \Rockwell Software\RSViewME\Runtime folder and font files in the \Rockwell Software\RSViewME\Fonts\ folder.

Modify Display Settings

You can access and modify these display settings for your terminal:

- View display temperature
- Adjust display contrast
- Adjust display intensity
- Configure the screen saver
- Enable or disable the screen cursor

View the Display Temperature

To view the current temperature of the display, select Terminal Settings>Display>Display Temperature.

The PanelView Plus 600 to 1500 terminals have a cold-cathode fluorescent lamp (CCFL) backlight. This backlight requires temperature control when the internal temperature of the product is below 10 °C (50 °F) or above 60 °C (140 °F). The terminal monitors low and high temperature conditions.

- If the internal temperature of the product is below 10 °C (50 °F), the backlight is set to overdrive or the full-rated current setting for at least five minutes.
- If the internal temperature is at or above 60 °C (50 °F), the backlight is set to underdrive; 40% or less of full brightness. This reduces heat generation from the backlight.

Temperature monitoring begins when the terminal powers on, or when the backlight turns on, for example, exiting Screen Saver mode. The temperature control affects only display intensity; it does not restrict the use or operation of the terminal.

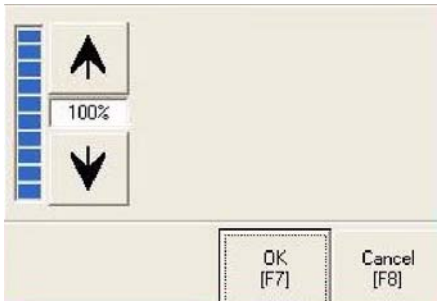
When a low or high temperature condition is detected, an error is sent to the system event log. If the temperature control is not functioning, a noncritical error is sent to the system event log but the terminal continues to operate normally.

TIP The CCFL backlight temperature control takes precedence over the application Backlight Settings.

Adjust the Display Contrast

You can view or modify the display contrast for PanelView 400 and 600 grayscale terminals. Displays are shipped with the contrast level set at 50%, which is the optimum setting.

1. Select Terminal Settings>Display>Display Contrast.



2. Press the up an down cursor buttons to adjust the contrast.

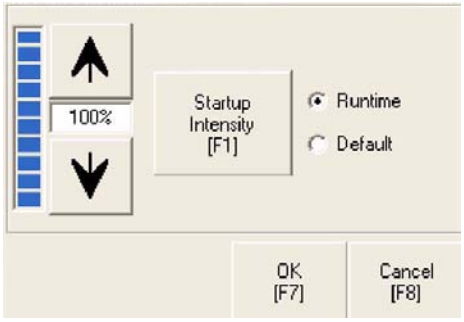
   The current contrast level is shown as a percentage. The change is not permanent until you press OK.

3. Press OK when done.

Adjust the Display Intensity

You can view or modify the intensity of the terminal backlight. You can use the default intensity of 100% or you can set the intensity for runtime operations.

1. Select Terminal Settings>Display>Display Intensity.



2. Press the Startup Intensity button to switch between the Default intensity and the Runtime intensity.
   - If you choose Runtime, the startup screens will use the runtime intensity.
   - If you choose Default, the startup screens will use the default setting of 100%

3. Increase or decrease the intensity for runtime operations, by pressing the up or down arrow keys.

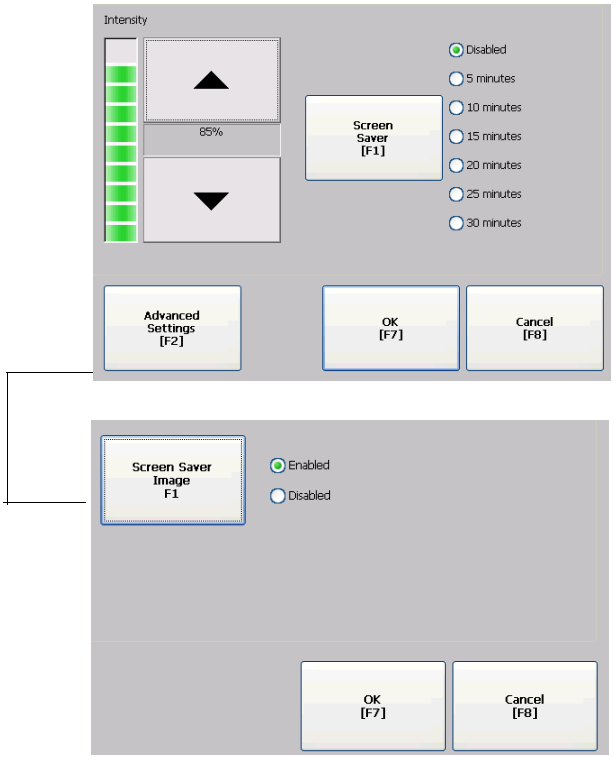
   Intensity changes are not permanent until you press OK.

4. Press OK when done.

Configure the Screen Saver

The terminal screen saver activates after an idle period using a specific intensity. You can adjust the idle timeout and intensity, disable the screen saver, and enable or disable the screen saver bitmap.

1. Select Terminal Settings>Display>Screen Saver.



2. Press the Screen Saver button to select an idle timeout for activating the screen saver.

   To disable the screen saver, select the Disabled option.

3. Increase or decrease the brightness intensity of the screen saver by pressing the up and down cursor buttons.

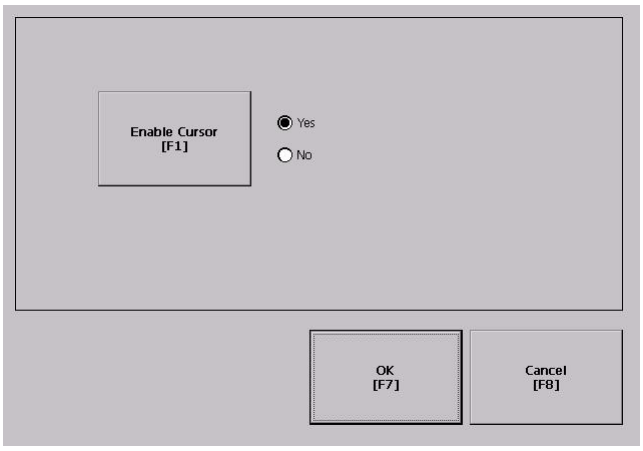
4. Press the Advanced Settings button to access the bitmap option.
   - Select the Screen Saver Image button to enable or disable the screen saver bitmap.
   - Press OK to return to the previous.

5. Press OK to exit and return to the terminal settings.

Enable or Disable the Screen Cursor

The terminal has a screen cursor that you can enable or disable.

1. Select Terminal Settings>Display>Cursor.



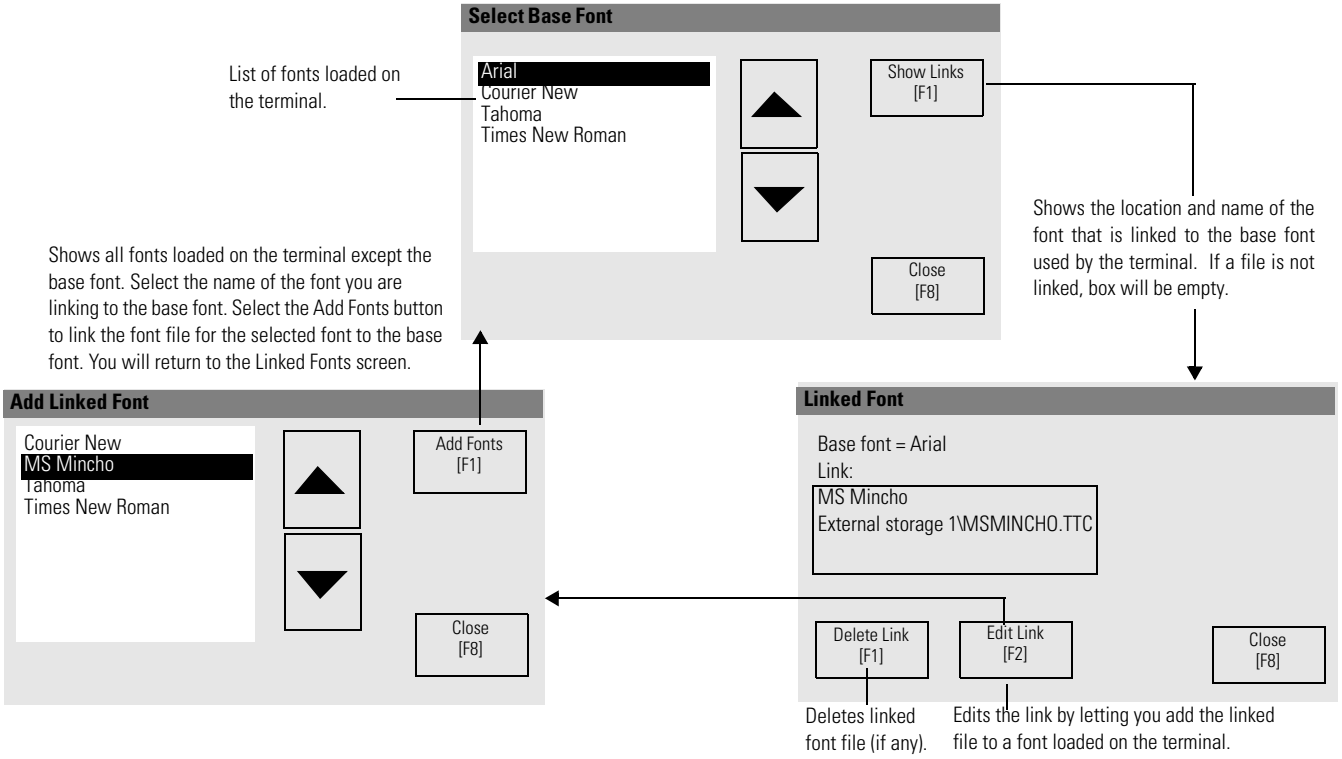
2. Press the Enable Cursor button to enable or disable the cursor.
3. Press OK to exit and return to Terminal Settings.

Font Linking

Terminal Settings
↓
Font Linking

Font linking lets you run a translated application on the terminal by linking a font file to the base font (for example, linking a Chinese font file to the base font Arial).

For more details on preinstalled terminal fonts and additional fonts available for downloading, see Appendix C.



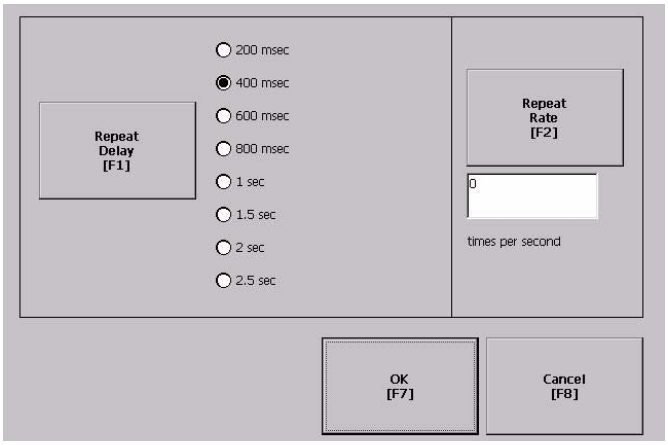
Configure Keypad, Keyboard, or Mouse

You can configure input devices used with your terminal, including the keyboard, keypad, mouse, and attached keyboard.

Configure Keyboard Settings

You can adjust settings for the keys on the terminal keypad or for keys on an attached keyboard.

1. Select Terminal Settings>Input Devices>Keyboard.



2. Press the Repeat Rate button to specify the number of times a key is repeated per second when you hold a key down.

   Valid values for the keypad are 0 and 2…30. The keyboard is device dependent but typical values are the same.

3. Press the Repeat Delay button to select the amount of time that elapses per second before a key is repeated.

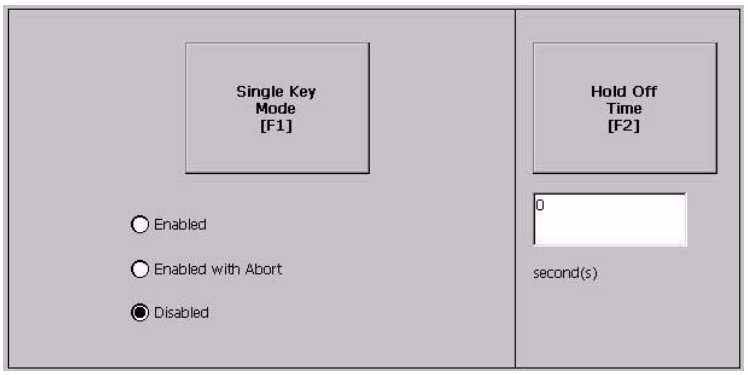
   Values are device dependent. Unsupported values are dimmed.

4. Press OK when done.

Configure Keypad Settings for the Terminal

You can restrict multiple or simultaneous key presses on the keypad of your terminal.

1. Select Terminal Settings>Input Devices>Keypad.



2. Press the Single Key Mode button to select a key option.
   - If Enabled, any programmable key that is pressed inhibits all keys until the programmable key is pressed again. This includes the Alt, Ctrl, Shift keys.
   - If Enabled with Abort, any secondary key press will terminate the initial key press immediately.
   - If Disabled, there are no restrictions on key presses. This is the default.

IMPORTANT The keypad cannot produce Home, End, Page Up or Page Down when Single Key mode is enabled.

3. Press the Hold Off Time button to enter the length of time, in seconds, to ignore multiple presses of the same key.

4. Press OK when done.

Configure the Sensitivity of the Mouse

You can set and test the sensitivity for both the speed and physical distance between mouse clicks. The process is identical to setting the double-tap sensitivity for the touch screen.

To set the mouse sensitivity, select Terminal Settings>Input Devices>Mouse.

Configure the Touch Screen

You can configure these operations for terminals with a touch screen:

- Calibrate the touch screen
- Enable or disable Cursor
- Set the double-tap sensitivity

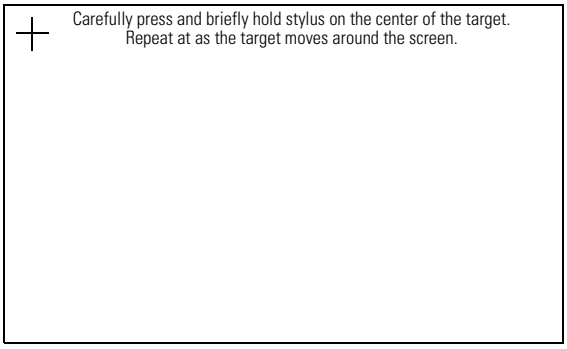
Calibrate the Touch-screen

IMPORTANT Use a plastic stylus device with a minimum tip radius of 1.3 mm (0.051 in.) to prevent damage to the touch screen.

Follow these steps to calibrate the touch screen.

1. Select Terminal Settings>Input Devices>Touch Screen>Calibration.

   The screen for calibrating the touch screen appears.



2. Touch the center of the target (+) each of the four times it appears on the screen.

   When the calibration is complete, you will see this message.

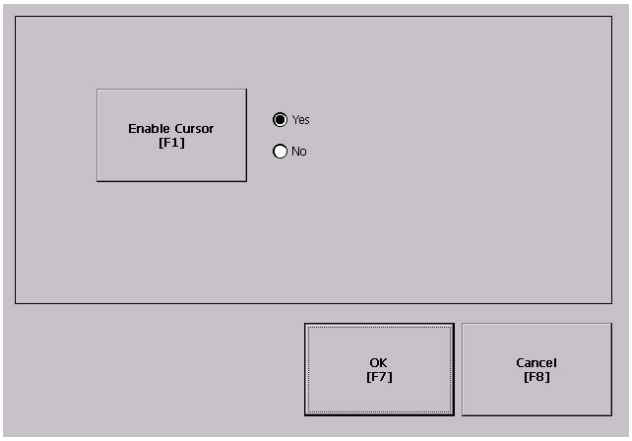
   Tap the screen to register saved data. Wait for 30 seconds to cancel saved data and keep the current settings.

3. Tap the screen to save the data or wait 30 seconds to cancel the saved data, retaining the current settings.

Enable or Disable the Cursor on Touch Screens

You can enable or disable the cursor on terminals with a touch screen. Disabling the cursor will not disable the mouse.

1. Select Terminal Settings>Input Devices>Touch Screen>Cursor.

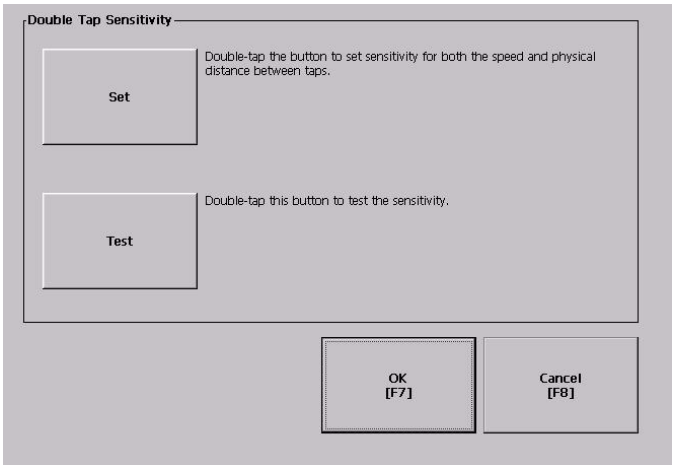


2. Press the Enable Cursor button to enable or disable the cursor.
3. Press OK.

Set the Double-tap Sensitivity

You can set and test the sensitivity for both the speed and physical distance between touch-screen presses. The process is identical to setting the double-tap sensitivity for the mouse.

1. Select Terminal Settings>Input Devices>Touch Screen>Double-tap Sensitivity.



2. Double-tap the Set button to set the sensitivity of touch-screen presses.

3. Double-tap the Test button to test the sensitivity of touch-screen presses.

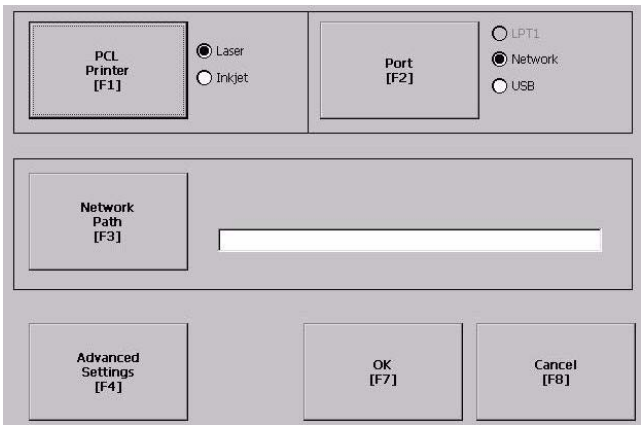
   If you double-tap the test button with the time set using the Set button, the Test button will reverse its foreground and background colors.

4. Press OK when done.

Configure Print Options

You can configure settings for printing displays, alarm messages, or diagnostic messages from FactoryTalk View ME .MER applications. The general setup for printing displays and messages is the same, however, the advanced settings are different.

1. Select a Terminal Settings>Networks and Communications>Print Setup> option.
   - Displays
   - Alarms
   - Diagnostic Messages



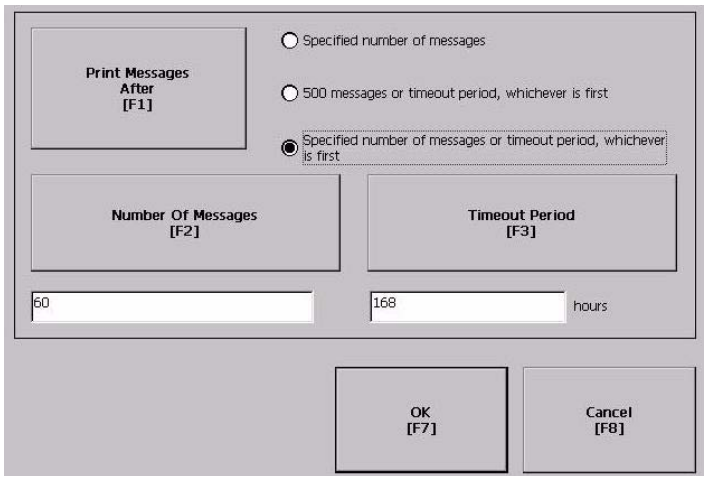
2. Update properties by selecting the appropriate button and changing the value, if necessary.

Field	Description	Valid Values
PCL Printer	Type of printer to use.	Laser (default) Inkjet
Port	Port to use for printing displays, alarm messages, and diagnostic messages.	Network (default) USB
Network Path	Network path of printer to use if the Port selection is Network.	519 characters max
Advanced Settings	Accesses additional settings.	

3. Press the Advanced button to access additional settings.

   The advanced settings for printing displays are:
   - print orientation (portrait or landscape).
   - draft mode (enable or disable).

- The advanced settings for printing diagnostic and alarm messages determines when to print messages that are sent to the network or USB port.



Print Messages After	Default Value	Example
Specified number of messages	60 messages	When the queue has 60 messages, the messages are printed regardless of how long they have been in the queue. You can change the number of messages.
500 messages or timeout period, whichever is first	168 hours (7 days)	If the queue has 350 messages after 168 hours, the 350 messages are printed. You can change the timeout period.
Specified number of messages or timeout period, whichever is first.	60 messages 168 hours (7 days)	If the queue has 60 messages after 24 hours, then the 60 messages are printed. You can change the number of messages and the timeout period. For example, the number of messages is set to 75 and the timeout period is set to 48 hours. • If the queue has 75 messages after 24 hours, then the 75 messages are printed before the set timeout of 48 hours. • If the queue has 15 messages after 48 hours, the 15 messages are printed after the set timeout period.

4. Press OK when done.

5. Press OK to return to Terminal Settings.

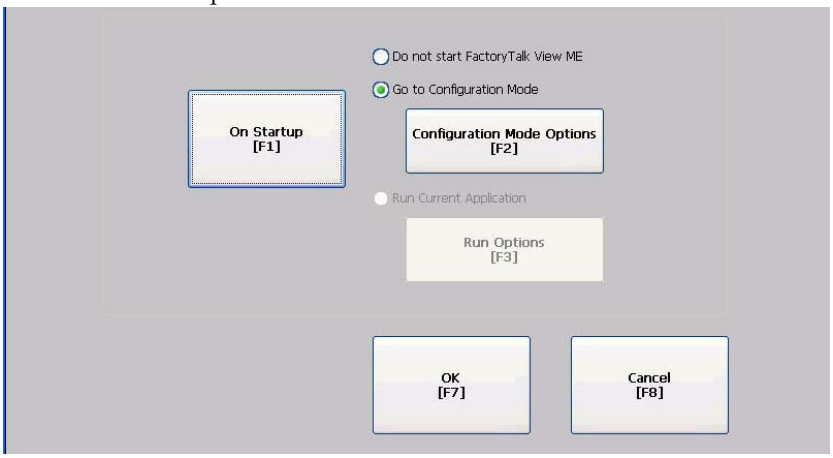
Configure Startup Options

FactoryTalk View ME Station software starts based on shortcuts in the Windows startup folder and whether an application is loaded. You can modify the action the terminal takes on startup.

- Disable FactoryTalk View ME Station software
- Go to FactoryTalk View Configure mode
- Run the current application

Disable FactoryTalk View ME Station Software on Startup

1. Select Terminal Settings>Startup Options>FactoryTalk View ME Station Startup.



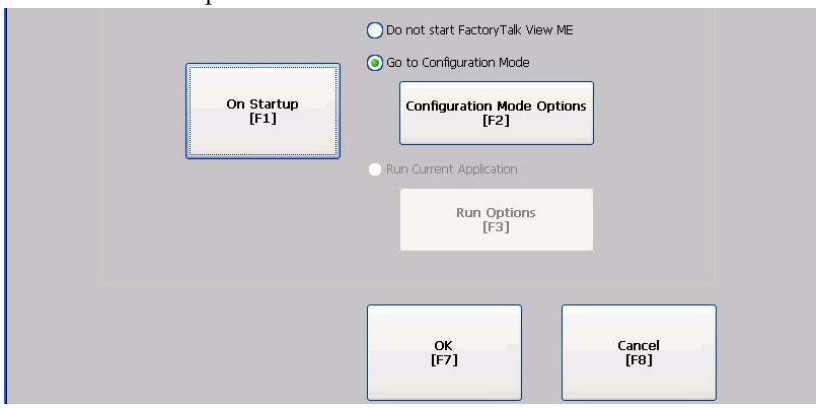
2. Press the On Startup button until Do not start FactoryTalk View ME is selected.

3. Press OK.

Enter Configuration Mode on Startup

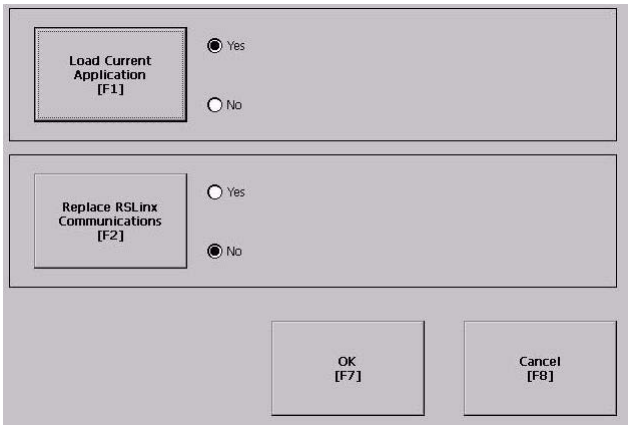
Follow these steps to enter Configuration mode on startup.

1. Select Terminal Settings>Startup Options>FactoryTalk View ME Station Startup.



2. Press the On Startup button to select Go to Configuration Mode.

3. Press the Configuration Mode Options button.

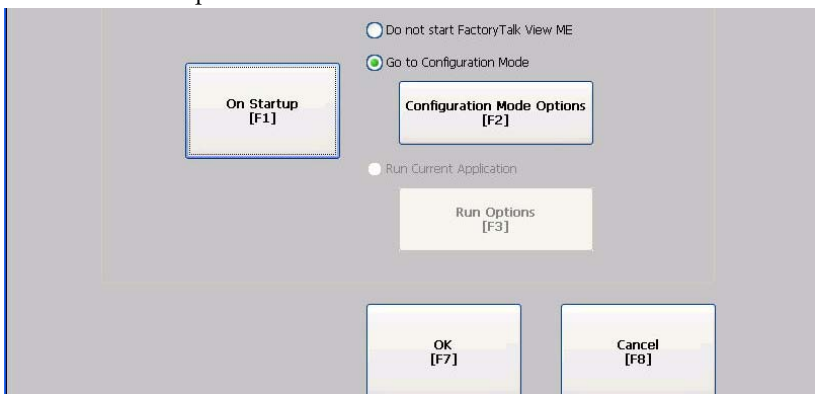


4. Press the Load Current Application button to specify whether you want to load the current application on startup.
5. Press the Replace RSLinx Communications button to specify whether to use the communication configuration of the current application or the terminal on startup.
   - Select No to use the RSLinx configuration of the terminal.
   - Select Yes to use the configuration of the application. The terminal configuration is replaced with the application settings. Any changes to device addresses or driver properties in RSLinx communication will be lost.
6. Press OK to return to the previous screen.
7. Press OK to return to Terminal Settings.

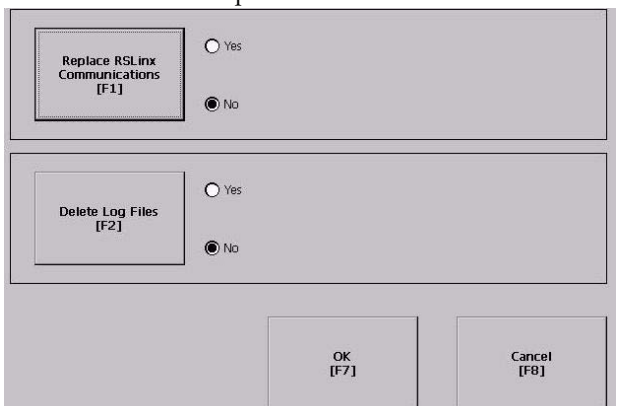
Run the Loaded Application on Startup

Follow these steps to run the loaded application on startup.

1. Select Terminal Settings>Startup Options>FactoryTalk View ME Station Startup.



2. Press the On Startup button to select Run Current Application.



   If an application is not loaded, the options are disabled.

3. Press the Replace RSLinx Communications button to specify what configuration settings to use when running the application.
   - Select No to use the RSLinx configuration of the terminal.
   - Select Yes to use the configuration of the application. The terminal configuration is replaced with the application settings. Any changes to device addresses or driver properties in RSLinx communication will be lost.

4. Press the Delete Log Files to specify what action to take with the log files on startup.
   - Select Yes to delete all log files (data, alarm history, alarm status) generated by the terminal before running application. The files are deleted from the system default location.
   - Select No to retain all log files.
5. Press OK twice to return to Terminal Settings.

Startup Shortcuts for PanelView Plus CE Devices

On PanelView Plus CE devices, FactoryTalk View ME Station software starts based on shortcuts in the Windows startup folder and whether an application is loaded. FactoryTalk View ME Station software can start:

- without loading or running an .MER application.
- automatically loading an .MER application.
- automatically loading and running an .MER application.

Start without Loading or Running .MER Application

To start FactoryTalk View ME runtime software without loading or running a CompactFlash application, do one of the following:

- Open the FactoryTalk View ME Station icon from the desktop.
- Select FactoryTalk View ME Station from the Start menu.

  Programs>Rockwell Software>FactoryTalk View> FactoryTalk View ME Station

- Type MERuntime.exe and its path in the Run dialog of the Windows Start menu.

  Path to MERuntime.exe

  If the path to FactoryTalk View ME runtime contains spaces, you must enclose the path in double quotes.

  Example:
  "Storage Card\Rockwell Software\RSViewME\MERuntime.exe"

If you copy the FactoryTalk View ME Station shortcut from the desktop to the Windows Startup folder (\Storage Card\Windows\Startup), FactoryTalk View ME Station software will automatically run on startup.

Start FactoryTalk View ME Station Software and Load .MER Application

To start FactoryTalk View ME Station software and automatically load an .MER application, type the appropriate shortcut path in the Run dialog on the Windows Start menu.

Path to MERuntime.exe, followed by a space, followed by the path to the .MER

If the path to FactoryTalk View ME runtime or the path to the application contains spaces, you must enclose the path in double quotes.

Example:
"Storage Card\Rockwell Software\RSViewME\MERuntime.exe" "Storage Card\Rockwell Software\RSViewME\Runtime\MYAPP.MER"

If you place a shortcut to the .MER application into the Windows Startup (\Storage Card\Windows\Startup) folder, the ME Runtime will automatically start and load the .MER application on terminal startup.

If the application specified in the Run dialog or the Startup folder does not exist or is corrupted, the main FactoryTalk View ME Configuration Mode screen will open.

Start FactoryTalk View ME Station and Run .MER Application

To start FactoryTalk View ME Station software and automatically run an .MER application:

- in FactoryTalk View Studio software, select Tools>Transfer Utility and select Run application when download completes on the Download tab.
- type the appropriate shortcut path in the Run dialog on the Windows Start menu.

  Path to MERuntime.exe, followed by a space, followed by the path to the .MER, followed by /r

  If the path to FactoryTalk View ME runtime or the path to the application contains spaces, you must enclose the path in double quotes.

Example:
"Storage Card\Rockwell Software\RSViewME\MERuntime.exe" "Storage Card\Rockwell Software\RSViewME\Runtime\MYAPP.MER" **/r**

If you place a shortcut with the above command line in the Windows Startup folder (\Storage Card\Windows\Startup), the ME Runtime will start and automatically run the .MER application.

If the application specified in the Run dialog or the Startup folder does not exist or is corrupted, the main FactoryTalk View ME Configuration Mode screen will open and display the following message:

Unable to load application

Other Shortcut Paths for FactoryTalk View ME Station Software

IMPORTANT If the path to FactoryTalk View ME software or the path to the application contains spaces, you must enclose the path in double quotes.

- To run the .MER application and delete its log files without replacing the terminal's communication configuration with that of the applications, use the following path:

  Path to MERuntime.exe, followed by a space, followed by the path to the .MER, followed by /r/d.

Example:

"Storage Card\Rockwell Software\RSViewME\MERuntime.exe" "Storage Card\Rockwell Software\RSViewME\Runtime\MYAPP.MER" **/r/d**

- To run the .MER application and replace the terminal's communication configuration with that of the applications without deleting its log files, use the following path:

  Path to MERuntime.exe, followed by a space, followed by the path to the .MER, followed by /r/o

Example:

"Storage Card\Rockwell\Software\RSViewME\MERuntime.exe" "Storage Card\Rockwell\Software\RSViewME\Runtime\MYAPP.MER" **/r/o**

- To run the .MER application, delete its log files, and replace the terminal's communication configuration with that of the applications, use the following path:

  Path to MERuntime.exe, followed by a space, followed by the path to the .MER, followed by /r/d/o

Example:

"Storage Card\Rockwell\Software\RSViewME\MERuntime.exe" "Storage Card\Rockwell\Software\RSViewME\Runtime\MYAPP.MER" **/r/d/o**

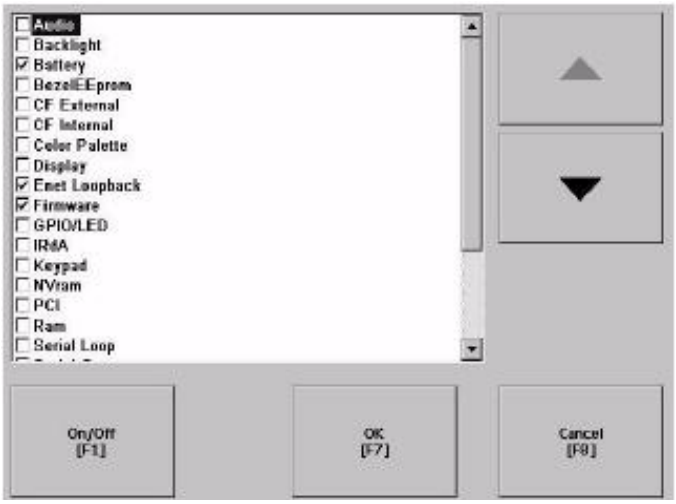
Configure Startup Tests

The terminal can run extended tests on startup. You can select which test to run and also specify test settings on startup.

Select Tests to Run on Startup

Follows these steps to select which tests you want to run on startup.

1. Select Terminal Settings>Startup Options>Startup Tests.



   The screen shows a list of each test that can be performed on the terminal at startup and its current On/Off status. You can turn any test in the list on or off by selecting the On/Off button. The terminal will run tests only with a checked box.

2. Select the tests you want to run on startup.
   - Use the up and down cursor buttons to highlight a test.
   - Press the On/Off button to select a test. A checked box means the test is selected to run. Press the button again to clear the check box.

3. Press OK.

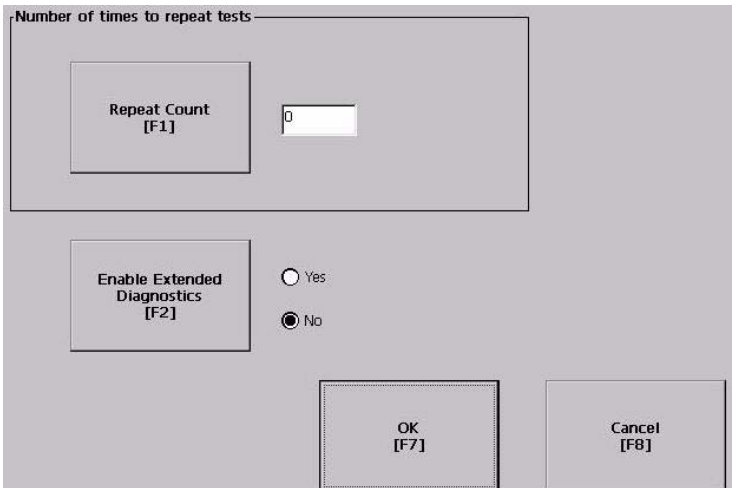
Configure Startup Test Settings

Follow these steps to specify how many times to run the selected tests on startup and to enable extended diagnostics.

IMPORTANT Enabling extended diagnostics and setting a high repeat count will increase the time it takes the terminal to reboot.

The tests will run each time you reset or cycle power to the terminal until you disable extended diagnostics. Setting a low repeat count will also decrease the startup time.

1. Select Terminal Settings>Startup Options>Startup Test Settings.



2. Press the Repeat Count button to specify the number of times, 0… 128, to run the selected tests on startup.

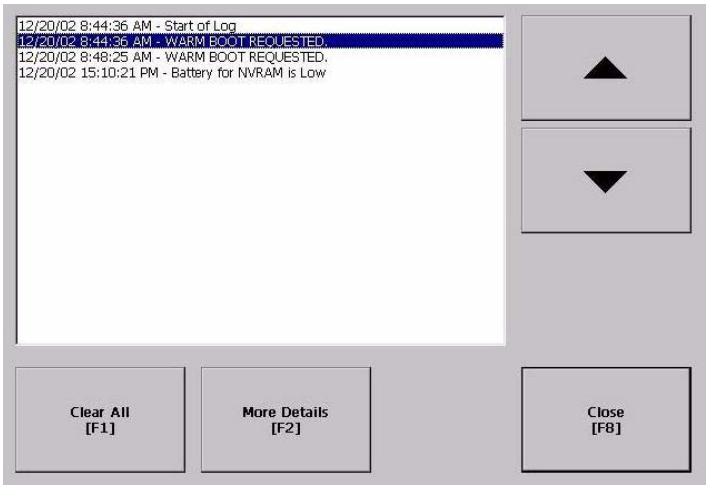
3. Press the Enable Extended Diagnostics button to enable or disable extended diagnostics on startup.
   - Select Yes to enable extended diagnostics.
   - Select No to disable extended diagnostics.

4. Press OK.

View and Clear the System Event Log

The System Event Log screen displays a list of system events logged by the terminal.

1. Select Terminal Settings>System Event Log.



2. Select an event and then press the More Details button to display system event log details for that event.

3. Press the Clear All button to clear all system event logs.

4. Press OK.

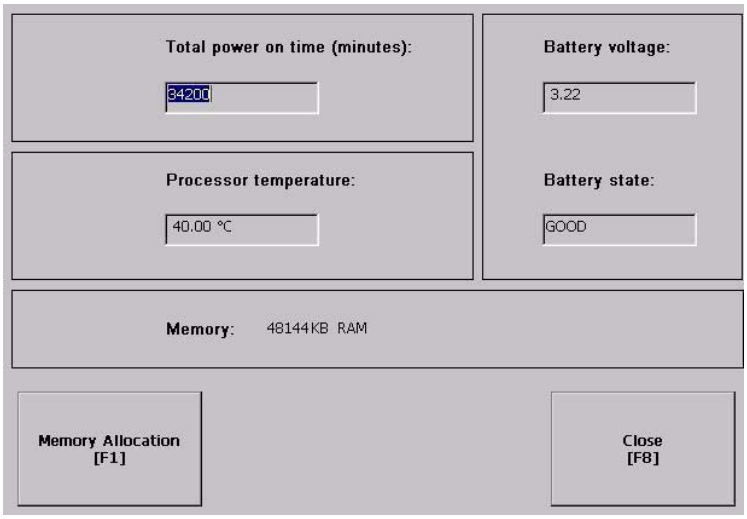
Display Terminal Information

You can view these details for your terminal:

- Total power on time
- Processor temperature
- Battery voltage and battery state
- Amount of memory on terminal

Follow these steps to display terminal information.

1. Select Terminal Settings>System>Information>Terminal Information.

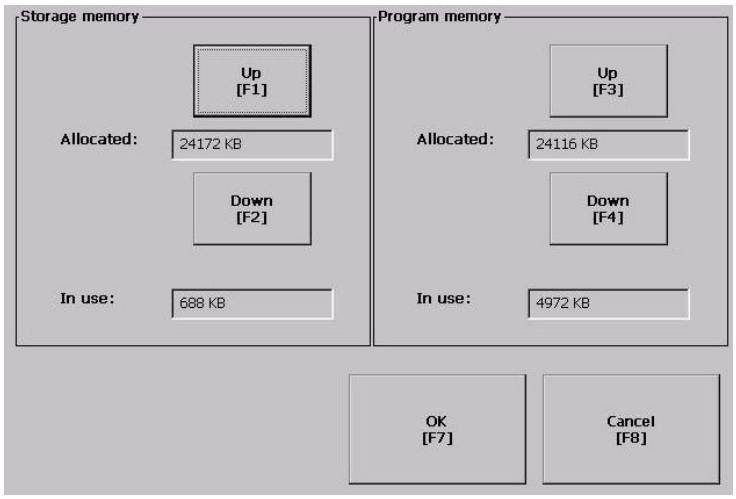


All fields are read-only except for memory allocation.

Battery State	PanelView Plus 400 and 600 Terminals	PanelView Plus 700 to 1500 Terminals
Good	Good battery condition.	Good battery condition.
Failing	Does not have a replaceable battery. Replace the terminal.	Low battery. Replace the battery.
Bad	Does not apply.	Battery is missing or bad. Replace the battery.

IMPORTANT For the 400 and 600 terminals, the Battery Voltage indicates the battery state only and the Processor Temperature shows the temperature of the display.

2. Press the Memory Allocation button to view or adjust the:
   - amount of allocated storage or program memory.
   - amount of storage or program memory in use.



3. Press the Up or Down button to increase or decrease the allocation of storage or program memory.

   Each button press changes the allocation by a value of four. If you change the allocation for one type of memory, the other is updated accordingly.

IMPORTANT These settings are not retained after a power cycle. The settings return to the defaults.

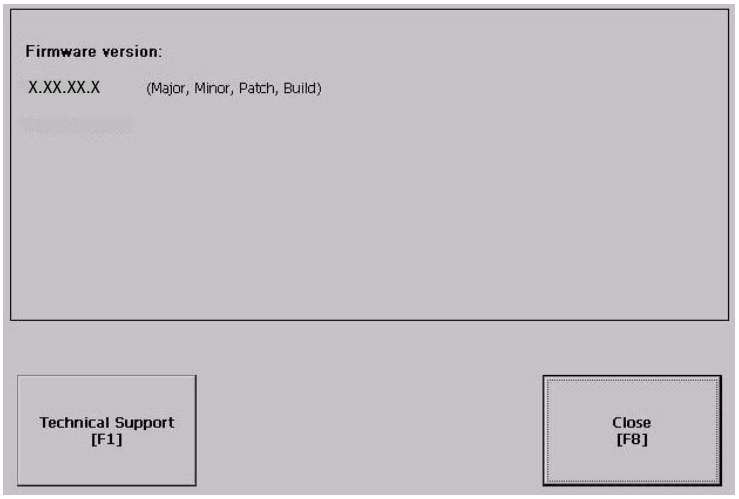
4. Press OK to return to previous screen.

5. Press OK to return to terminal settings.

Display FactoryTalk View ME Station Information

You can display the firmware number of FactoryTalk View ME Station software and the Rockwell Automation technical support number.

1. Select Terminal Settings>System>Information>About FactoryTalk View ME Station.



2. Press the Technical Support button, if desired.

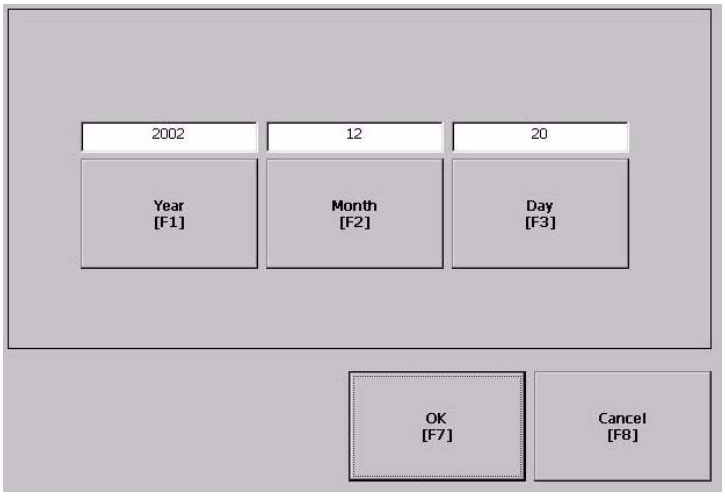
3. Press Close.

Modify the Date, Time, or Time Zone

You can adjust the date and time for terminal operations, or change the time zone.

Change the Date

1. Select Terminal Settings>Time/Date/Regional Settings>Date. The current date appears in the Year, Month, and Day fields.



2. Press the Year, Month, and Day buttons to change the values.

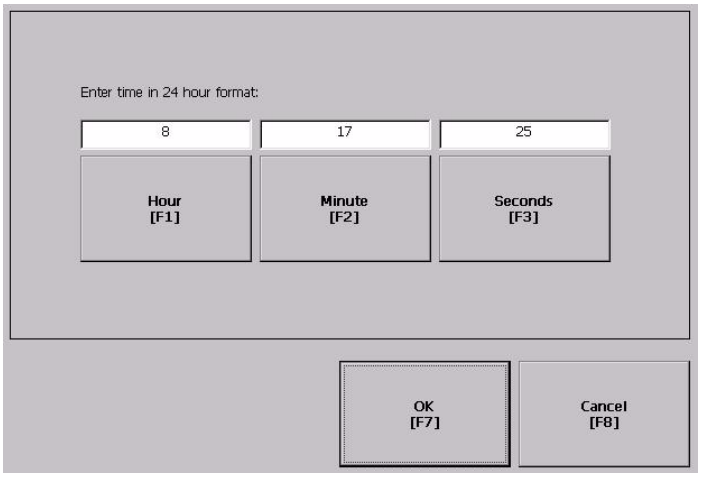
Field	Description	Valid Values
Year	The current year in a four-digit format.	1980…2099
Month	The current month.	1…12
Day	The current day. The day of the month is validated based on the month.	0…31

3. Press OK when done.

Change the Time

1. Select Terminal Settings>Time/Date/Regional Settings>Time.

   The current time appears in 24-hour format in separate Hour, Minute, and Second fields.



2. Press the Hour, Minute, and Seconds buttons to change the values.

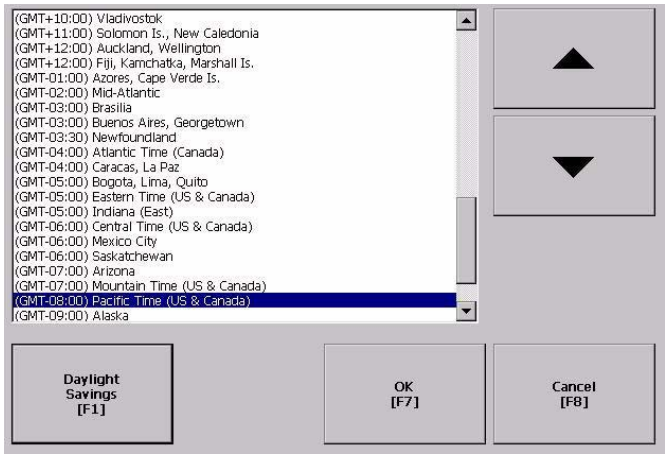
Field	Description	Valid Values
Hour	The current hour in 24-hour format.	0…23
Minute	The current minute in 24-hour format.	0…59
Seconds	The current second in 24-hour format.	0…59

3. Press OK when done.

Change the Time Zone

You can view or modify the current time zone that is installed on the terminal. Time zones are installed as a part of the operating system. Changing the time zone adjusts the current time and date to match the new time zone.

1. Select Terminal Settings>Time/Date/Regional Settings>Time Zone.



2. Press the up and down cursor buttons to select a time zone.

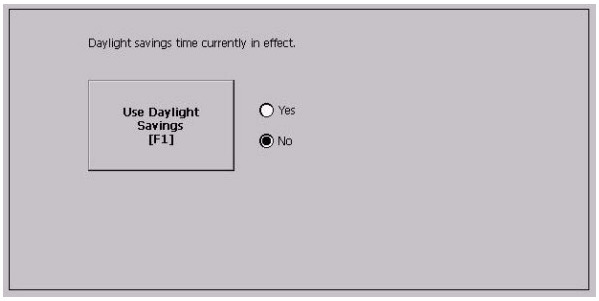
Language	Default Time Zone
English	(GMT -05:00) Eastern Time (US and Canada)
French	(GMT +01:00) Brussels, Copenhagen, Madrid, Paris
German	(GMT +01:00) Amsterdam, Berlin, Bern, Rome, Stockholm, Vienna
Japanese	(GMT +09:00) Osaka, Sapporo, Tokyo

   If the selected time zone supports Daylight Savings, you can press the Daylight Savings button.

3. Press the Daylight Savings button to enable or disable daylight savings for the selected time zone.

   Daylight Savings is set to Yes for all time zones except for Japanese, which does not support daylight savings. Daylight savings changes are not permanently applied until you close the Time Zone screen.

4. Press the Use Daylight Savings Button to select Yes or No.



5. Click OK when done.

6. Click OK to return to Terminal Settings.

Modify Regional Settings

You can adjust regional settings for a specific language installed on the terminal, including the date, time and numeric formats.

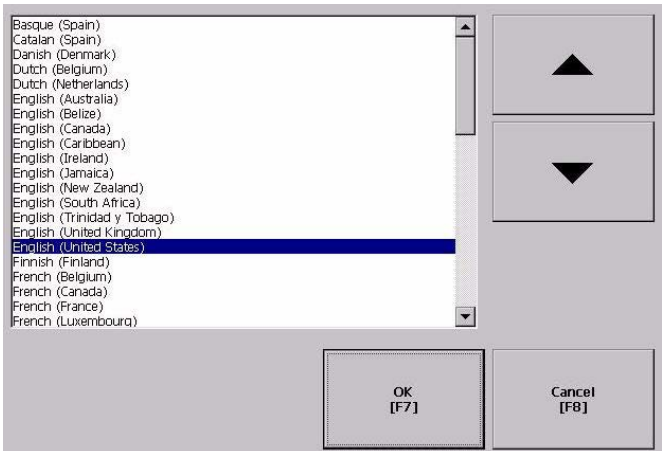
To access regional settings, select Terminal Settings>Time/Date/Regional Settings>Regional Settings.

The current language is shown at the bottom of the Regional Settings screen.

Select a Language

You can select a language that is installed on the terminal. Languages are installed as a part of the operating system.

1. Select Terminal Settings>Time/Date/Regional Settings>Regional Settings>Language.



2. Select a language by pressing the up and down cursor keys.

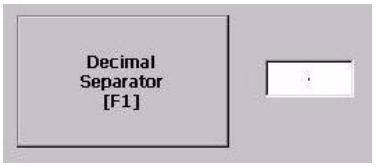
3. Press OK.

   The selected language will appear at the bottom of the Regional Settings screen.

Change the Decimal Separator for Numeric Formats

You can change the decimal separator used in numerics for the current language. The default decimal separator is a period.

1. Select Terminal Settings>Time/Date/Regional Settings>Regional Settings>Numeric Format.

   The field shows the default decimal separator. The field will accept a separator up to three characters.

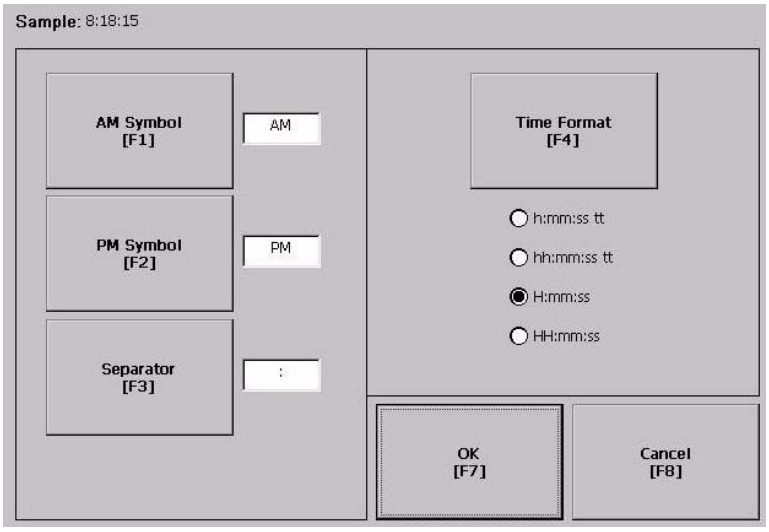
2. Enter up to three characters for the new separator.

3. Click OK.

Change the Time Format

You can change the time format for the selected language.

1. Select Terminal Settings>Time/Date/Regional Settings>Regional Settings>Time Format.



   The current time is shown using the currently selected format.

2. Press the appropriate buttons to adjust the formats.

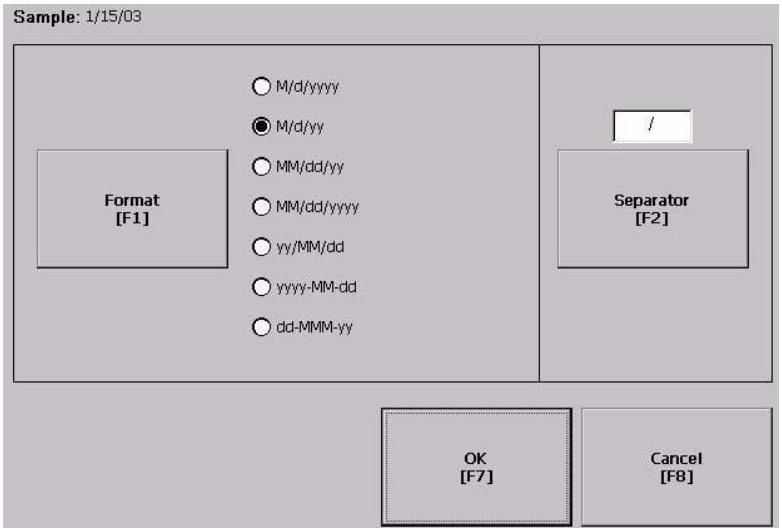
Field	Description	Example
Time Format	h:mm:ss tt (default) h = hour, no leading zero tt = AM or PM symbol	7:23:02 AM or 1:13:31 PM 11:43:59 AM
	hh:mm:ss tt hh = hour with leading zero tt = AM or PM symbol	07:23:02 AM or 01:13:31 PM 11:43:59 PM
	H:mm:ss H = hour in 24-hour format, no leading zero	7:03:42 or 1:13:32 23:43:59
	HH:mm:ss HH = hour in 24-hour format with leading zero	07:03:42 or 01:13:22 23:43:59
AM Symbol	Characters to indicate AM. If the time format is set to h:mm:ss tt or hh:mm:ss tt, you can modify the AM symbol.	AM (default) 12 character max
PM Symbol	Characters to indicate PM. If the time format is set to h:mm:ss tt or hh:mm:ss tt, you can modify the PM symbol.	PM (default) 12 character max
Separator	Characters that separate fields in time format.	: (default) 3 character max

3. Click OK.

Change the Short Date Format

You can change the short date format for the selected language.

1. Select Terminal Settings>Time/Date/Regional Settings>Regional Settings>Short Date Format.



The current date is shown in the selected, short date format.

Field	Short Date Formats	Example
Format	M/d/yyyy (default) M/d/yy MM/dd/yy MM/dd/yyyy yy/MM/dd yyyy-MM-dd dd-MMM-yy	1/2/2003 1/2/03 01/02/03 01/02/2003 03/01/02 2003-01-02 02-Jan-03
Separator	Character separator for fields in time format. The default separator is either - or / depending on short date format.	- or / (default) 3 character max

2. Press the Format button to select an available format.

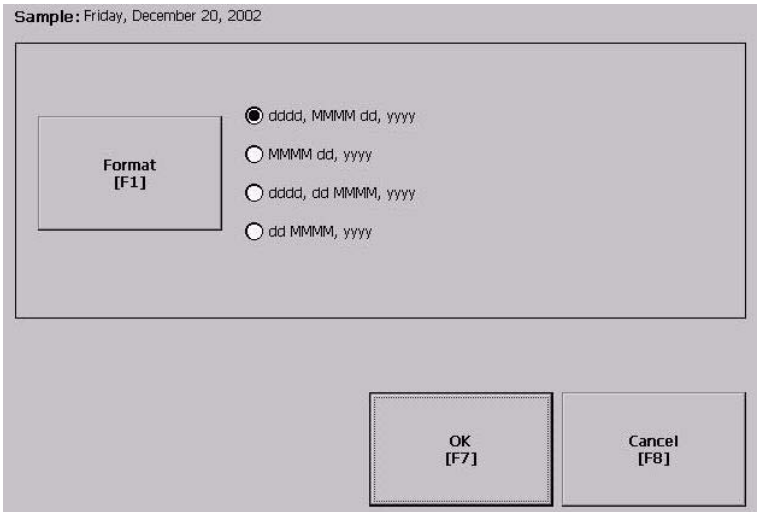
3. Press the Separator button to change the field separator for the date elements.

4. Click OK when done.

Change the Long Date Format

You can change the long date format used by the selected language.

1. Select Terminal Settings>Time/Date/Regional Settings>Regional Settings>Long Date Format.



   The current date is shown in the selected long date format.

2. Press the Long Date Format button to select a date format.

Long Date Formats	Example
dddd, MMMM, dd, yyyy (default) dddd is name of week day MMMM is name of month dd is two-digit day of month with leading zero yyyy is four-digit year	Monday, January 01, 2003
MMMM dd, yyyy MMMM is name of month dd is two-digit day of month with leading zero yyyy is four-digit year	January 01, 2003
dddd, dd MMMM, yyyy dddd is name of week day dd is two-digit day of month with leading zero MMMM is name of month yyyy is four-digit year	Monday, 01 January, 2003
dd MMMM, yyyy dd is two-digit day of month with leading zero MMMM is name of month yyyy is four-digit year	01 January, 2003

3. Click OK when done.

Windows CE .NET Operating System

Chapter Objectives

This chapter applies only to PanelView Plus CE terminals and provides information on these topics:

- Windows CE .NET architecture
- Windows CE .NET programs for PanelView Plus CE terminals
- Using Windows CE .NET operating system
- PanelView Plus CE terminal memory
- Control panel applications for configuring PanelView Plus CE terminals

Windows CE .NET Architecture

The Windows CE .NET operating system from Microsoft provides a portable, scalable, real-time operating system for embedded devices. The modular design of Windows CE .NET allows the platform builder to include only those features required for the specific product application. However, the Windows CE .NET operating system is still a subset of the other Microsoft operating systems, and it runs Win32 applications.

Windows CE .NET Benefits

There are three major differences between the Windows CE .NET operating system and other Microsoft Windows operating systems. The Windows CE .NET operating system:

- has a small memory footprint requirement.
- runs on a wide variety of processor architectures.
- has a real-time scheduler.

The small memory footprint allows the Windows CE .NET operating system to operate in small solid-state memory devices (8 MB typical). In contrast, computers that run Windows operating systems require hundreds of megabytes of storage space.

The PanelView Plus CE terminal has an x86-based processor to maximize the consistency between Windows 2000/XP and Windows CE .NET applications.

Compile Windows CE .NET Applications

While the Windows CE .NET operating system brings a higher level of standardization to embedded computing devices, third-party software applications must still be compiled and tested to run on each Windows CE .NET device. The compilation is required to tailor the software application to the device's processor and unique hardware features.

Microsoft created hardware reference models for the handheld (HPC) and the pocket (PPC) personal computer so that third-party applications can run on these standard platforms. There are no hardware standards for embedded devices.

The PanelView Plus CE terminal is largely compatible with HPC and PPC, so applications that are compiled for the x86 may run on the PanelView Plus CE terminal.

Windows CE .NET Programs

The PanelView Plus CE terminal includes FactoryTalk View ME software. Refer to the user manual and online help shipped with FactoryTalk View Studio software for information about using this software.

The Windows CE .NET operating system and applications are stored on the internal CompactFlash of the PanelView Plus CE terminal for permanent storage and can be accessed as the \Storage Card directory in the Windows Explorer. (They are also available on the PanelView Plus CE Accessory CD). The operating system and FactoryTalk View ME software are loaded into RAM at startup to improve response time.

Additional programs can be installed by using ActiveSync or an external CompactFlash card on the PanelView Plus CE terminal.

The PanelView Plus CE terminal ships with the following programs preloaded.

Application	Description
Microsoft Internet Explorer, version 5.5	Web browser
ActiveSync Support	Connects the PanelView Plus CE terminal to a desktop computer running ActiveSync software
Control Panel	Set of configuration tools for setting up the PanelView Plus CE terminal
Windows Explorer (Shell)	User interface to the system much like a desktop computer
Remote Desktop Connection	Services for thin client applications included on the PanelView Plus CE Accessory CD (formerly Terminal Server Client)
WordPad	Text editor
PDF Viewer	Reader for Adobe Acrobat PDF files

Other Windows CE .NET programs are available.

Most of these programs have been written for PPC devices, and some may run on the PanelView Plus CE terminals. For more information on Windows CE .NET programs, see the Knowledgebase at http://support.automation.rockwell.com.

Install Applications

The PanelView Plus CE terminal allows field-installation of third-party software.

Refer to Chapter 8 for details on how to use Microsoft ActiveSync software to install and remove application programs on the PanelView Plus CE terminal. Each application program must be compiled for the x86 processor.

If the application program literature does not specifically identify the PanelView Plus CE terminal as a compatible hardware platform, take caution if trying to install and run it on the terminal. While the program may operate on the X86 processor, there could be conflicts with running it on the PanelView Plus CE terminal. Testing is essential.

Windows CE .NET Operating System

The Windows CE .NET operating system provides a user interface similar to other Microsoft Windows operating systems. This user interface has been simplified to reduce the memory footprint. Therefore, minor differences exist between the desktop Windows interface and the Windows CE .NET interface.

The Windows CE .NET graphical interface simplifies interaction with the computer. You simply select and move objects on the screen by tapping and dragging them using your finger or stylus on the touch screen, or using an external mouse.

TIP If you have difficulty selecting objects using the touch screen, run the calibration program.

The PanelView Plus CE terminal has a keypad, touch screen, or input panel for operator input. In addition, an external keyboard or mouse can be connected to one of the USB ports of the terminal.

You may find it convenient to use the following shortcuts. These shortcuts work with the PanelView Plus CE terminal keypad, an attached keyboard, or the input panel.

Keyboard Shortcuts

Shortcut	Description
Ctrl+Esc	Opens the Windows CE .NET Start menu. Use arrow keys to select a program and Enter to run.
Alt+Tab	Starts the Task Manager.
Enter	This key is equivalent to double-tap. In a dialog, you can select Enter or OK.
Shift + Tab or ⇤	Selects the previous control in a dialog.
Tab or ⇥	Selects the next control in a dialog.
Ctrl+Tab	Opens the next tab in a tabbed dialog.
Esc	Closes a dialog without saving changes.
Arrow keys	Selects controls or items from a list in a dialog.
Alt	Activates menus.

Start Menu and Taskbar

Use the Start menu to run programs, configure settings, and open recently-used documents. A single-click on the Start menu button on the bottom left of the screen brings up the menu. Subsequent clicks select the program or item you want to open. The key sequence Ctrl+Esc also activates the Start menu.

The taskbar across the bottom of the screen contains buttons for programs already running, along with a status area and a Desktop icon. You can alternately minimize and maximize an open application by clicking on its taskbar button. Double-clicking on any icon in the status area shows more information about that function. A single-click on the Show Desktop button (far right side of taskbar) minimizes all open windows and displays the PanelView Plus CE computer desktop. You can close an application by clicking with the right mouse button on its taskbar button and choosing Close.

Command Bar

A Windows CE.NET program has a command bar located across its top. This command bar contains pull-down menu names and toolbar buttons for the application.

Click on a menu name or toolbar icon to interact with the specific program. The Help (?) button on the right side of the command bar provides application-specific help. The Exit (X) button on the far right side of the command bar exits the application.

Windows CE .NET command bar does not have a Minimize button. Click the taskbar button to minimize a program window, or use the Show Desktop button to minimize all open program windows.

Find Files

Select Start>Programs>Windows Explorer to locate files on the PanelView Plus CE terminal. You can alternately double-click the My Computer icon on the Desktop to open the Windows Explorer program. The Windows Explorer web browser lets you browse and manipulate the PanelView Plus CE files and folders. The Edit menu lets you move files from one location to another by using the Copy or Cut and Paste commands. When you create and save a new file, it is stored in the My Documents folder unless you specify another location.

TIP The PanelView Plus CE file system resides in RAM and flash memory. RAM is volatile and is not persistent after a power cycle. Save files that must be persistent to the\Storage Card Folder that resides on the internal CompactFlash card.

Browse Web Pages

Select Start>Programs>Internet Explorer to view Web pages. You can alternately double-click the Internet Explorer icon on the desktop to open the Internet Explorer program. To access pages stored on the PanelView Plus CE terminal, use the File>Open command and select the Browse button to locate the file. To view Internet or intranet pages, type a URL in the Address box.

Before you can access remote Web pages, the PanelView Plus CE terminal must be connected to a network. See the section on Network and Dialup Connections for details on configuring the Ethernet interface. Additional network settings such as a Proxy Server can be configured in the Internet Explorer application by using the Options command under the View menu.

The Microsoft Internet Explorer application is similar to the personal computer version. It offers many of the same features of the personal computer version, and can be used to view most Internet HTML Web pages. Some advanced Web features may not be fully supported.

Print

Some PanelView Plus CE software applications may support printing. To print from these applications, select the File>Print command. A PCL compatible printer must be connected to the USB or Ethernet port on the PanelView Plus CE terminal.

PanelView Plus CE Memory

The PanelView Plus CE has the following memory areas:

- Boot ROM
- Internal CompactFlash
- Dynamic RAM
- External CompactFlash cards
- USB mass storage devices

Boot ROM

The boot ROM is used to start up the PanelView Plus CE terminal, perform power on self tests, and load the Windows CE .NET operating system into dynamic RAM. The boot ROM code is not user accessible.

Internal CompactFlash

The internal CompactFlash is the main storage memory in the PanelView Plus CE terminal. The Windows CE .NET operating system and user applications are stored in flash memory. On startup, the operating system and any auto-start applications are transferred to dynamic RAM, where they are executed.

The remainder of the flash memory is a FAT partition that appears as a folder named \Storage Card in Windows CE .NET. Files stored here are persistent (saved even after a reset or power cycle).

WARNING

Only programs and files loaded in the \Storage Card folder are permanently saved to flash memory. All other folders or files existing in RAM are lost when power is cycled.

Dynamic RAM

The RAM memory is split into two segments: Storage and Program memory. The System application in the Control Panel has a slider control that determines the allocation mix between Storage and Program memory.

The Storage memory segment is a virtual RAM disk known as the Object Store. It provides specialized storage for the Windows CE .NET Registry, the file system, and system databases. The RAM-based Storage memory segment is **not** persistent as in HPC devices, so all files stored here must be recreated at every startup.

The Program memory segment provides traditional computer RAM-like functions for holding application code, heaps, stacks, and data at runtime. The PanelView Plus CE terminal loads the Windows CE .NET operating system and any auto-start applications from flash memory into the Program memory at powerup.

External CompactFlash Cards

External CompactFlash cards are available for the PanelView Plus CE terminal to increase the space for storing files. When a CompactFlash card is installed in the card slot of the PanelView Plus CE terminal, a StorageCard2 icon is displayed under My Computer, and files on the memory card can be manipulated by using the Windows Explorer program.

The card slot on the PanelView Plus CE terminal supports Type 1 CompactFlash cards. The cards (2711P-RCx) are available in different sizes.

For details on how to install/remove cards from the card slot, refer to page 164.

USB Mass Storage Devices

USB devices that comply with the USB Mass Storage Class Specification, version 1.0, are supported to enable a wide variety of USB-based storage devices such as hard drives, floppy disks, CD-ROM drives and ATA flash readers. Up to 10 devices are supported, concurrently. DVD drives are not supported.

Control Panel Applications

The PanelView Plus CE terminal has user-configurable settings that are accessed from the Windows CE .NET Control Panel applications. These applications are similar to other Microsoft Windows operating systems. Select Start>Settings>Control Panel to open the Control Panel window.

Application	Description	See page
Certificates	Manages digital certificates used by some applications for establishing trust and secure communications.	139
Date/Time	Sets the date and time on the terminal.	137
Dialing	Configures dialing rules for telephone and modem communications.	123
Display	Configures the display and color settings, the brightness of the backlight, and the screen saver.	130
Extended Diagnostics	Enables tests to run on the terminal at each startup and the number of times to run each test.	132
Hardware Monitor	Views the current voltage and temperature, and system events logged on the terminal.	134
Input Panel	Configures an input panel for entering/editing data on a touch screen terminal.	129
Internet Options	Configures start and search pages, clears cache and history, and specifies connection and security settings for Internet Explorer web browser.	139
Keyboard	Configures settings for an attached keyboard.	127
Keypad	Configures settings for keys on the PanelView Plus CE terminal.	128
Mouse	Sets the sensitivity of the mouse, if attached.	129
Network and Dial-up Connection	Configures ActiveSync and Ethernet network connections between your terminal and a computer.	124
Owner	Configures network and user identification information for your terminal.	122
Password	Sets a password to protect your terminal against unauthorized use. The password can be enabled at system startup or when the screen saver is activated.	123
PC Connection	Selects a configured connection for connecting your PanelView Plus CE terminal to another computer.	125

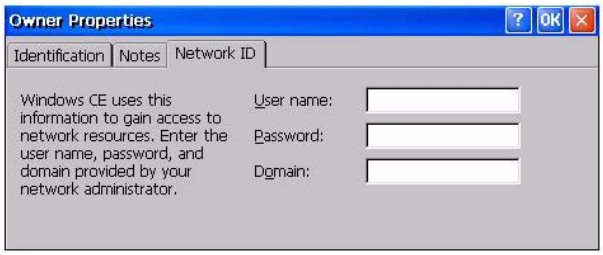
Application	Description	See page
Power	Provides information on the battery condition of the terminal and other power management features.	134
Regional Settings	Sets the clock, date and language, and configures formats for numbers, currency, time, date, and regional settings.	137
Remove Programs	Removes programs installed on your terminal.	140
Storage Manager	Displays information on terminal's hard drive. Also reformats and manages partitions for hard drive.	140
System	Lists system properties like memory allocation, device information, operating system version.	135
Touch	Calibrates the touch screen, sets the sensitivity of touch screen taps, and enables/disables the touch screen cursor.	126

Owner

The Owner dialog provides network and user identification information for your PanelView Plus CE terminal.

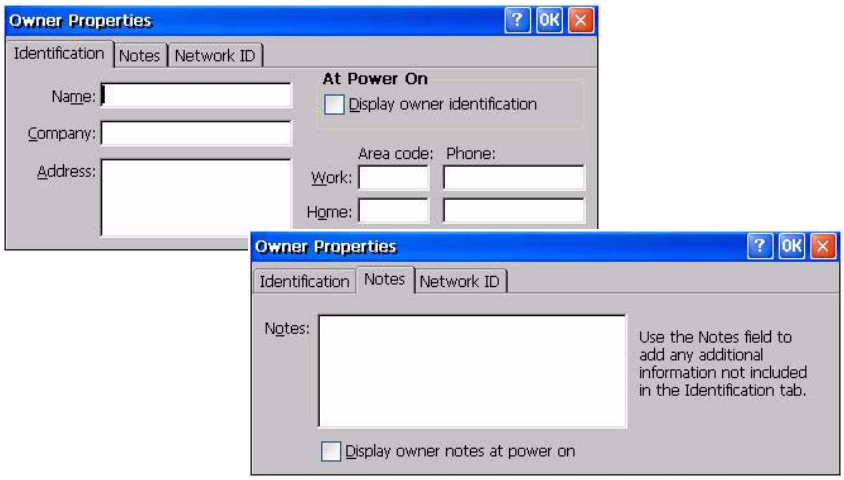
Network ID

The Network ID tab identifies the PanelView Plus CE terminal to a network so it can gain access to network resources. A username, password, and domain may be necessary; if so, contact your system administrator. When done, click OK.



Identification and Notes

The Identification tab defines optional user information for your PanelView Plus CE terminal. Use the Notes tab if it is necessary to document additional information.

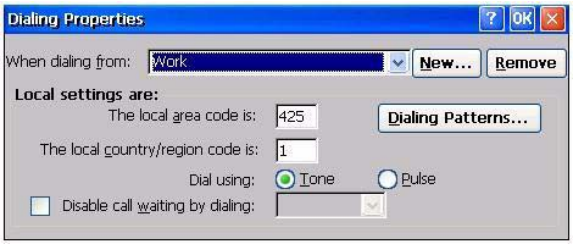


Password

The Password dialog lets you define a password to protect your terminal against unauthorized use. You can require that the defined password be entered each time the terminal is restarted and/or when the screen saver is activated. Select OK to activate settings.

Dialing

The Dialing dialog is a standard Windows control-panel application that configures dialing rules for modem communication.



Network and Dial-up Connections

The Network and Dial-up Connections application lets you configure:

- ActiveSync connection between your PanelView Plus CE terminal and another computer.
- Ethernet network connection.

ActiveSync Connection

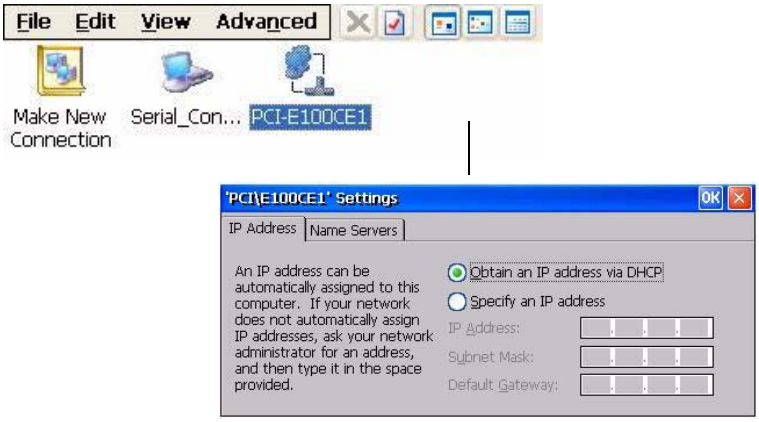
For details on establishing an ActiveSync connection between your PanelView Plus CE terminal and a computer, see Chapter 8.

Serial Connect is the default, pre-configured ActiveSync connection.

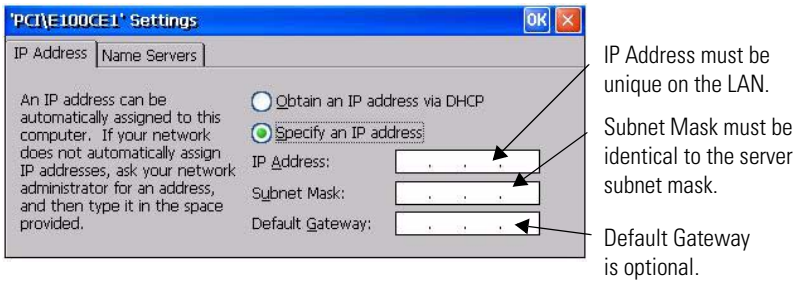
Configure Ethernet Connection

Follow these steps to configure an Ethernet network connection.

1. Select the Network and Dial-up Connections application.
2. Click the PCI-E100CE1 icon to configure Ethernet settings.



3. On the IP address tab, select Obtain an IP address via DHCP or Specify an IP Address
   - IP addresses may be automatically assigned if DHCP is enabled for the Ethernet adapter.
   - If you select Specify an IP Address, complete the three text boxes with information from your network administrator.



4. Click OK in the title bar.

   A dialog will prompt you to either remove and reinstall your card or restart the device for the new settings to take effect. Click OK in the notification dialog.

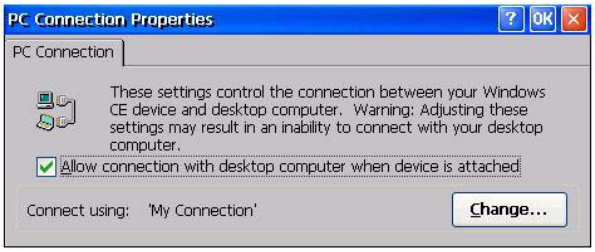
5. For the built-in Ethernet Controller, you must restart the terminal.

6. Click OK to close the Network Configuration dialog.

TIP If DHCP is enabled for the adapter, Name Server addresses may be automatically assigned. You can specify additional WINS or DNS addresses on the Name Servers tab.

PC Connection

The PC Connection dialog lets you select and enable a configured connection between your PanelView Plus CE terminal and another computer. The current connection is listed at the bottom of the tab. To change the connection to another computer, click Change. A dialog will open letting you select another configured computer. Click OK when done to activate change.



WARNING Adjusting the PC connection named Serial_Connect may result in an inability to connect with your desktop computer via ActiveSync software.

Touch

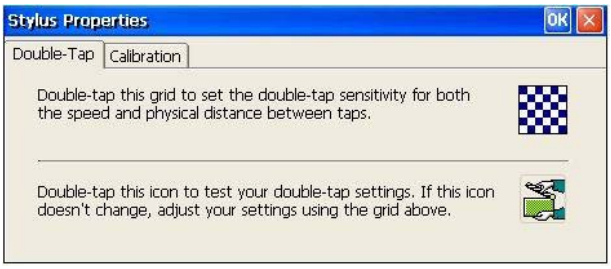
The Touch Properties dialog lets you perform the following operations for PanelView Plus CE touch screen terminals:

- Set double-tap sensitivity
- Calibrate the touch screen

When done performing operations, remember to click OK in the title bar to activate settings.

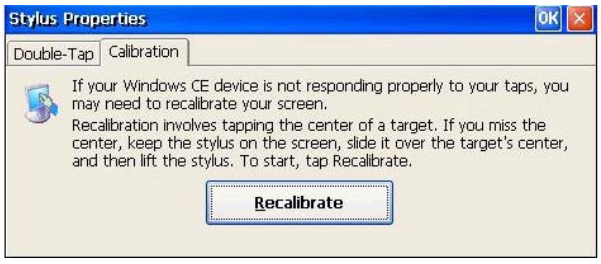
Double-tap Sensitivity

The Double-tap tab sets the sensitivity for both the speed and physical distance between screen taps. Double-tap the top grid to set the sensitivity. Double-tap the bottom grid to test the setting.



Calibration

The Calibration tab provides instructions on how to calibrate the touch screen. You may have to do this if the terminal is not responding to your taps. Click Recalibrate. Touch the center of the target as it moves around the screen. When the target returns to its initial position, the calibration is complete.



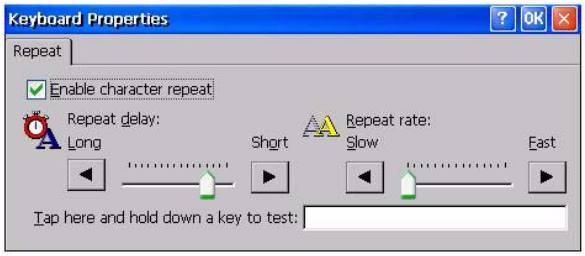
Keyboard

The Keyboard dialog configures key settings for a keyboard that is attached to the USB port of the PanelView Plus CE terminal. You can adjust the:

- rate for repeating a key press.
- delay from the first key press to when repeating begins.

To adjust key repeat settings, check the Enable character repeat checkbox. Adjust how often a key repeats by moving the slider between Slow and Fast. To adjust the delay between key repeats, move the slider between Long and Short. Tap the field at the bottom of the dialog and then hold down a key to test the new settings.

When done performing operations, remember to click OK in the title bar to activate settings.



Keypad

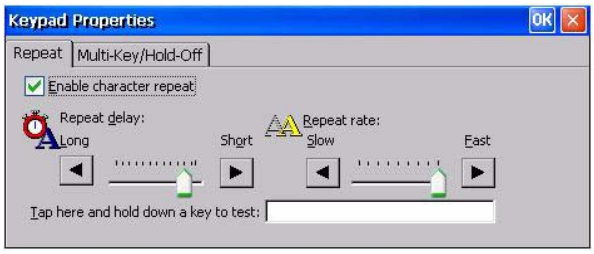
Use the Keypad dialog to:

- configure key settings for keys on the PanelView Plus CE terminal.
- adjust the rate for repeating a key press and the delay from the first key press to when repeating begins
- enable/disable multi-key lockout.

When done performing operations, remember to click OK in the title bar to activate settings.

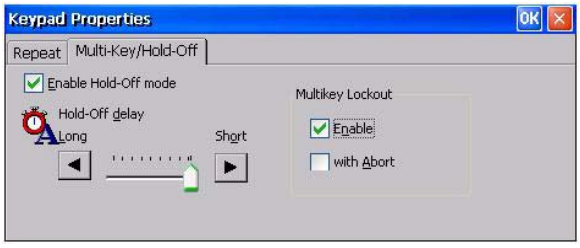
Key Repeat

To adjust repeat settings for keys on an attached keyboard, check the Enable character repeat checkbox. Then adjust how often a key repeats by moving the slider between Slow and Fast. To adjust the delay between key repeats, move the slider between Long and Short. Tap the field at the bottom of the dialog and then hold down a key to test the new settings.



Multi-Key/Hold-Off Lockout

The Multi-Key/Hold-Off tab restricts multiple or simultaneous key presses on the PanelView Plus CE terminal and specifies a hold-off delay between presses of the same key.



Multi-Key Lockout

Under Multi-Key Lockout, select one of the following options:

- Enabled - any programmable key that is pressed inhibits all keys until the programmable key is pressed again. This includes the Alt, Ctrl, and Shift keys.
- Enabled with Abort - any secondary key press will terminate the initial key press immediately.
- Disable - places no restrictions on key presses. Clear both checkboxes.

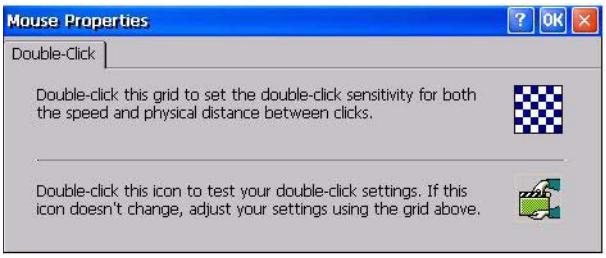
IMPORTANT The keypad cannot produce Home, End, Page Up, or Page Down when Multi-Key Lockout is enabled.

Hold-Off Delay

If enabled, this option will ignore multiple presses of the same key for a specified length of time. To enable this option, select the Enable Hold-Off mode checkbox. Then adjust the delay time by moving the slider to the left or right to increase or decrease the hold off time.

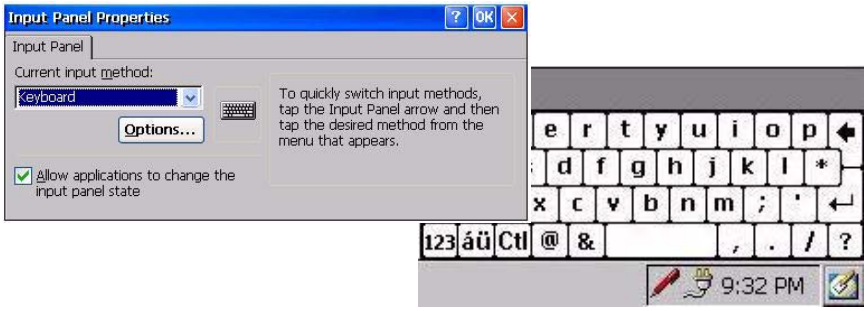
Mouse

If a mouse is attached to one of the USB ports of the PanelView Plus CE terminal, you can set the sensitivity for both the speed and physical distance between mouse taps. Double-tap the top grid to set the sensitivity. Double-tap the bottom grid to test the setting. Click OK.



Input Panel

The Input Panel dialog sets properties for the soft Keyboard input panel. Use the Options button to select Large or Small keys, and other soft key options. Click OK after making any changes.



Display

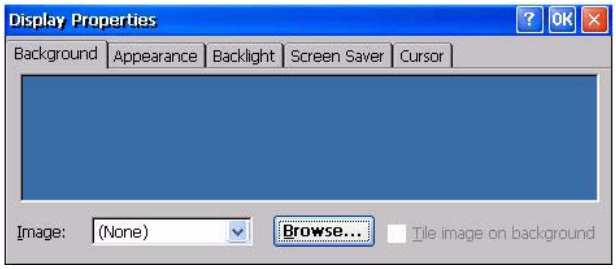
The Display dialog set the following display properties for the PanelView Plus CE terminal.

- Background
- Appearance
- Backlight
- Screen saver
- Cursor

When done performing operations, remember to click OK in the title bar to activate settings.

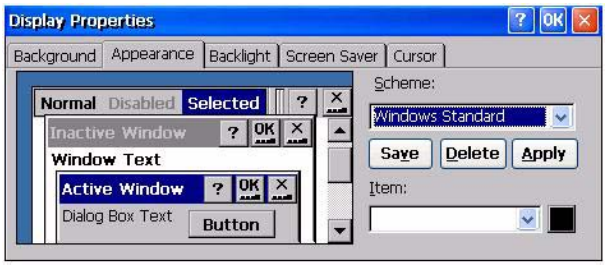
Background

The Background tab lets you select an image to use for the PanelView Plus CE desktop and whether the image should be tiled.



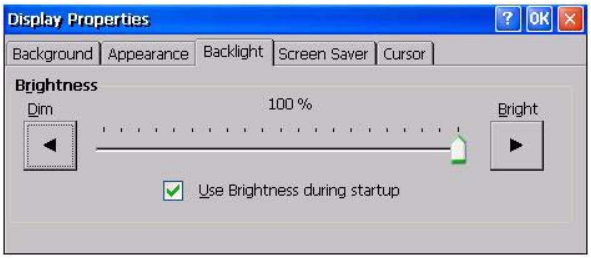
Appearance

The Appearance tab let you change the color scheme of your desktop.



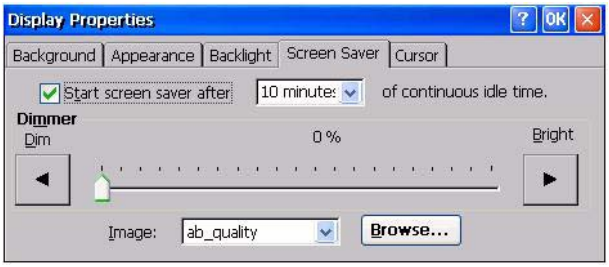
Backlight

The Backlight tab adjusts the brightness of the terminal's backlight. To adjust the brightness of the terminal's backlight, move the slider to the left or right. To use the adjusted brightness when the terminal starts up, select the Use Brightness during startup checkbox.



Screen Saver

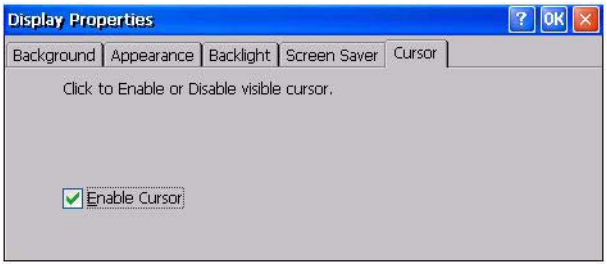
The Screen Saver tab enables and disables the screen saver. To enable the screen saver, check the checkbox and then select an idle time. This will activate the screen saver after the terminal has been idle for the specified time. You can also select a screen saver image. To adjust the brightness of the screen saver, move the slider to the left or right.



To add a custom image for the screen saver, copy the bitmap (.bmp file) to the \Storage Card folder and then use the Browse button to select the image. You can disable the screen saver bitmap by selecting (None) from the Image pull-down list.

Cursor

Use the Cursor tab to enable or disable the visible screen cursor.



Extended Diagnostics

From the Extended Diagnostics dialog, you can:

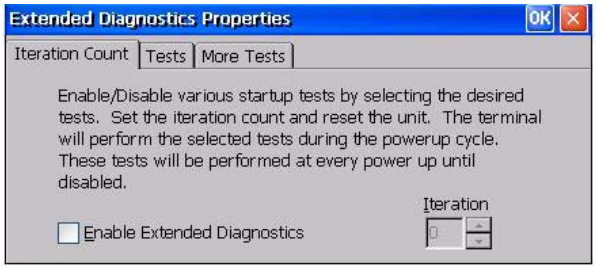
- enable/disable extended diagnostics to run on the PanelView Plus CE terminal at each reset or power cycle.
- select specific tests to run.
- specify the number of times to repeat each test.

When done performing operations, remember to select OK in the title bar to activate settings.

Iteration Count

From the Iteration tab, check the Enable Extended Diagnostic checkbox to run selected tests on the PanelView Plus CE terminal at each reset or startup. You can also specify how many times to run each test. The tests are selected from the Tests and More Tests tab.

The selected tests will run each time the PanelView Plus CE terminal is reset until disabled (by unchecking the Enable Extended Diagnostics checkbox).



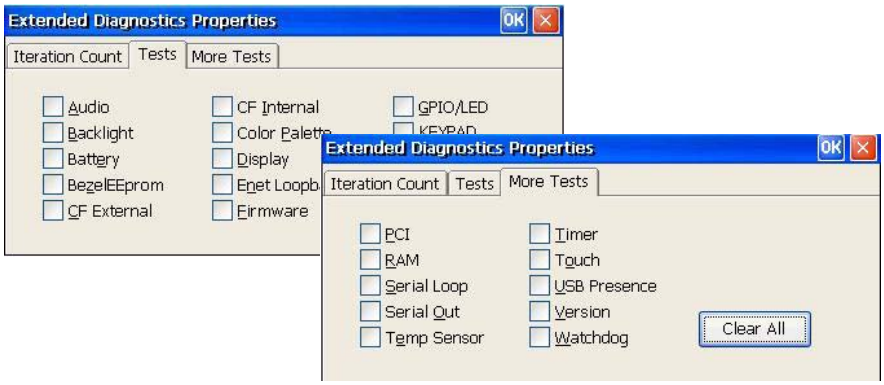
TIP

Enabling Extended Diagnostics and setting a high Iteration count will increase the time it takes for the terminal to start up.

The tests will run each time you reset or cycle power to the terminal until you disable Extended Diagnostics. Setting a low iteration count will also decrease the start up time.

Tests

The Tests and More Tests tabs show a list of tests that can be performed on the PanelView Plus CE terminal at startup and the on/off status of each test. The terminal will run only the test with checked boxes. To enable a test, check the checkbox; to disable a test, uncheck the checkbox. Click Clear All if you want to clear all checkboxes.



Hardware Monitor

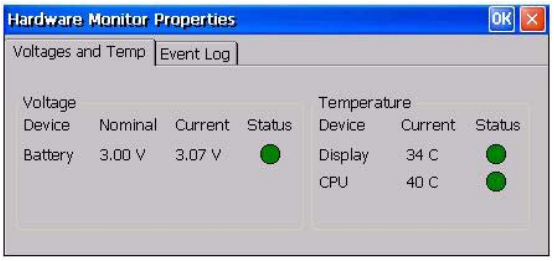
Use the Hardware Monitor dialog to:

- view the current battery voltage state and temperature of the display and processor.
- view and clear all recorded events.

When done performing operations, remember to click OK in the title bar to activate settings.

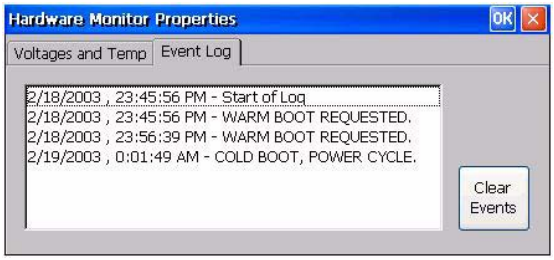
Voltages and Temperature

The Voltages and Temp tab shows both the nominal and actual voltage of the battery in the PanelView Plus CE terminal and its current status. The current temperature of the display and the processor is also shown along with its status.



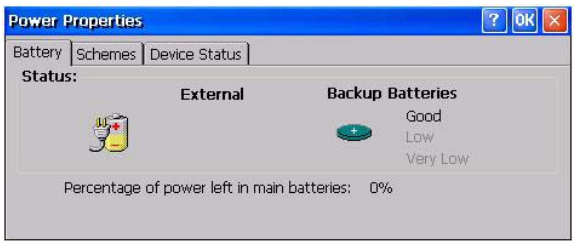
Event Log

The Event Log shows a list of all events that have occurred in the system. Select the Clear Events button to clear all events from the list.



Power

The Battery tab on the Power dialog shows the status of the internal battery in the terminal. Replace the battery in the terminal, when the Battery State is Low or Very Low. For the PanelView Plus CE terminal, you can ignore the other tabs.

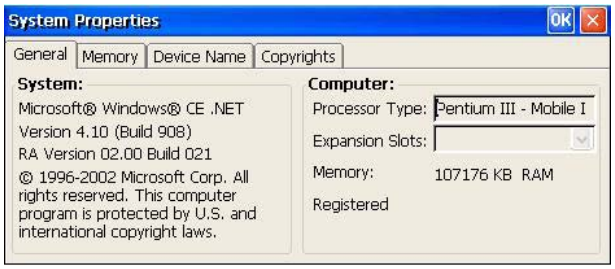


System

The System dialog provides system, device, and copyright information for the PanelView Plus CE terminals. It also provides memory allocations for storage and programs. If you make memory adjustments, remember to click OK to activate settings.

General

The General tab displays system operating and computer information.



Memory

The Memory tab displays the amount of memory allocated and in use for storage and programs. These settings are controlled by the system at startup and can be adjusted by an application program. Normally, it is not necessary to the change the setting unless a program reports a need for more memory. Move the slider to the left to increase the allocation for program memory. The memory allocations are automatically adjusted as you move the slider.

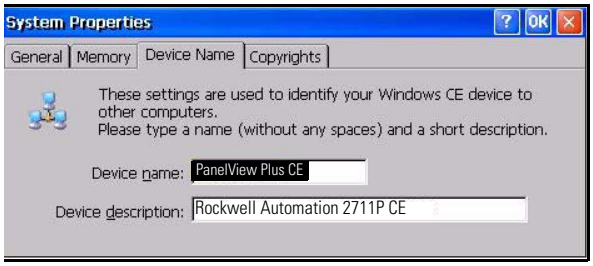
Device Name

The Device Name tab defines a name and description for your PanelView Plus CE terminal. This information identifies your CE terminal to other computers on the Ethernet network. The name must be unique on the network. You must change the name from the initial default the terminal was shipped if more than one PanelView Plus CE terminal is present on your Ethernet network.

The device name must include:

- 1…15 characters.
- a leading alpha character in the range a through z or A through Z.
- remaining characters in the range a through z, A through Z, 0 …9 or - (hyphen).

The device description is optional but useful if you want to further describe a specific terminal.



Copyrights

The Copyright tab provides copyright information for your PanelView Plus CE terminal.

Date/Time

The Date/Time dialog sets the current date and time for the selected time zone. Changing the time zone will adjust the date and time accordingly. Check the checkbox if Daylight Savings is in effect for the current time zone.

The time appears according to the format set in the Regional Settings dialog. After making adjustments, click Apply and then OK.

Regional Settings

Use the tabs on the Regional Settings dialog to select a language and then set the format for how the time, date, and numbers appear for the selected language.

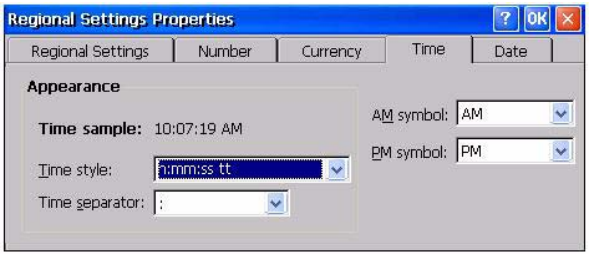
When done performing operations, remember to click OK in the title bar to activate settings.

Language

The Language tab selects a language that is installed on the PanelView Plus CE terminal. Languages are installed as a part of the operating system.

Time

The Time tab configures the time format for the selected language. A sample of the current time format is shown. This sample changes as you make adjustments. You can adjust the time format, the separator between the time fields, and the AM/PM symbol.

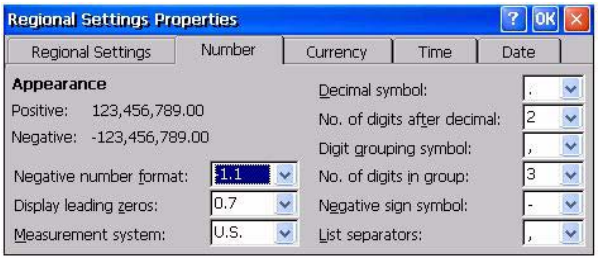


Date

The Date tab configures the style of the short date format and the long date format for the selected language. A sample of the current formats is shown. These samples are updated as you make changes.

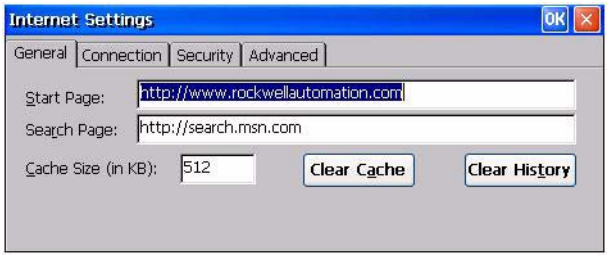
Number

The Number tab configures how negative and positive numbers will appear for the selected language. The appearance of the current formats is shown for both positive and negative numbers. These samples are updated as you make changes.



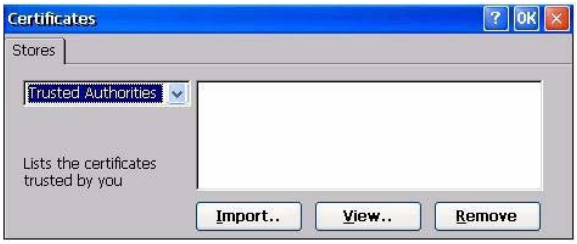
Internet Options

The Internet Setting dialog provides tabs to configure parameters for accessing and using the Internet on your PanelView Plus CE device.



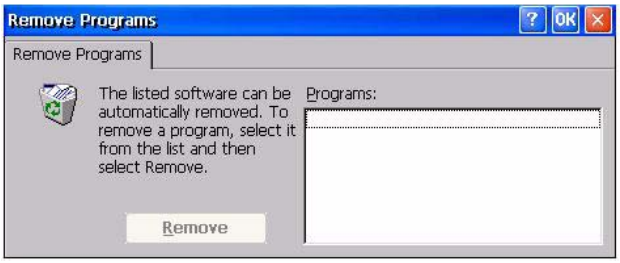
Certificates

The Certificates dialog manages digital certificates used by some applications for establishing trust and secure communications. Certificates are signed and issued by certificate authorities and are valid for a prescribed period of time.



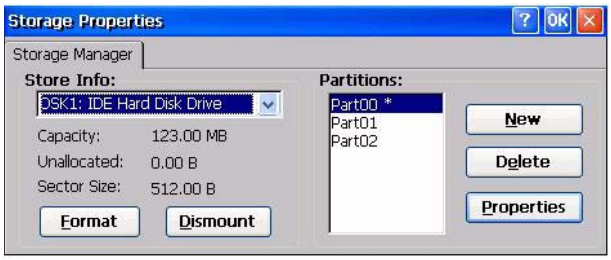
Remove Programs

Use the Remove Programs dialog to remove installed programs from your terminal. The dialog shows a list of programs that can be removed. Select a program from the list, click Remove, and then OK.



Storage Manager

Use the Storage Properties dialog to display information about the internal CompactFlash card and other storage devices such as the external CompactFlash card and USB Mass Storage Devices. From this dialog, you can also configure partitions and reformat the device.



WARNING

Do not try to alter the internal CompactFlash storage device that is displayed under Storage Info as DSK1: IDE Hard Disk Drive. You may not be able to reboot the terminal if modifying the internal CompactFlash partitions.

Install and Replace Components

Chapter Objectives

This chapter shows how to install, replace, or upgrade various components of the PanelView Plus terminals.

- Logic module
- RAM and internal CompactFlash
- Communication module
- Display module
- Battery
- Display module bezel
- Backlight
- Product ID label
- Keypad legend inserts
- External CompactFlash card

Required Tools

These tools are required to install and replace components:

- #00, #1, and #2 Phillips screwdriver
- Electrostatic Discharge (ESD) wristband

Precautions

Before installing or replacing any components, disconnect power from the terminal. During installation, take care not to touch any of the exposed electronic components.

WARNING

Disconnect all power from the terminal before installing or replacing any components. Failure to disconnect power may result in electrical shock or damage to the terminal.

ATTENTION

Be careful when touching any of the exposed electronic components to prevent damage from electrostatic discharge (ESD).

Work in a static free environment and wear a properly grounded ESD wristband.

Component Compatibility for PanelView Plus CE Terminals

It is important to match the series of the internal CompactFlash card with the correct series of the logic module and software version. The series of the CompactFlash determines the version of FactoryTalk View ME software and version of the operating system. The logic module is available with or without memory installed.

Logic Module 6189-RP*x*, 6189-RPRHx, 6189-RPEH*x*, 2711P-RP*x*, 2711P-RP*x*, 2711P-RP6*x*, 2711P-RP7x	**Internal CompactFlash 6189-RW2, -RW3, -RW4 2711P-RW6, -RW7, -RW8**	**FactoryTalk View ME & OS Software Version**
Series A: 6189-RP*x*H/A[1]	**Series B**: 6189-RW*x*/B	FactoryTalk View ME 3.0 Windows CE 3.0
Series B: 6189-RP*x*H/B	**Series C**: 6189-RW*x*/C	FactoryTalk View ME 3.10 Windows CE 4.1
Series B: 6189-RP*x*H/B **Series C**: 6189-RP*x*H/C **Series D**: 6189-RP*x*H/D **Series E**: 6189-RP*x*H*x*/E **Series F**: 2711P-RP*xx*/F[2] **Series G**: 2711P-RP*xxx*/G[2] **Series H**: 2711P-RP*xxx*/H[2]	**Series D**: 6189-RW*x*/D **Series E**: 6189-RW*x*/E	FactoryTalk View ME 3.20 Windows CE 4.1
	Series F: 6189-RW*x*/F **Series G**: 6189-RW*x*/G **Series H:** 2711P-RW*x*/H	FactoryTalk View ME 4.0 Windows CE 4.1
	Series J: 2711P-RW*x*/J	FactoryTalk View ME 5.0 or 5.1 Windows CE 4.1

(1) When upgrading from FactoryTalk View ME software, version 3.0 to 3.10 or later, the Firmware Upgrade Kit is recommended.

(2) Series F and later logic modules work with PanelView Plus and PanelView Plus CE CompactFlash cards.

Component Compatibility for PanelView Plus Terminals

It is important that you match the series of the internal CompactFlash card with the correct series of the logic module and software revision. The series of the CompactFlash determines the version of FactoryTalk View ME software. The logic module is available with or without memory installed.

Logic Module 2711P-RP*x*, 2711P-RP1*x*, 2711P-RP2*x*, 2711P-RP3*x*	**Internal CompactFlash 2711P-RW1, -RW2, -RW3**	**FactoryTalk View ME Software Version**
Series A: 2711P-RP*x*/A[1]	**Series B**: 2711P-RW*x*/B	FactoryTalk View ME 3.0
Series B: 2711P-RP*x*/B	**Series C**: 2711P-RW*x*/C	FactoryTalk View ME 3.10
Series B: 2711P-RP*x*/B **Series C**: 2711P-RP*x*/C **Series D**: 2711P-RP*x*/D **Series E**: 2711P-RP*xx*/E **Series F**: 2711P-RP*xx*/F[2] **Series G**: 2711P-RP*xxx*/G[2] **Series H**: 2711P-RP*xxx*/H[2]	**Series D**: 2711P-RW*x*/D **Series E**: 2711P-RW*x*/E	FactoryTalk View ME 3.20
	Series F: 2711P-RW*x*/F **Series G**: 2711P-RW*x*/G **Series H**: 2711P-RW*x*/H	FactoryTalk View ME 4.0
	Series J: 2711P-RW*x*/J	FactoryTalk View ME 5.0 or 5.1

(1) Series A logic modules are compatible with series B Compact Flash cards. When upgrading from FactoryTalk View ME software, version 3.0 to 3.10 or later, the Firmware Upgrade Kit is required.

(2) Series F and later logic modules work with PanelView Plus and PanelView Plus CE CompactFlash cards.

Compatibility After Upgrade

FactoryTalk View ME terminals are compatible with .MER applications that are the same or a previous version. For example, FactoryTalk View ME 3.20 terminals can run .MER applications for FactoryTalk View ME software, versions 3.0, 3.10, and 3.20.

For PanelView Plus CE devices, the appropriate changes are made to the OS, from Windows CE software, version 3.0 to 4.1, when upgrading from FactoryTalk View ME software, version 3.0 to 3.10 or later.

Install RAM or Internal CompactFlash

The logic module of the 700 to 1500 terminals is available with or without RAM and internal CompactFlash installed. If ordered as separate components, you must install the memory before attaching the logic module to the display module. The internal CompactFlash contains flash memory, FactoryTalk View ME software, and the operating system for CE devices.

Follow these steps to install or replace RAM or internal CompactFlash.

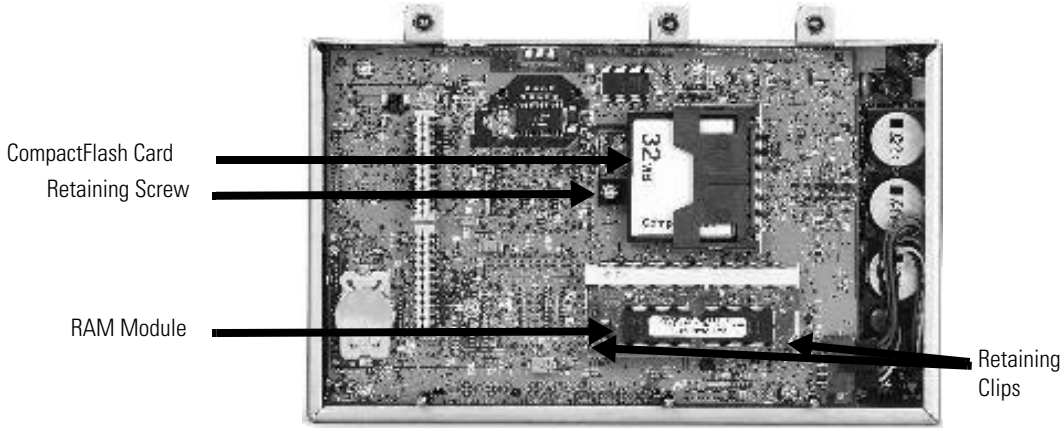
1. Remove power from the terminal.
2. Place the terminal, display side down, on a flat stable surface.
3. Loosen the six captive screws that secure the logic module.
4. Carefully lift the logic module away from the terminal and turn over to expose the circuit board.

ATTENTION

Wear a properly grounded ESD wristband before touching any of the electronic components in the logic module.

Skip steps 5 and 6 if not replacing RAM.

5. Locate the RAM module on the circuit board, pull the metal retaining clips away from the module, and slide out the module.



6. Insert the new RAM module at a 45° angle and snap down.

   Skip steps 7…11 if not replacing the internal CompactFlash.

7. Unscrew and remove the retaining clip that secures the internal CompactFlash card.
8. Pull out the internal CompactFlash card.
9. Insert the new internal CompactFlash card.
10. Reattach the retaining clip.
11. Attach the logic module by aligning the two connectors on the bottom of module with the connectors on the display module.
12. Push down on the logic module until firmly seated.
13. Tighten the six captive screws that secure the logic module to a torque of 0.58 Nm (5…7 lb•in).

Install or Replace the Logic Module

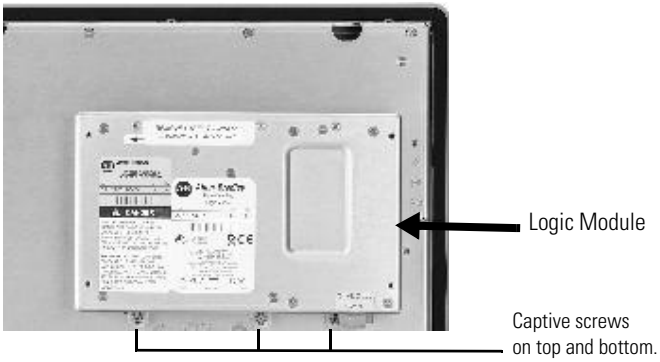
This section shows how to install and replace the logic module for 700 to 1500 terminals. If the display module and logic module are ordered as separate components, attach the logic module to the display module before panel installation.

The logic module is available with or without RAM and internal CompactFlash installed. If ordered as separate components, you must install the memory before attaching the logic module to the display module.

Follow these steps to install a logic module.

1. Disconnect power from the terminal.
2. Set the terminal, display side down, on a clean, flat, stable surface to prevent scratches, if the terminal is removed from panel.
3. Position the logic module over the back of the display module until the two connectors on the bottom of the logic module align with the connectors on the display module.

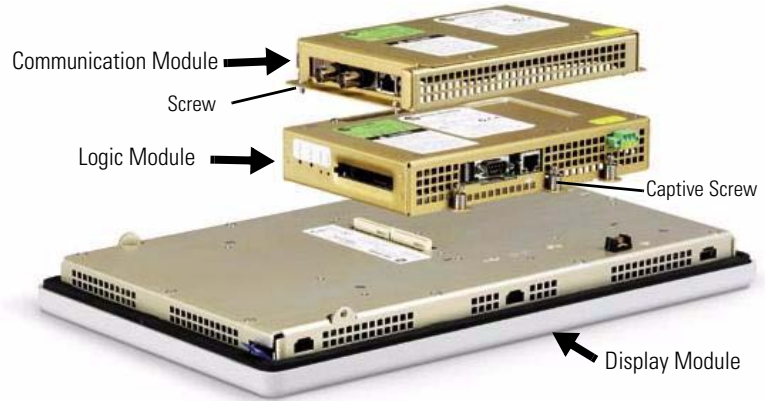
4. Push down on the logic module until firmly seated.
5. Tighten the six captive screws that secure the logic module to the display module to a torque of 0.58 Nm (5…7 lb•in).



Before replacing the logic module, you must remove the communication module, if attached. You will also need to remove the Internal RAM and CompactFlash from the logic module to reuse in the new logic module.

Follow these steps to replace a logic module.

1. Disconnect power from the terminal.
2. Disconnect all power and communication cables.
3. Set the terminal, display side down, on a clean, flat, stable surface to prevent scratches, if the terminal is removed from panel.
4. Remove the four screws that attach the communication module, if attached, to the logic module and carefully lift the communication module away from the logic module.



5. Loosen the six captive screws that secure the logic module to the display module.
6. Carefully lift the logic module away from the back of the display module.

ATTENTION

Wear a properly grounded ESD wristband before touching any of the electronic components in the logic module.

7. If reusing the memory in the new logic module:
   - remove the RAM and internal CompactFlash from the logic module.
   - insert the RAM and internal CompactFlash in the new logic module.
8. Install the new logic module.
9. Attach the communication module, if necessary.

Install or Replace a Communication Module

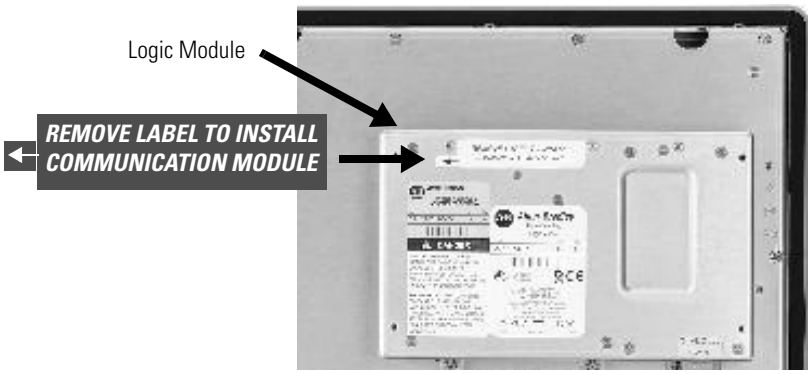
This section shows how to install and replace a communication module. The communication module installs over the logic module. The communication modules are available as separate catalog numbers for specific communication protocols.

PanelView Plus 700 to 1500 Terminals

TIP The logic module must be attached to the display module before you attach the communication module.

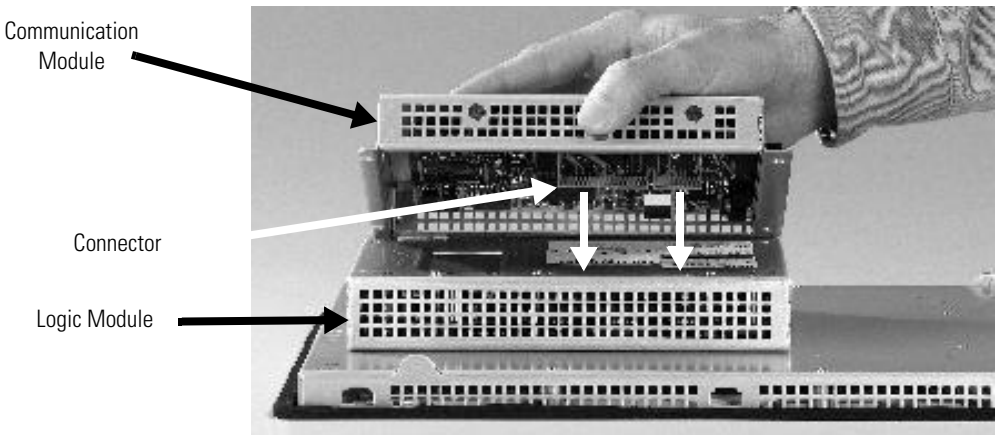
Follow these steps to install a communication module.

1. Disconnect power from the terminal.
2. Set the terminal, display side down, on a clean, flat, stable surface to prevent scratches if the terminal is removed from panel.
3. Remove the label covering the communication module connector on the logic module.



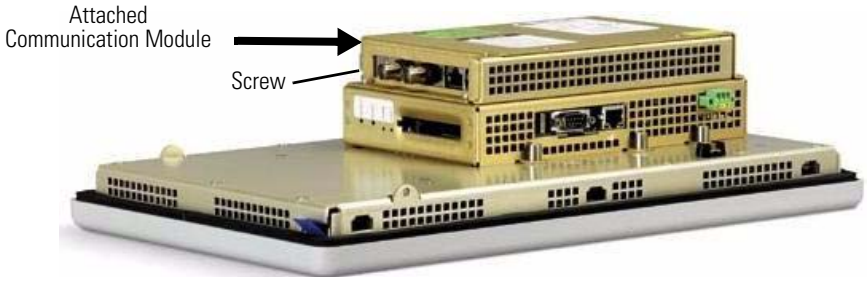
4. Position the communication module over the logic module so that the connectors on bottom of module align with connectors on the logic module.

To prevent ESD between the modules, allow the communication module to touch the logic module before making connection.



5. Push down on the communication module until the connectors are firmly seated.

6. Tighten the four screws that secure the communication module to the logic module to a torque of 0.58 Nm (5…7 lb•in).



Follow these steps to replace a communication module:

1. Disconnect power from the terminal.
2. Disconnect the communication cables from the module.

WARNING

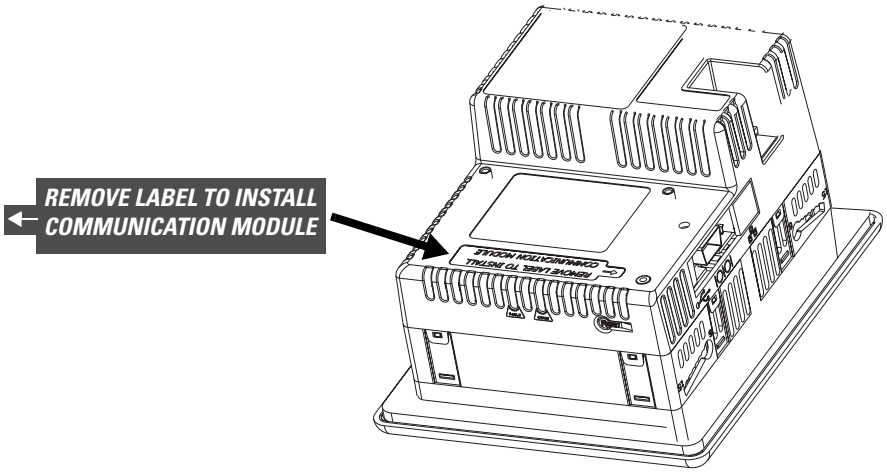
Do not connect or disconnect any communication cable with power applied to this device or any device on the network. An electrical arc could cause an explosion in hazardous location installations. Be sure that power is removed or the area is nonhazardous before proceeding.

3. Remove the four screws that secure the communication module to the logic module.
4. Carefully lift the communication module away from the logic module and set aside.
5. Install the new communication module.

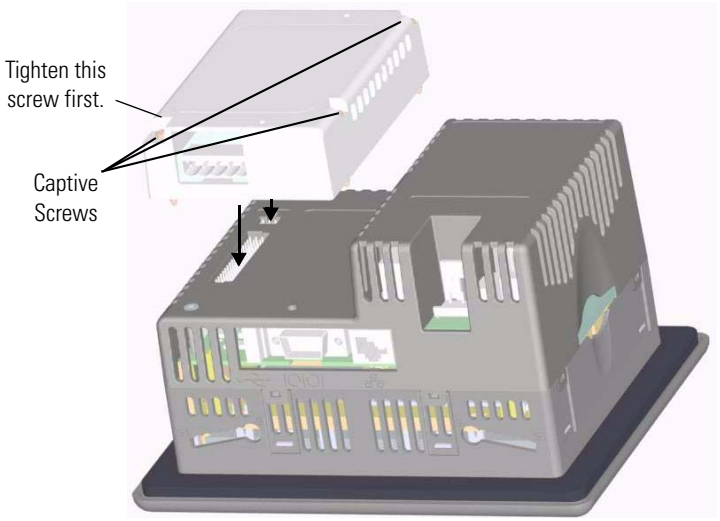
PanelView Plus 400 and 600 Terminals

Follow these steps to install a communication module.

1. Disconnect power from the terminal.
2. Set the terminal, display side down, on a clean, flat, stable surface.
3. Remove the label covering the connectors on the base unit of the terminal.



4. Position the communication module over back of the terminal so that the connector on bottom of communication module align with the connector on the base unit.



5. Push down on the communication module until the connector is firmly seated.

6. Tighten the three captive screws that secure the module to the terminal, starting with the bottom, left screw on the module. Tighten screws to a torque of 0.34…0.45 Nm (3…4 lb•in).

Follow these steps to replace a communication module.

1. Disconnect power from the terminal.

2. Disconnect the communication cables from the module.

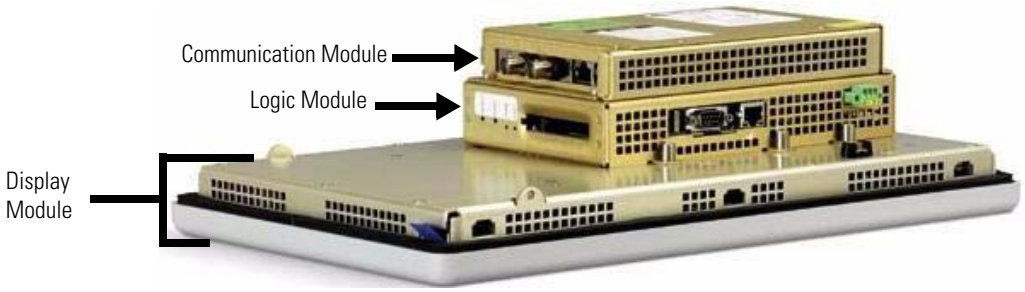
3. Loosen the three screws that secure the communication module to the terminal.

4. Carefully lift the communication module away from the terminal and set aside.

5. Install the new communication module.

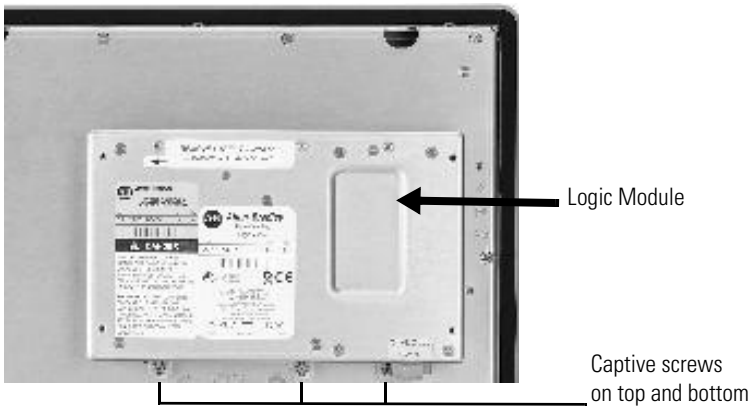
Replace the Display Module

This section shows how to replace the display module on 700 to 1500 terminals. It is necessary to remove the communication module from the logic module to perform this operation.



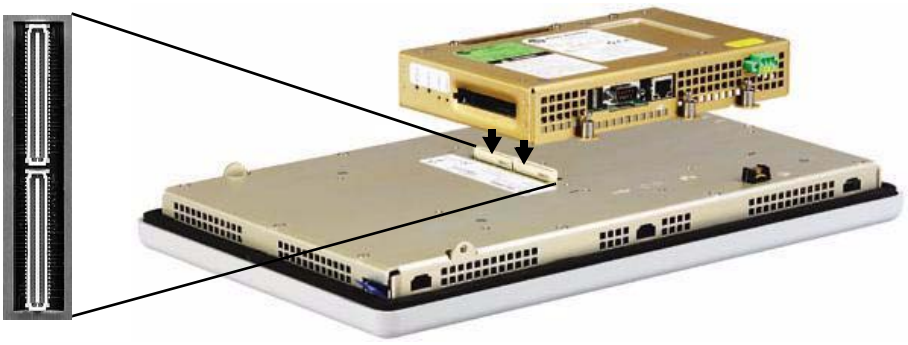
Follow these steps to replace the display module.

1. Disconnect power from the terminal.
2. Remove the terminal from the panel.
3. Detach the communication module, if attached, from the logic module by removing the four screws.
4. Loosen the six captive screws that attach the logic module to the display module.



5. Carefully lift the logic module from the terminal.
6. Set the display module aside.

7. Position the new logic module over the new display module so that the connectors align.



8. Push down on the logic module until firmly seated.

9. Tighten the six captive screws that secure the logic module to the display module to a torque of 0.58 Nm (5…7 lb•in).

10. Attach the communication module (if necessary) and tighten the four screws to a torque of 0.58 Nm (5…7 lb•in).

Replace the Battery

The terminals have a lithium battery that is used by the real-time clock and static RAM. It is not used for application backup or retention.

- For the 700 to 1500 terminals, the lithium battery is intended to be replaced during the life of the product.
- For the 400 and 600 terminals, the lithium battery is permanently connected and should be removed only by trained professionals at the end of product life.

  For information on battery removal for 400 and 600 terminals, see Disposal Information on page 223.

The 700 to 1500 terminals contain a hermetically sealed lithium battery which may need to be replaced during the life of the product.

At the end of its life, the battery contained in this product should be collected separately from any unsorted municipal waste.

The collection and recycling of batteries helps protect the environment and contributes to the conservation of natural resources as valuable materials are recovered.

ATTENTION

To avoid voiding your product warranty, use only the Rockwell Automation Allen-Bradley approved battery. Use of another battery may present a risk of fire or explosion.

SHOCK HAZARD

Failure to follow proper safety precautions could result in severe electrical shock or damage to the computer.

WARNING

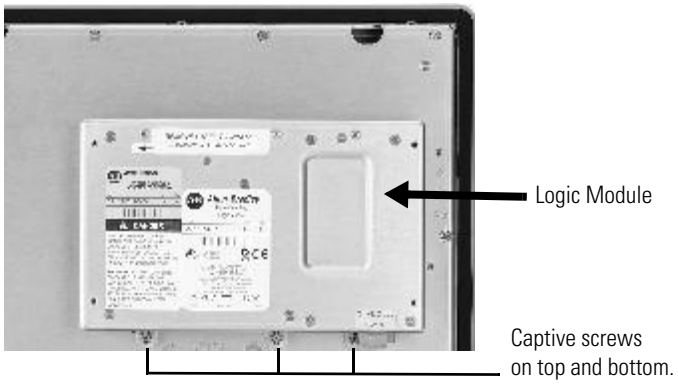
There is a danger of explosion if the lithium battery is incorrectly replaced. Replace the battery only with the indicated type. Do not replace the battery unless the area is known to be nonhazardous.

For Safety information on the handling of lithium batteries, including handling and disposal of leaking batteries, see Guidelines for Handling Lithium Batteries, publication AG-5.4. Replace the battery only with the indicated catalog number.

Do not dispose of battery in a fire or incinerator. Dispose of used batteries in accordance with local regulations.

Follow these steps to replace the battery.

1. Disconnect power from the terminal.
2. Place the terminal, display side down, on a flat stable surface.
3. Detach the communication module, if attached, from the logic module by removing the four screws.
4. Loosen the six captive screws that attach the logic module to the display module.

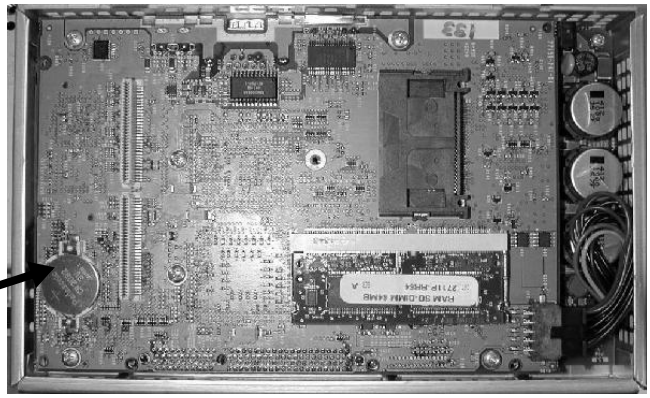


5. Carefully lift the logic module away from the terminal and flip over to expose the circuit board.

ATTENTION

Wear a properly grounded ESD wristband before touching any of the electronic components in the logic module.

6. Locate the battery on the circuit board.



7. Remove the battery by lifting up the side of the battery.

8. Insert the new battery.

IMPORTANT Use only replacement battery 2711P-RY2032.

9. Attach the logic module by aligning the two connectors on the bottom of the module with the connectors on the terminal.

10. Push down on the logic module until firmly seated.

11. Tighten the six captive screws that secure the logic module to a torque of 0.58 Nm (5…7 lb•in).

12. Attach the communication module (if necessary) and tighten the four screws to a torque of 0.58 Nm (5…7 lb•in).

Replace the Bezel

It is not necessary to remove the logic module or communication module before removing the bezel, except on the PanelView Plus 700 terminal.

Remove the Display Module Bezel

Follow these steps to remove the display module bezel on a 700 to 1500 terminal.

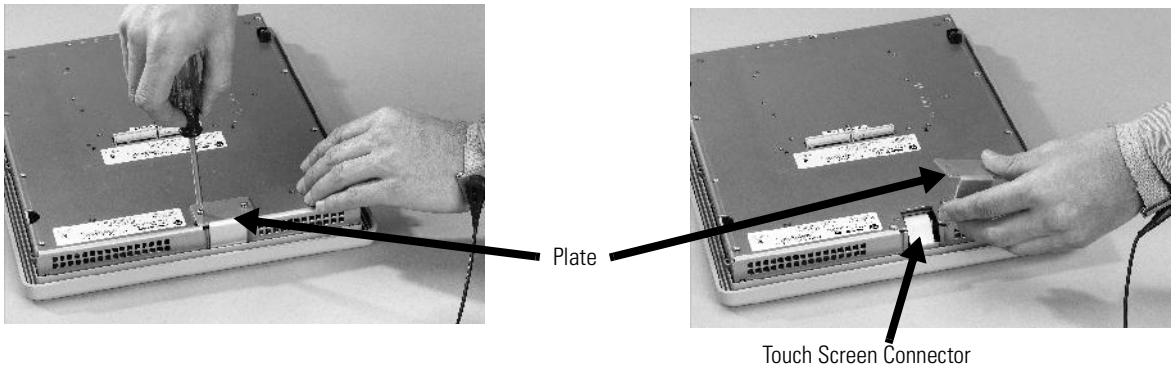
1. Disconnect power from the terminal.

2. Set the terminal, display side down, on a flat stable surface.

ATTENTION Wear a properly grounded ESD wristband before touching any of the electronic components in the logic module.

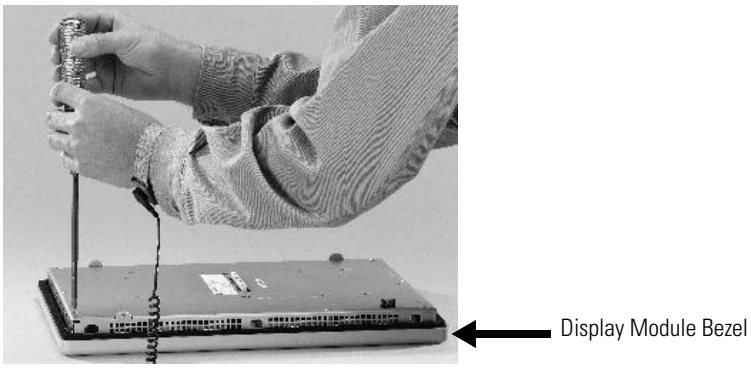
3. On touch-screen only terminals, remove the two screws that secure the small metal plate to the back of the display module.

4. Disconnect the touch screen connector.

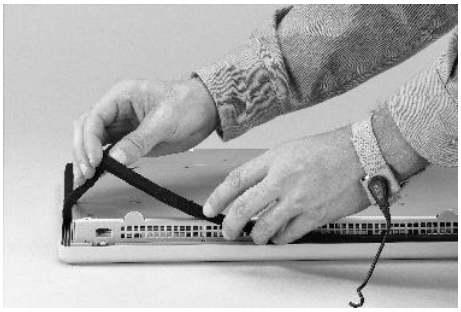


5. Remove the screws from the back of the display module.

   The number of screws varies for each terminal type.

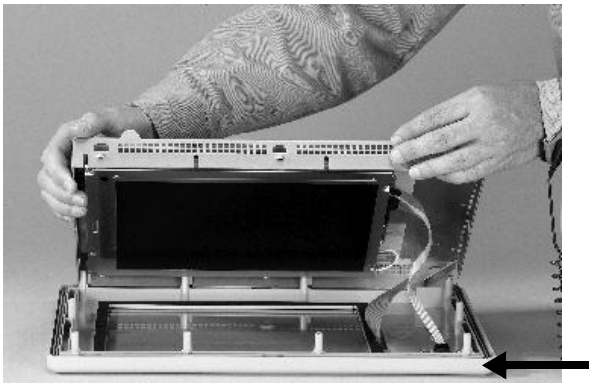


6. Remove the sealing gasket.



7. Lift the back of the display module away from the bezel.

   Work on a clean, flat, stable surface to protect the display from debris, scratches and damage.



8. Detach all connectors, maximum of three.

   The number of connectors varies by model.
   - IrDa connector, if present
   - Function key connector
   - Touch screen connector

9. Set the bezel aside.

Replace the Display Module Bezel

Follow these steps to replace the display module bezel.

1. Make sure the bezel is free of lint and marks before attaching.

2. Attach the connectors.

   The number of connectors varies by model.
   - IrDa connector, if present
   - Function key connector
   - Touch screen connector

3. Place the back of the display module over the bezel.

   Be careful not to pinch any of the cables. Allow the touch screen connector to extend out of the access opening.

4. Attach the touch screen connector.

5. Replace the sealing gasket.

6. Attach the screws that secure the display module to the bezel and tighten to a torque of 1.35…1.58 Nm (12…14 lb•in).

7. On touch screen terminals, reattach the small metal plate to the back of the display module using two screws and torque to 0.58 Nm (5…7 lb•in).

Replace the Backlight

This section shows how to replace the backlight for the 700, 1000, 1250, and 1500 terminals. The 1250 high-bright terminals do not have a replaceable backlight.

Backlights for PanelView Plus 700 to 1500 Displays

Use Cat. No.	For Display	Series	# of Backlights
2711P-RL7C	700	A and B	1
2711P-RL7C2		C	1
2711P-RL10C	1000	A	1
2711P-RL10C2		B and C	1
2711P-RL12C	1250	A and B	2
2711P-RL12C2		C	1
2711P-RL15C	1500	B	2

IMPORTANT Disposal: The backlights for these products contain mercury. Dispose of per applicable laws.

Follow these steps to replace the backlight.

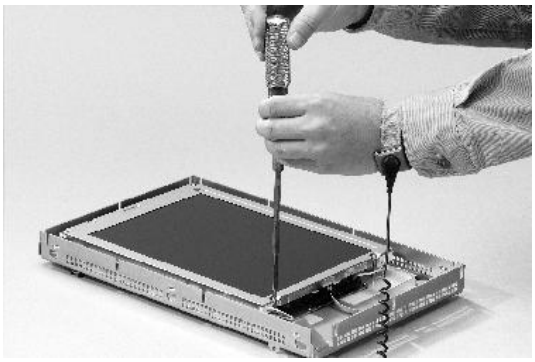
1. Disconnect power from the terminal.

2. Remove the display module bezel.

IMPORTANT The 700 series C display is not secured by screws and is only retained by a bracket. Use care not to drop the display once the bezel is removed.

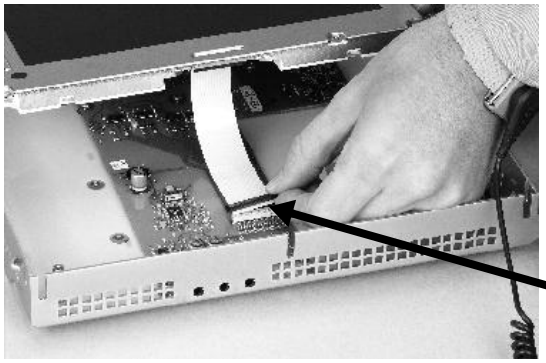
3. Remove the four screws that secure the display bracket for the 700 series C display.

4. Remove the four screws that secure the LCD display for all other displays.



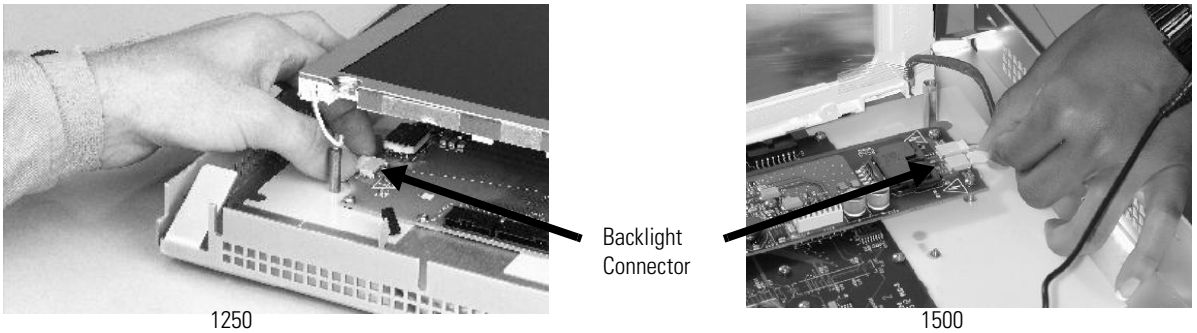
5. Lift the LCD display and detach the display connector from the circuit board.

   The circuit board layout may vary for each terminal model. The location of the connector varies by model.



6. Detach the backlight connectors from the circuit board.

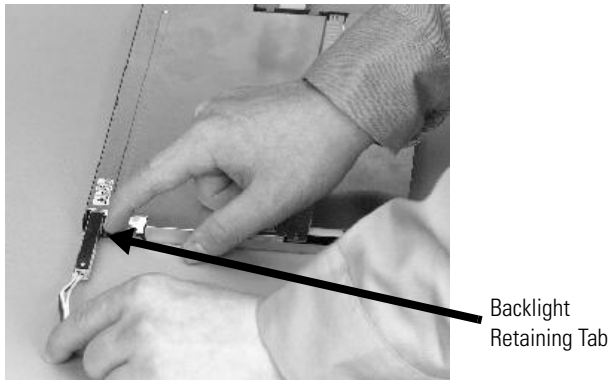
   The 1250 has one or two backlight connectors depending on the series of the display. The 1500 has four backlight connectors.



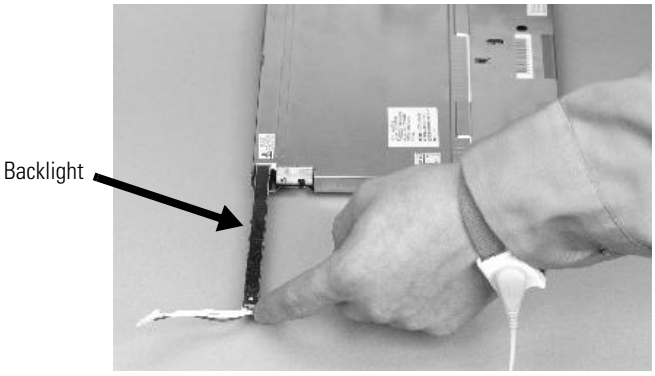
1250 1500

7. Follow these steps for the PanelView Plus 700 and 1000 displays.

a. Press the retaining tab that secures the backlight and then pull out the backlight.



b. Insert the new backlight.

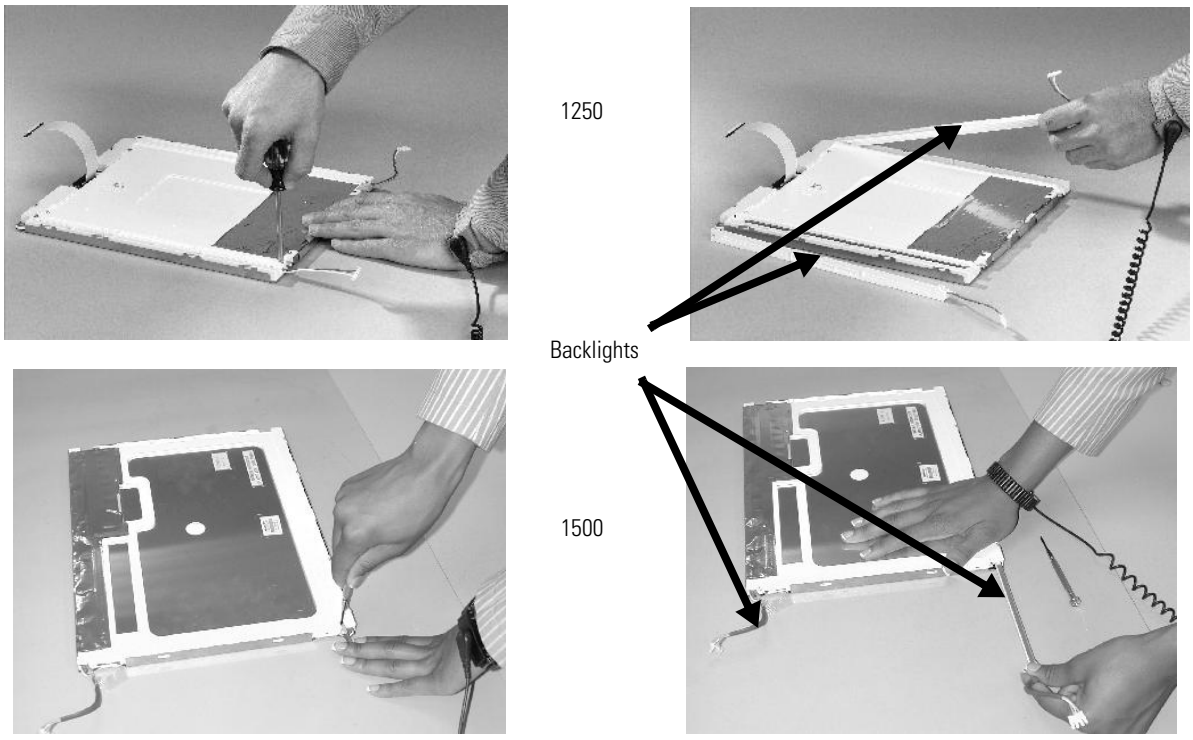


8. Follow these steps for the PanelView Plus 1250 and 1500 displays.

a. Remove the screws that secure the backlights and remove the backlights.

– The two backlights for the 1250 series A and B displays are each secured with two screws. The single backlight for the 1250 series C displays is secured with one screw.

– For the 1500 series B displays, remove the tape and then remove the backlights.



b. Insert the new backlights and then secure each with the same screws from the previous step and torque to 0.117 Nm (1.04 lb•in).

9. Attach the LCD display connector to the circuit board.

Refer to step 5.

10. Attach the backlight connector to the circuit board.

Refer to step 6.

11. Secure the LCD display.

a. Attach the display bracket then secure the display in the bracket for the 700 series C display.

b. Attach the four screws for all othe displays.

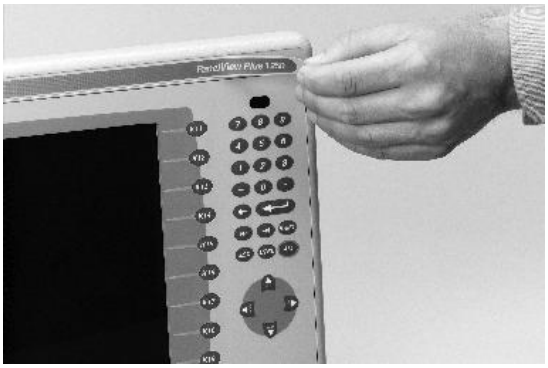
Tighten the screws and torque to 0.58 Nm (5…7 lb•in).

12. Replace the display module bezel.

Remove the Product ID Label

You can remove the label on your terminal and attach your own label.

1. Remove the Allen-Bradley label using your fingers or a tweezers.



2. Clean area with damp cloth and isopropyl alcohol.

3. Remove adhesive backing of OEM label and affix over area where label was located.

Replace the Keypad Legend Inserts

This section shows how to replace the legend inserts in the keypad terminals. The legend strips are available as separate catalog numbers for each keypad terminal, except for the PanelView Plus 400 terminal, which does not support replaceable legend strips. One side of the legend strips have the default key legends and the other side is blank for creating custom legends.

PanelView Plus 600 Terminal

The legend inserts for function keys F1 through F10 are accessible from the back on the unit and can be replaced with the terminal mounted in the enclosure.

Follow these steps to replace the F1 through F10 function key legends.

1. From the rear of the unit, pull the legend strips out from the slots on the lower side of the terminal.

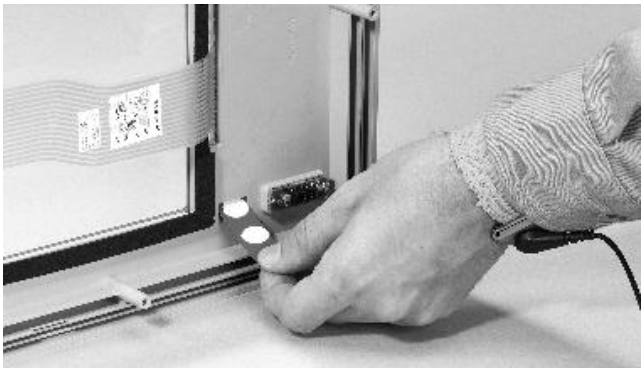
2. Slide the new insert into the same slot until only the end tab is visible.

600 Terminal

PanelView Plus 700 to 1500 Terminals

The F1-F*xx* and K1-K*xx* legend inserts on the PanelView Plus 700 to 1500 terminals are accessible when the display module bezel is removed.

1. Remove power from the terminal.
2. Remove the display module bezel.
3. Pull the legend inserts out from the slots on the bezel.

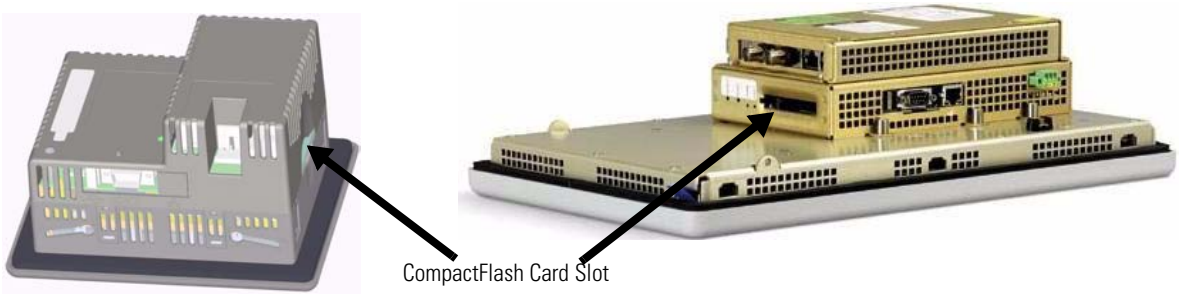


4. Slide the new legend strips into the same slots until only the end tab is visible.
5. Replace the display module bezel.

Use an External CompactFlash Card

All of the terminals have a CompactFlash card slot that supports Type 1 CompactFlash cards that come in different memory sizes.

The orientation of the card slot on the 700 to 1500 terminals varies depending on the series of the logic module.

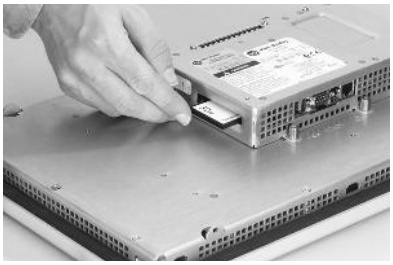


Insert a CompactFlash Card

Insert the card in the CompactFlash card slot until firmly seated.

400 and 600 Terminals

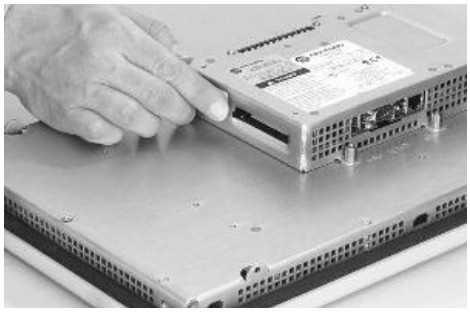
700 to 1500 Terminals



Remove a CompactFlash Card

Press the Eject button on the logic module. When the button pops out, press it again to release the card. The location of the button varies depending on the series of the logic module.

The PanelView Plus 400 and 600 terminals do not have an eject button. Secure edge of card with fingers and pull card away from slot.



Terminal Connections

Chapter Objectives

This chapter provides network and device connections for the terminals.

- Wiring and safety guidelines
- Logic controller cable charts
- Communication port isolation
- USB ports
- Serial connections on base unit
- Ethernet (onboard communication)
- DH-485/DH+/RIO communication module
- ControlNet communication module
- DeviceNet communication module

Wiring and Safety Guidelines

Use publication NFPA 70E, Electrical Safety Requirements for Employee Workplaces, IEC 60364 Electrical Installations in Buildings or other applicable wiring safety requirements for the country of installation when wiring the devices. In addition to the NFPA guidelines.

- Route communication cables to terminal by a separate path from incoming power.

IMPORTANT Do not run signal wiring and power wiring in the same conduit.

- Cross power and communication lines at right angles if they must cross.

  Communication lines can be installed in the same conduit as low-level DC I/O lines (less than 10V).

- Shield and ground cables appropriately to avoid electromagnetic interference (EMI).

  Grounding minimizes noise from EMI and is a safety measure in electrical installations.

For more information on grounding recommendations, refer to the National Electrical Code published by the National Fire Protection.

Logic Controller Cable Charts

The charts provide a summary of terminal connections to controllers and network interface modules.

Runtime Communication Cables - To Controller

PanelView Plus and PanelView Plus CE Terminals to SLC Controllers

		Cables: PanelView Plus and PanelView Plus CE to SLC Controllers				
Protocol	**PanelView Plus Comm Port**	**SLC-500, 5/01, 5/02 CH1 RJ45 (DH-485)**	**SLC-5/03, 5/04, 5/05 CH0 (9-pin RS-232) (DF1 or DH-485)**	**SLC 5/03 CH1 (RJ45) (DH-485)**	**SLC 5/04 CH1 (DH+)**	**SLC 5/05 CH1 (ENET)**
DF1 (any)	RS-232 (DF1) Port (9-pin) PanelView Plus 400 to 1500 2711P-RN22C	N/A	2711-NC13 (5 m/16 ft) 2711-NC14 (10 m/32 ft) 2706-NC13 (3 m/10 ft)	N/A	N/A	N/A
DH-485 (any)	RS-232 (DH-485) Port (9-pin) PanelView Plus 400 to 1500 2711P-RN22C	Use AIC+ Module (1761-NET-AIC) Connect to Port 1 or 2	2711-NC13 (5 m/16 ft) 2711-NC14 (10 m/32 ft) 2706-NC13 (3 m/10 ft)	Use AIC+ Module (1761-NET-AIC) Connect to Port 1 or 2	N/A	N/A
	DH-485 Port PanelView Plus 400 and 600 2711P-RN3[2]	1747-C10 (2 m/6 ft) 1747-C11 (0.3 m/1 ft) 1747-C20 (6 m/20 ft)	Use AIC+ Module (1761-NET-AIC) Connect to Port 3	1747-C10 (2 m/6 ft) 1747-C11 (0.3 m/1 ft) 1747-C20 (6 m/20 ft)	N/A	N/A
	DH-485 Port PanelView Plus 700 to 1500 2711P-RN6, -RN6K	1761-CBL-AS03 (3 m/10 ft) 1761-CBL-AS09 (9 m/30 ft)	Use AIC+ Module (1761-NET-AIC) Connect to Port 3	1761-CBL-AS03 (3 m/10 ft) 1761-CBL-AS09 (9 m/30 ft)	N/A	N/A
ControlNet	ControlNet Port PanelView Plus 400 and 600 2711P-RN15C PanelView Plus 700 to 1500 2711P-RN15S, -RN15SK	N/A	1747-KFC15A or 1747-SCRNR/A Module with ControlNet Cable			
DeviceNet[1]	DeviceNet Port PanelView Plus 400 and 600 2711P-RN10C PanelView Plus 700 to 1500 2711P-RN10H	N/A	Use 1747-SDN Module with DeviceNet Cable			
EtherNet/IP	EtherNet/IP Port PanelView Plus 400 to 1500 All except 2711P-xxx5xx	N/A	Use 1761-NET-ENI Module with Ethernet Cable	N/A	N/A	1585J-M Type Cable or 2711P-CBL-EX04 (4 m/14 ft) [3]
Remote I/O[1]	Remote I/O Port PanelView Plus 400 to 1500 2711P-RN1, 2711P-RN6	SLC 5/02 only Use 1747-SN with Shielded Twinaxial Cable (1770-CD)	Use 1747-SN Module with Shielded Twinaxial Cable (1770-CD)			
DH+	DH+ Port PanelView Plus 400 and 600 2711P-RN8 PanelView Plus 700 to 1500 2711P-RN6, -RN6K	N/A	N/A	N/A	Shielded Twinaxial Cable (1770-CD)	N/A

(1) DeviceNet and Remote I/O communication modules are no longer available. Cable information is provided for reference only.

(2) For CE compliance, use the 1761-NET-AIC or 1747-AIC module for cable lengths longer than 30 m (98 ft).

(3) EtherNet/IP direct connection from the terminal to an SLC 5/05 controller requires an Ethernet switch or the 2711P-CBL-EX04 crossover cable.

PanelView Plus and PanelView Plus CE Terminals to PLC-5 and MicroLogix Controllers

		Cables: PanelView Plus and PanelView Plus CE to PLC-5 and MicroLogix Controllers			
Protocol	**PanelView Plus Comm Port**	**PLC-5, PLC-5C, PLC-5E CH0 (25-pin RS-232) (DF1)**	**MicroLogix 1400, 1500LRP CH1/CH2 (9-pin RS-232) (DF1 or DH-485)**	**MicroLogix 1000, 1100, 1200, 1400, 1500LSP CH0 (8-pin Mini DIN) (DF1 or DH-485)**	**MicroLogix 1100, 1400 Ethernet**
DF1 (any)	RS-232 (DF1) Port (9-pin) PanelView Plus 400 to 1500 2711P-RN22C	2711-NC13 (5 m/16 ft) 2711-NC14 (10 m/32 ft) 2706-NC13 (3 m/10 ft) (9-to-25 pin adapter required)	2711-NC13 (5 m/16 ft) 2711-NC14 (10 m/32 ft) 2706-NC13 (3 m/10 ft)	2711-NC21 (5 m/16 ft) 2711-NC22 (15 m/49 ft) (null modem not required) (4)	N/A
DH-485 (any)	RS-232 (DH-485) Port (9-pin) PanelView Plus 400 to 1500 2711P-RN22C	N/A	2711-NC13 (5 m/16 ft) 2711-NC14 (10 m/32 ft) 2706-NC13 (3 m/10 ft)	2711-NC21 (5 m/16 ft) 2711-NC22 (15 m/49 ft) (null modem not required) (4)	N/A
	DH-485 Port PanelView Plus 400 and 600 2711P-RN3(2) PanelView Plus 700 to 1500 2711P-RN6, -RN6K	N/A	N/A	Use AIC+ Module (1761-NET-AIC) Connect to Port 3	N/A
ControlNet	ControlNet Port PanelView Plus 400 and 600 2711P-RN15C PanelView Plus 400 to 1500 2711P-RN15S, -RN15SK	To PLC-5C with ControlNet Cable	N/A	N/A	N/A
DeviceNet(1)	DeviceNet Port PanelView Plus 400 and 600 2711P-RN10C PanelView Plus 700 to 1500 2711P-RN10H	Use 1771-SDN Module with DeviceNet Cable	N/A	N/A	N/A
EtherNet/IP	EtherNet/IP Port PanelView Plus 400 to 1500 All except 2711P-xxx5xx	To PLC-5E with 1585J-M Type Cable or 2711P- CBL-EX04 (4 m/14 ft) (3)	Use 1761-NET-ENI Module with Ethernet Cable		1585J-M Type Cable or 2711P- CBL-EX04 (4 m/14 ft) (3)
Remote I/O(1)	Remote I/O Port PanelView Plus 400 to 1500 2711P-RN1, 2711P-RN6	Shielded Twinaxial Cable (1770-CD)	N/A	N/A	N/A
DH+	DH+ Port PanelView Plus 400 and 600 2711P-RN8 PanelView Plus 700 to 1500 2711P-RN6, -RN6K	Shielded Twinaxial Cable (1770-CD)	N/A	N/A	N/A

(1) DeviceNet and Remote I/O communication modules are no longer available. Cable information is provided for reference only.

(2) For CE compliance, use the 1761-NET-AIC or 1747-AIC module for cable lengths longer than 30 m (98 ft).

(3) For a direct connection between the terminal and the controller use the 2711P-CBL-EX04 crossover cable.

(4) The AIC+ module is recommended for isolation purposes when the terminal and controller are not on same power supply.

PanelView Plus and PanelView Plus CE Terminals to Logix Controllers

		Cables: PanelView Plus and PanelView Plus CE to Logix Controllers	
Protocol	**PanelView Plus Comm Port**	**ControlLogix CH0 (9-pin RS-232) (DF1)**	**CompactLogix CH0 (9-pin RS-232) (DF1 or DH-485)**
DF1 (any)	RS-232 (DF1) Port (9-pin) PanelView Plus 400 to 1500 2711P-RN22C	2711-NC13 (5 m/16 ft) 2711-NC14 (10 m/32 ft) 2706-NC13 (3 m/10 ft)	
DH-485 (any)	RS-232 (DH-485) Port (9-pin) PanelView Plus 400 to 1500 2711P-RN22C	N/A	2711-NC13 (5 m/16 ft) 2711-NC14 (10 m/32 ft) 2706-NC13 (3 m/10 ft)
	DH-485 Port PanelView Plus 400 and 600 2711P-RN3[2], PanelView Plus 700 to 1500 2711P-RN6, -RN6K	N/A	Use AIC+ Module (1761-NET-AIC) Connect to Port 3
ControlNet	ControlNet Port PanelView Plus 400 and 600 2711P-RN15C PanelView Plus 700 to 1500 2711P-RN15S, -RN15SK	Use 1756-CNB Module with ControlNet Cable	1769-L35CR, -L32C, -1768-CNB, or 1768-CNBR with ControlNet Cable
DeviceNet[1]	DeviceNet Port PanelView Plus 400 and 600 2711P-RN10C PanelView Plus 700 to 1500 2711P-RN10H	Use 1756-DNB Module with DeviceNet Cable	Use 1769-SDN Module with DeviceNet Cable
EtherNet/IP	EtherNet/IP Port PanelView Plus 400 to 1500 All except 2711P-xxx5xx	Use 1756-EN2T or 1756-ENBT Module with 1585J-M Type Cable or 2711P- CBL-EX04 (4 m/14 ft)[3]	To 1769-L35E, L23E, L32E, or 1768-ENBT Module with 1585J-M Type Cable or 2711P- CBL-EX04 (4 m/14 ft)[3]
Remote I/O[1]	Remote I/O Port PanelView Plus 400 to 1500 2711P-RN1, 2711P-RN6	Use 1756-DHRIO Module with Shielded Twinaxial Cable (1770-CD)	N/A
DH+	DH+ Port PanelView Plus 400 and 600 2711P-RN8 PanelView Plus 700 to 1500 2711P-RN6, -RN6K	Use 1756-DHRIO Module with Shielded Twinaxial Cable (1770-CD)	N/A

(1) DeviceNet and Remote I/O communication modules are no longer available. Cable information is provided for reference only.

(2) For CE compliance, use the 1761-NET-AIC or 1747-AIC module for cable lengths longer than 30 m (98 ft).

(3) For a direct connection between the terminal and controller, use the 2711P-CBL-EX04 crossover cable.

PanelView Plus Terminals to Communication Adapters

		Cables: PanelView Plus to Communication Adapters				
			1761-NET-AIC			
Protocol	**PanelView Plus Comm Port**	**1747-AIC**	**Port 1 (9-pin)**	**Port 2 8-pin Mini DIN()**	**Port 3 (DH-485)**	**1761-NETDNI or 1771-NET-ENI**
DF1 (any)	RS-232 Port (9-pin) PanelView Plus 400 to 1500 2711P-RN22C (for 400 and 600)	N/A	2711-NC13 (5 m/16 ft) 2711-NC14 (10 m/32 ft) 2706-NC13 (3 m/10 ft)	2711-NC21 (5 m/16 ft) 2711-NC22 (15 m/49 ft)	N/A	1761-CBL-AP00 (5 m) 1761-CBL-PM02 (2 m) 2711-CBL-PM05 (5 m) 2711-CBL-PM10 (10 m)
DH-485 (any)	RS-232 Port (9-pin) PanelView Plus 400 to 1500 2711P-RN22C (for 400 and 600)	N/A	2711-NC13 (5 m/16 ft) 2711-NC14 (10 m/32 ft) 2706-NC13 (3 m/10 ft)	2711-NC21 (5 m/16 ft) 2711-NC22 (15 m/49 ft)	N/A	
	DH-485 Port PanelView Plus 400 and 600 2711P-RN3[1]	1747-C10 (2 m/6ft) 1747-C11 (0.3 m/1 ft) 1747-C20 (6 m/20 ft)	N/A		1761-CBL-AS03 (3 m/10 ft) 1761-CBL-AS09 (9 m/30 ft) to single AIC+	N/A
	DH-485 Port PanelView Plus 700 to 1500 2711P-RN6, -RN6K	Direct Connection to Single AIC with Belden 9842 Cable[2]	N/A		Direct Connection to Single AIC+ with Belden 9842 Cable[2]	N/A

(1) For CE compliance, use the 1761-NET-AIC or 1747-AIC module for cable lengths longer than 30 m (98 ft).

(2) Use serial port on the PanelView Plus terminal with an AIC+ module for a DH-485 network solution.

Communication Port Isolation

The PanelView Plus and PanelView Plus CE terminals contain integral and modular (externally attached) communication ports. Some of these ports contain electrical isolation depending on the catalog number of the terminal or communication module.

Integral Communication Port Isolation

Communication Port	400 and 600 Terminal	700 to 1500 Terminal
RS-232	Nonisolated	Isolated
USB	Nonisolated	Nonisolated
Ethernet	Isolated	Isolated

400 and 600 Modular Communication Port Isolation

Communication Port	Module	Isolation
RS-232	2711P-RN22C	Isolated
DH-485	2711P-RN3	Nonisolated
DH+	2711P-RN8	Isolated
Remote I/O	2711P-RN1	Isolated
DeviceNet	2711P-RN10C	Isolated
ControlNet	2711P-RN15C	Isolated (1)

(1) NAP port is nonisolated.

700 to 1500 Modular Communication Port Isolation

Communication Port	Module	Isolation
DH-485	2711P-RN6	Isolated
DH+	2711P-RN6	Isolated
Remote I/O	2711P-RN6	Isolated
DeviceNet	2711P-RN10H	Isolated
ControlNet	2711P-RN15S	Isolated

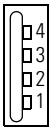
USB Ports

The 700 to 1500 terminals have two USB ports. The 400 and 600 terminals have one USB port. The terminals support standard USB keyboard and mouse devices (HID devices) with native device drivers. They also support some USB printers that have Printer Control Language (PCL) capabilities. A vendor specific Windows CE driver is required for all other USB devices.

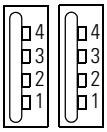
See Appendix B for a list of compatible USB devices.

Plug the USB device into either one of the two USB ports on the 700 to 1500 terminals.

400 and 600 USB Port



700 to 1500 USB Ports



USB Connector Pinout

Pin	Signal
1	USBVCC
2	USBD-
3	USBD+
4	USB-GND

WARNING

Do not connect or disconnect the communication cable with power applied to the terminal, or the serial device on the other end of the cable. An electrical arc could cause an explosion in hazardous location installations. Be sure that power is removed or the area is nonhazardous before proceeding.

WARNING

USB devices not powered by the USB port must be within the same enclosure and connected to a ground system common with the terminal, or the USB devices must be used with a USB hub that provides galvanic isolation.

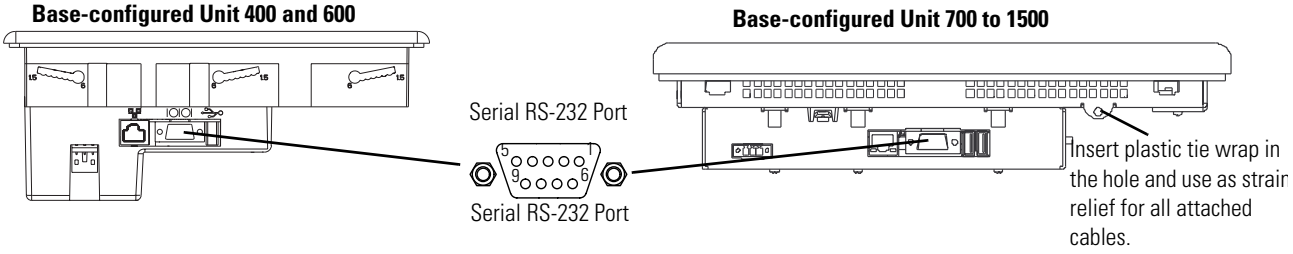
If a USB hub is connected to the terminal, an externally powered USB hub is recommended. Before attaching devices to a USB hub, check that the power adapter is connected and powered on.

Serial Connections

The base-configured unit of all terminals has a multi-purpose serial RS-232 port that supports:

- DH-485 communication through a serial connection.
- DF1 full duplex communication with controllers using direct connections or modem connections.
- third-party point-to-point communication.
- application uploads/downloads.
- printing.

The serial port on the base-configured unit of the terminal is a 9-pin, male, RS-232 connector. The table shows the pinout descriptions for this port and how these pins map to the serial ports on the controllers.



Serial Port Connector Pinout

PanelView Plus RS-232 Port 9-pin DCE		SLC 9-pin	PLC 25-pin	MicroLogix/ DNI 8-pin DIN
1				
2	RXD →	2	3	4
3	← TXD	3	2	7
4	← DTR	4	20	
5	↔ COM	5	7	2
6	DSR →	6	6	
7	← RTS	7	4	
8	CTS →	8	5	
9				
Connector Shell	Chassis Gnd			

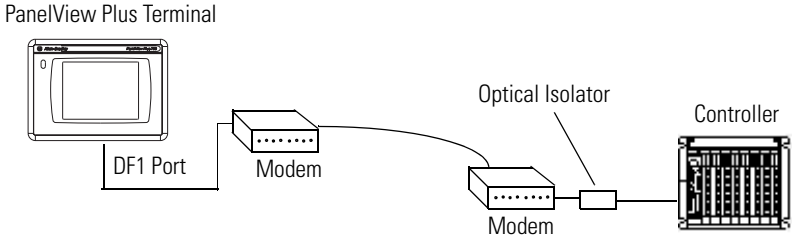
The maximum cable length for serial communication is 15.24 m (50 ft).

WARNING

Do not connect or disconnect the communication cable with power applied to the terminal, or the serial device on the other end of the cable. An electrical arc could cause an explosion in hazardous location installations. Be sure that power is removed or the area is nonhazardous before proceeding.

Modem Connection

Wire or radio modem communication is possible between the terminal and controller. Each modem must support full duplex communication. Refer to your modem user manual for details on settings and configuration.



Construct a Null Modem Cable

To construct a null modem cable, refer to this pinout.

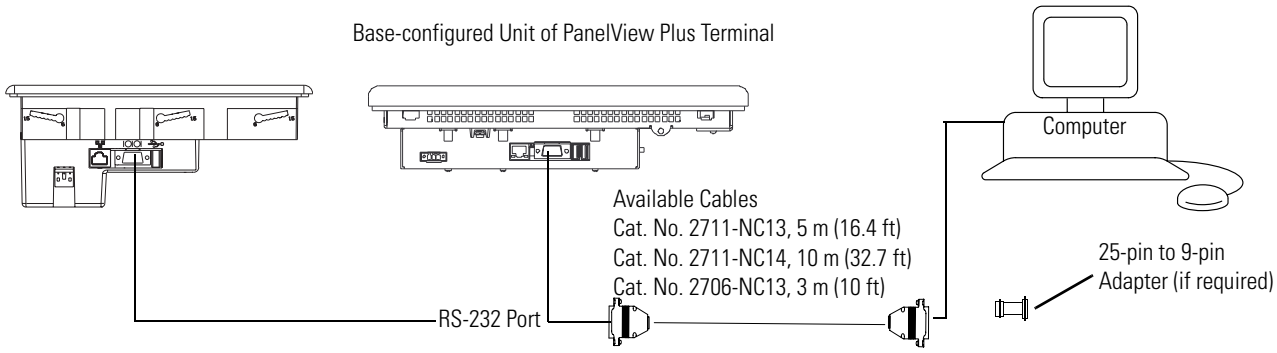
Null Modem Pinout

	PanelView Plus 9-pin	9-pin Modem	PanelView Plus 9-pin	25-pin Modem	
FG (Frame Ground)	-	-	-	1	FG
TD (Transmit Data)	3	2	3	3	RD
RD (Receive Data)	2	3	2	2	TD
RTS (Request to Send)	7	8	7	5	CTS
CTS (Clear to Send)	8	7	8	4	RTS
SG (Signal Ground)	5	5	5	7	SG
DSR (Data Set Ready)	6	4	6	20	DTR
DTR (Data Terminal Ready)	4	6	4	6	DSR

Computer Connections

The RS-232 serial port on the base-configured unit of the terminals supports:

- application uploads/downloads using a direct connection.
- printing.



PanelView Plus Port (DCE) 9-pin male		Computer Port (DTE) with Handshaking 9-pin male
1 NC		1 DCD
2	RXD →	2 RXD (Data Receive)
3	← TXD	3 TXD (Data Transmit)
4 NC		4
5	↔ COM	5 COM
6 (pulled high to +12V)	DSR →	6 DSR
7	← RTS	7 RTS
8	CTS →	8 CTS
9 NC		9 NC

Upload/Download Cable without Hardware Handshaking

PanelView Plus Printer Port (DCE) 9-pin male		Computer Port (DTE) 9-pin	25-pin
2	RXD →	2	3
3	← TXD	3	2
5	↔ COM	5	7

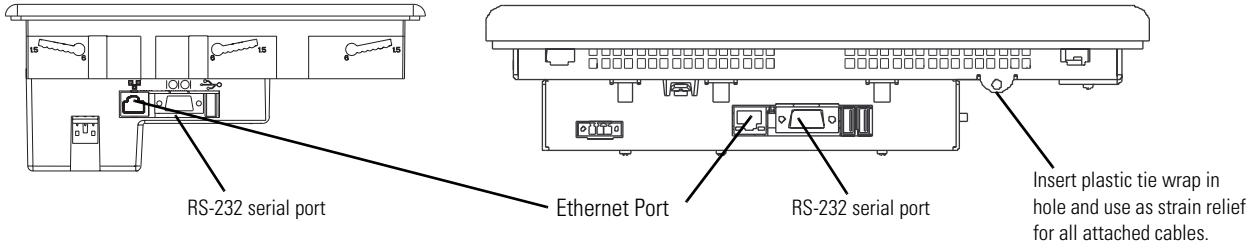
Ethernet Connections

The base-configured unit of the 700 to 1500 terminals and the network based unit of the 400 and 600 terminals have an Ethernet port that supports:

- EtherNet/IP communication.
- third-party Ethernet communication.
- network connections.
- application uploads/downloads.
- printing.

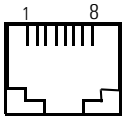
Ethernet Connector

The base-configured unit of the terminals has an RJ45, 10/100 Base-T connector for EtherNet/IP or Ethernet TCP/IP network communication.



The table shows the connector pinouts.

Ethernet Connector Pinout

Pin	Pin	Pin Name
Looking into RJ45 Connector 1 8 	1	TD+
	2	TD-
	3	RD+
	4	NC
	5	NC
	6	RD-
	7	NC
	8	NC
	Shield Connection	No direct connection (AC coupled to chassis GND)

Use point-to-point, 10/100 Base-T cables with cross over pin-outs, such as 2711P-CBL-EX04, when connecting the Ethernet port on the terminal directly to a logic controller's Ethernet port or a computer 10/100 Base-T port.

Ethernet Cable

For PanelView Plus 700 to 1500 terminals, use Belden 7921A shielded Ethernet Category 5e cable according to TIA 568-B.1 and RJ45 connector according to IEC 60603-7 for compliance with Marine emissions limits and the European Union 89/336/EEC EMC Directive.

The maximum cable length between the terminal's Ethernet port and a 10/100 Base-T port on an Ethernet hub (without repeaters or fiber) is 100 m (328 ft).

WARNING

Do not connect or disconnect any communication cable with power applied to this device or any device on the network. An electrical arc could cause an explosion in hazardous location installations. Be sure that power is removed or the area is nonhazardous before proceeding.

Security Considerations

IGMP (Internet Group Management Protocol) is used for IPv4 multicast. A multicast is communication between a single sender and multiple receivers on a network. IGMP is used to exchange membership status data between IPv4 routers that support multicasting and members of multicast groups. A router is an intermediary device on a communication network that expedites message delivery by finding the most efficient route for a message packet within a network, or by routing packets from one subnetwork to another. A sub-network is a separate part of an organization's network identified through IP addressing.

PanelView Plus terminals provide level 2 (full) support for IPv4 multicasting (IGMP version 2) as described in RFC 1112 and RFC 2236.

SNMP (Simple Network Management Protocol) is used for internal network management and is not supported.

Ports 137 and 138 are normally open to support the NetBIOS protocol used by Windows CE.NET similar to other Microsoft and IBM network operating systems.

DH-485/DH+/Remote I/O Module

Terminals with a DH-485/DH+/Remote I/O communication module support communication with these networks.

- DH+ networks
- DH-485 networks
- Remote I/O networks

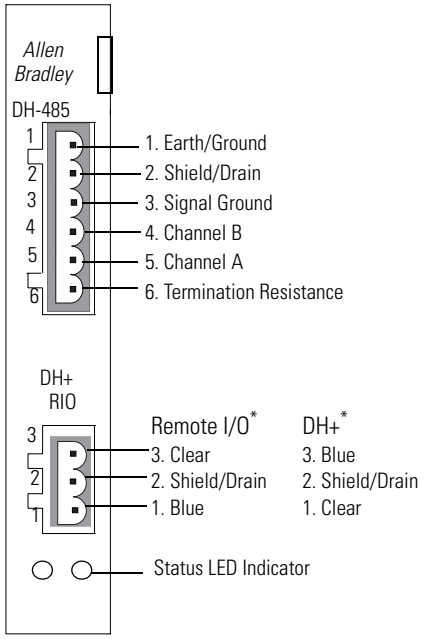
You can communicate with only one network at one time.

The 700 to 1500 terminals support all protocols on one module. The 400 and 600 terminals require a separate module for each protocol. The DH+, DH-485, and Remote I/O connections are different between the modules for the 400 and 600 and 700 to 1500 terminals.

Module Connections

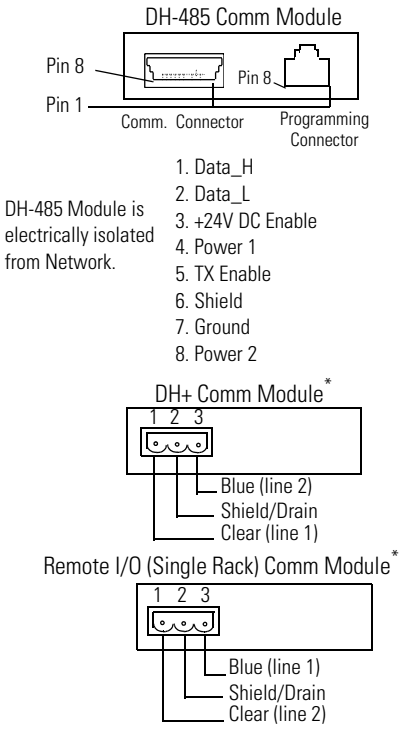
IMPORTANT See your controller documentation for appropriate controller connections.

700 to 1500 Terminals



***** Use a Belden 9463 twin axial or equivalent cable, cat. no. 1770-CD.

400 and 600 Terminals



IMPORTANT When using the DH-485 module, catalog number 2711P-RN3, with PanelView Plus 400 and 600 terminals, the cable length must not exceed 30 m (98 ft) to comply with CE requirements. For longer cable lengths, use the 1761-NET-AIC or 1747-AIC module.

DH+ Status Indicator

Condition	Indication
Off	Channel is not online.
Blinking green	Device is only node on the network.
Solid green	Device is online and receiving token.
Blinking red	Duplicate node.
Solid red	Failed selftest.

DH-485 Status Indicator

Condition	Indication
Off	Channel is not online.
Blinking green	Device is only node on the network.
Solid green	Device is online and receiving token.
Blinking red	Parity error.
Solid red	Failed selftest.

Remote I/O Scanner Mode Status Indicator

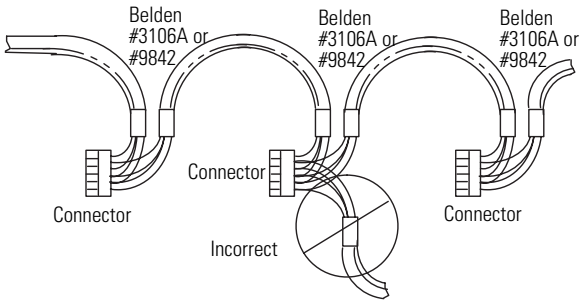
Condition	Indication
Off	Channel is not online.
Blinking green	At least one but not all adapters in the scanlist are not responding.
Solid green	All adapters in the scanlist are responding.
Blinking red	None of the adapters in the scanlist are responding.
Solid red	Failed selftest.

DH-485 Network Port Wiring for 700 to 1500 Terminals

Use these instructions for wiring Belden cable. If you are using standard Allen-Bradley cables, see the Logic Controller Cable Charts .

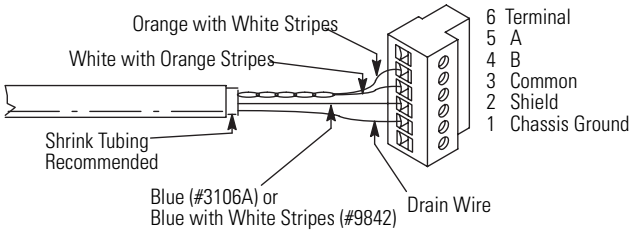
IMPORTANT A daisy-chained network is recommended. We do not recommend hybrid star/daisy chain networks as shown.

RS-485 Connector to the Communication Cable

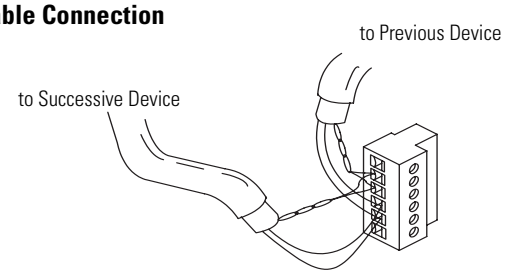


Attach the connector to the Belden #3106A or #9842 Cable as shown.

Single Cable Connection



Multiple Cable Connection



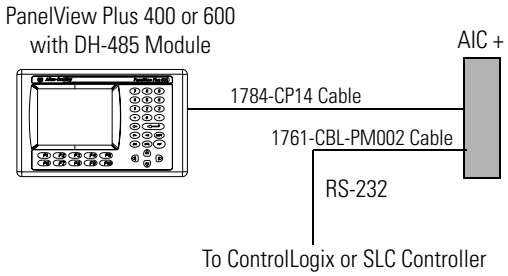
The table shows connections for Belden #3106A.

Belden 3106A Wire Connections

For this Wire/Pair	Connect this Wire	To this Terminal
Shield/Drain	Non-jacketed	Terminal 2 - Shield
Blue	Blue	Terminal 3 - (Common)
White/Orange	White with Orange Stripe	Terminal 4 - (Data B)
	Orange with White Stripe	Terminal 5 - (Data A)

DH-485 Connections for 400 and 600 Terminals

This section shows connections between a 400 and 600 terminal with a DH-485 communication module and an SLC or ControlLogix controller through the AIC+ module.



DH+ Network Connections

Use the Belden 9463 twin axial or equivalent cable (cat. no. 1770-CD), to connect a terminal to a DH+ link.

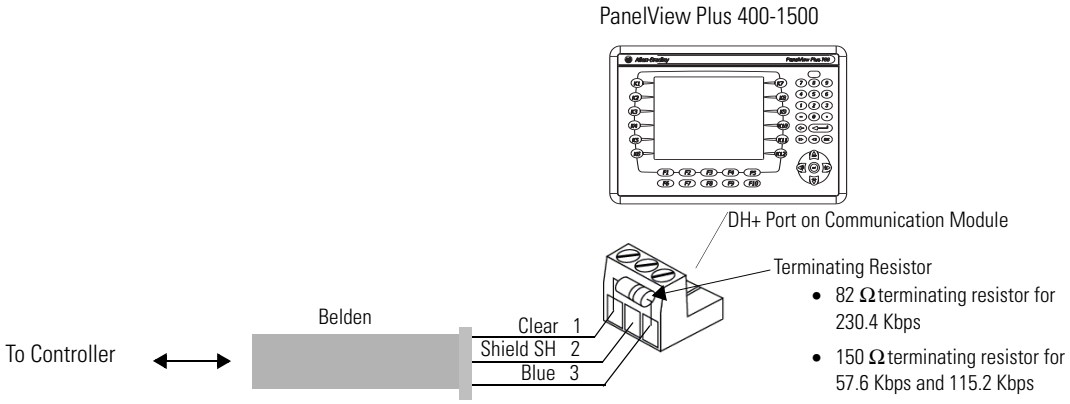
You can connect a DH+ link in two ways.

- Trunk line/drop line - from the drop line to the connector screw terminals on the DH+ connectors of the processor
- Daisy chain - to the connector screw terminals on the DH+ connectors on the processor

Follow these guidelines when installing DH+ communication links.

- do not exceed these cable lengths:
  - Trunk line-cable length: 3,048 m (10,000 ft).
  - Drop-cable length: 30.4 m (100 ft).

  The maximum cable length is determined by baud rate.
- Do not connect more than 64 stations on a single DH+ link.

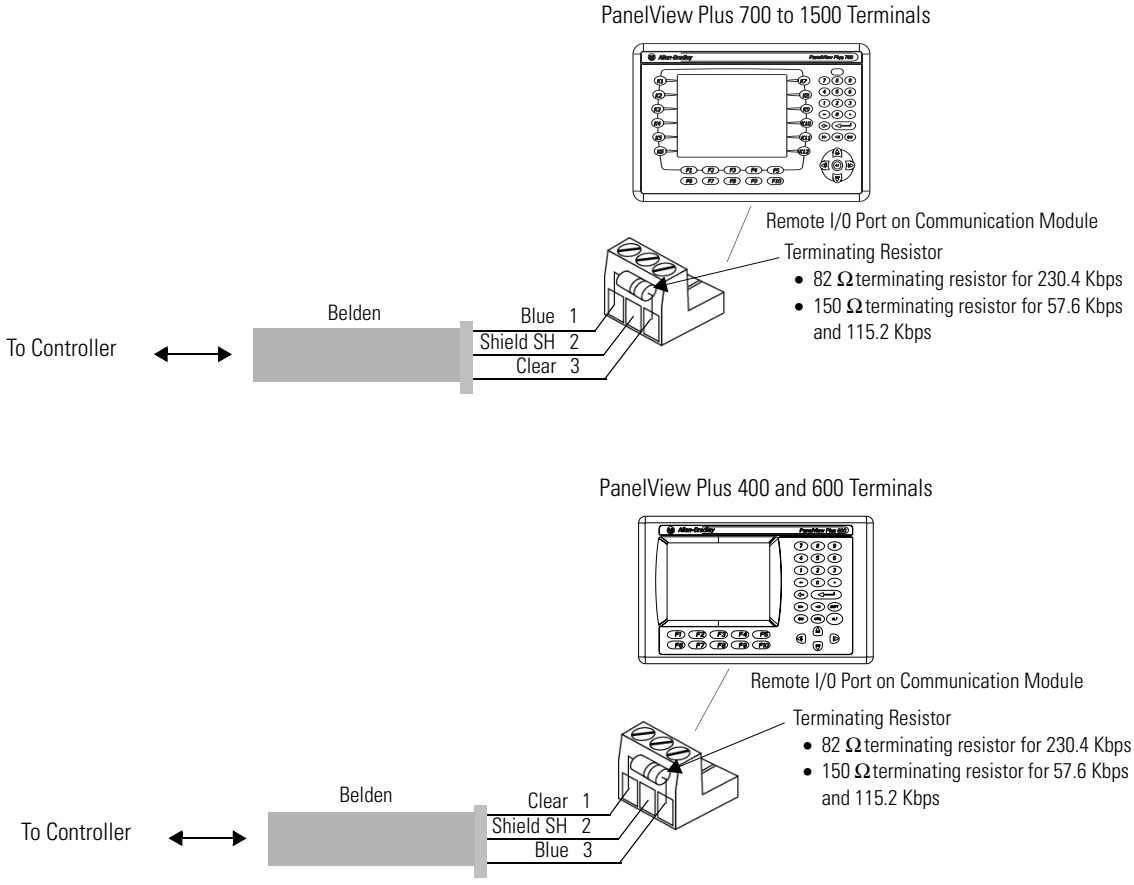


Remote I/O Connections

Use the Belden 9463 twin axial or equivalent cable (cat. no. 1770-CD), to connect a terminal to a Remote I/O scanner. The maximum cable length (link distance) is determined by the baud rate.

- 2800 m (10,000 ft) for 57.6 Kbps
- 1400 m (5,000 ft) for 115.2 Kbps
- 700 m (2,500 ft) for 230.4 Kbps

See Industrial Automation Wiring and Grounding Guidelines, publication 1770-4.1. The user manual for the I/O scanner module also provides cabling information.



ControlNet Module

Terminals with a ControlNet communication module support communication and the transfer of applications between devices on a ControlNet network.

Related Information

For more information on ControlNet products, refer to these publications:

- NetLinx Selection Guide, publication NETS-SG001
- ControlNet Coax Media Planning and Installation Guide, publication CNET-IN002
- ControlNet Communication for PanelView Plus and PanelView Plus CE Terminals User Manual, publication 2711P-UM003

The Rockwell Automation website http://rockwellautomation.com provides information and product descriptions of ControlNet products. Under the Products and Services heading, select Communication.

ControlNet Protocol

The terminals support Unscheduled and Scheduled messaging, Scheduled I/O, and redundant cabling with PLC-5C and ControlLogix controllers.

The ControlNet architecture supports multiple processors and up to 99 nodes (via taps) anywhere along the trunk cable of the network. There is no minimum tap separation and you can access the ControlNet network from every node (including adapters).

Compatible ControlNet Controllers

A terminal with a ControlNet Module communicates with a PLC-5C (PCCC commands) or a ControlLogix processor (CIP protocol) using Unscheduled messaging. The following controllers are supported:

- ControlLogix using 1756-CNB module
- PLC-5/20C, PLC-5/40C, PLC-5/60C, PLC-5/80C

Minimum Requirements

The software and firmware must be installed on the development computer and the PanelView Plus terminal to configure and communicate with an Allen-Bradley controller on a ControlNet network.

ControlNet Unscheduled Communication

Software/Firmware	PanelView Plus 700 to 1500	PanelView Plus 400 or 600
FactoryTalk View Studio	Version 3.10 or later	Version 4.0 or later
FactoryTalk View Machine Edition Runtime	Version 3.10 or later	Version 4.0 or later
ControlNet Module Firmware	2711P-RN15S, Series A, Rev A (firmware version 2.07 or later) (1)	2711P-RN15C, Series B, Rev A or later

(1) This applies to terminals that are ordered as pre-configured units with the ControlNet module.

ControlNet Scheduled Communications

Requirements	PanelView Plus 700 to 1500	PanelView Plus 400 or 600
FactoryTalk View Studio	Version 3.20 or later	Version 4.0 or later
FactoryTalk View Machine Edition Runtime	Version 3.20.04 or later	Version 4.0 or later
RSNetWorx for ControlNet	Version 5.11 or later	Version 6.0 or later
RSLogix 5000	Version 13.0 or later	Version 15.0 or later
ControlNet Module Firmware	2711P-RN15S, Series A, Rev C (firmware version 3.08 or later) (1)	2711P-RN15C, Series B, Rev A or later

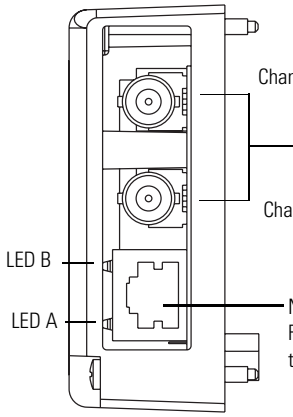
(1) This applies to terminals that are ordered as preconfigured units with the ControlNet module.

WARNING

The ControlNet Communications Module, cat. no. 2711P-RN15S, will not run with FactoryTalk View ME firmware version 3.20.04 or earlier. All ControlNet Modules with version 3.07 firmware must be upgraded to version 3.08 or later; otherwise, outputs may turn on an indeterminate state.

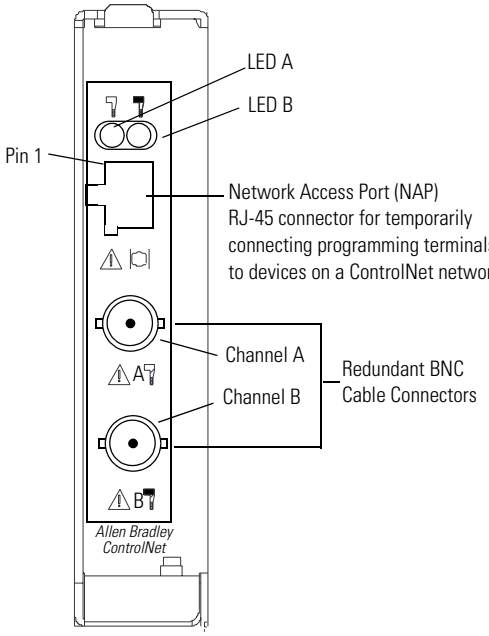
ControlNet Connections

2711P-RN15C ControlNet Module for 400 and 600 Terminals



Pin	NAP Signal
1	Signal Common
2	No Connection
3	TX_H
4	TX_L
5	RX_L
6	RX_H
7	No Connection
8	Signal Common
Shell	Earth/Ground

2711P-RN15S ControlNet Module for 700 to 1500 Terminals



Pin	NAP Signal
1	Signal Common
2	No Connection
3	TX_H
4	TX_L
5	RX_L
6	RX_H
7	No Connection
8	Signal Common
Shell	Earth/Ground

ATTENTION

Do not connect more than one ControlNet network to the Communications Module. If you attempt to connect a second network to the module, your communication system will operate erratically.

NAP and Redundant Cables

Refer to the ControlNet Coax Media Planning and Installation Guide, publication CNET-IN002, for descriptions of ControlNet components.

Item	Cat. No.
RG-6 quad-shield	1786-RG6
Coax repeater	1786-RPT, -RPTD
Coax taps	1786-TPR, -TPS, -TPYR, -TPYS
Network access cable	1786-CP
Coax tool kit	1786-CTK
Segment terminators	1786-XT
BNC connectors	1786-BNC, -BNCJ, -BNCP, -BNCJ1

IMPORTANT Do not connect to a network using both the redundant cable BNC connector and the Network Access Port (NAP).

Connect the Module to the Network

You can connect the ControlNet Module:

- directly to a ControlNet network, which requires a tap.
- to a device already connected to the ControlNet network.

WARNING

When used in a Class I, Division 2, hazardous location, this equipment must be mounted in a suitable enclosure with proper wiring that complies with the governing electrical codes.

Do not connect or disconnect any communication cable with power applied to this device or any device on the network. An electrical arc could cause an explosion in hazardous location installations. Be sure that power is removed or the area is nonhazardous before proceeding.

DeviceNet Module

Terminals with a DeviceNet communication module support communication and the transfer of applications between devices on a DeviceNet network.

Related Information

For more information on DeviceNet products, refer to these publications:

- NetLinx Selection Guide, publication NETS-SG001B
- DeviceNet Media Design Installation Guide, publication DNET-UM072

The Rockwell Automation website http://rockwellautomation.com provides information and product descriptions of DeviceNet products. Under the Products and Services heading, select Communications.

DeviceNet Protocol

The terminals support DeviceNet Scheduled I/O only. This protocol allows direct connection of field devices such as lights, drives, and valves. It also provides a control architecture that supports multiple processors. The DeviceNet network is a trunk/drop or bus-based network that supports up to 64 nodes and operates at 125, 250, or 500 Kbps.

Compatible DeviceNet Controllers

A terminal with a DeviceNet module communicates with an SLC-500 and PLC-5 (PCCC commands), or a ControlLogix processor (CIP protocol) using Unscheduled messaging. Supported controllers include:

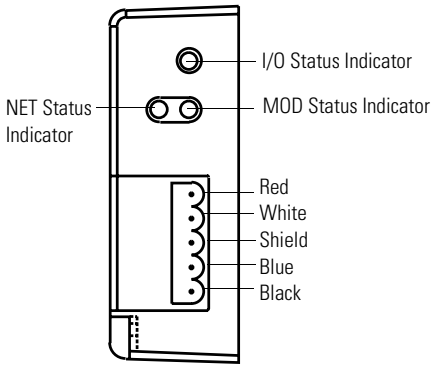
- ControlLogix using 1756-DNB module.
- PLC-5 with a 1771-SDN module.
- SLC 5/03 - SLC 5/05 with a 1747-SDN module.

Minimum Requirements

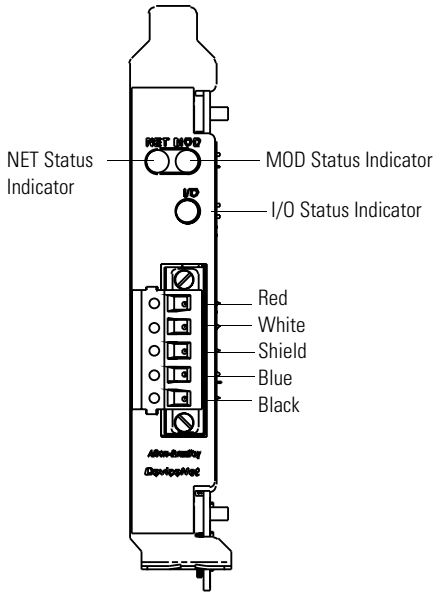
Software/Firmware	PanelView Plus 700 to 1500	PanelView Plus 400 and 600
FactoryTalk View Studio	Version 4.0 or later	Version 4.0 or later
FactoryTalk View Machine Edition Runtime	Version 4.0 or later	Version 4.0 or later
DeviceNet Module	2711P-RN10H	2711P-RN10C

DeviceNet Connections

2711P-RN10C DeviceNet Module for 400 and 600 Terminals



2711P-RN10H DeviceNet Module for 700 to 1500 Terminals



WARNING

Do not connect or disconnect any communication cable with power applied to this device or any device on the network. An electrical arc could cause an explosion in hazardous location installations. Be sure that power is removed or the area is nonhazardous before proceeding.

DeviceNet I/O Status Indicator

This bicolor (green/red) LED provides information on the states of inputs and/or outputs.

Condition	Status	Indication
Off	Outputs active	All outputs are active.
	Inputs active	All inputs are active.
Green	Outputs active	One or more outputs are active and under control, and no outputs are faulted.
	Inputs active	One or more inputs are active and producing data, and no inputs are faulted.
Flashing green(1)	Outputs idle	One or more outputs are idle, and no outputs are active or faulted.
Flashing red (1)	Outputs faulted	One or more outputs are faulted, and may be in the fault state.
	Inputs faulted	One or more inputs are faulted, and may be in the fault state.
Red	Outputs forced off	One or more outputs are forced off (may be an unrecoverable fault).
	Input unrecoverable fault	One or more inputs has an unrecoverable fault.

(1) The flash rate of the LED is approximately 1 flash per second. The LED should be on for approximately 0.5 seconds and off for approximately 0.5 seconds.

DeviceNet Module (MOD) Status Indicator

This bicolor (green/red) LED provides device status. It indicates whether or not the device has power and is operating properly.

Condition	Status	Indication
Off	No power	No power applied to device.
Green	Device operational	Device is operating in a normal condition.
Flashing green(1)	Device in standby (device needs commissioning)	Device needs commissioning due to configuration missing, incomplete, or incorrect.
Flashing red (1)	Recoverable fault	For example, the device's scan list configuration does match the actual network configuration.
Red	Unrecoverable fault	Device has an unrecoverable fault. Cycle power to your computer. If the problem persists, the device may need to be replaced.
	Device self testing	Device is in self test. Refer to the DeviceNet Specification, Volume II, Identity Object.

(1) The flash rate of the LED is approximately 1 flash per second. The LED should be on for approximately 0.5 seconds and off for approximately 0.5 seconds.

DeviceNet Network (NET) Status Indicator

This bicolor (green/red) LED indicates the status of the communication link.

Condition	Status	Indication
Off	Not powered	Device is not online.
	Not online	The device has not completed the Dup_MAC_ID test yet.
		The device may not be powered; look at the Module Status LED.
Flashing green[1]	Online	Device is online, but has no connections in the established state.
	Not connected	The device has passed the Dup_MAC_ID test, is online, but has no established connections to other nodes.
Green	Link okay, online, connected	The device is online and has connections in the established state.
Flashing red [1]	Connection timeout	One or more I/O connections are in the timed-out state.
Red	Critical link failure	Failed communication device. The device has detected an error that has rendered it incapable of communicating on the network (Duplicate MAC ID or Bus-off). Check network integrity and baud rate of all devices. Then cycle power to the card by shutting down and cycling power to your computer.

[1] The flash rate of the LED is approximately 1 flash per second. The LED should be on for approximately 0.5 seconds and off for approximately 0.5 seconds.

ATTENTION

Extensive use of Change-of-State connections, particularly with rapidly changing data, can adversely impact the available DeviceNet network bandwidth. If the network bandwith becomes consumed, some devices may only be able to communicate intermittently. This can result in timeout errors and possible loss of data. If timeouts occur, consider changing the connection type for some of the Change-of-State connections to Cyclic or Polled.

Upgrade Firmware

Chapter Objectives

This chapter covers these topics:

- Transfer applications
- Create an ActiveSync connection
- Upgrade terminal firmware
- Upgrade operating system for CE terminals

Transfer Applications

You can transfer applications using a CompactFlash card or a computer.

PanelView Plus terminals let you copy or load applications in configuration mode using a CompactFlash card, see page 79.

The PanelView Plus CE terminals let you copy or load applications using a CompactFlash card from Windows Explorer or FactoryTalk View ME configuration mode.

- To copy files in terminal configuration mode, see page 79.
- To copy files in Windows Explorer, see page 118.

For details on transferring .MER applications from a computer to the PanelView Plus or PanelView Plus CE terminals, refer to FactoryTalk View Studio help or documentation.

Create an ActiveSync Connection

This section shows how to create an ActiveSync connection between a computer and a PanelView Plus CE terminal.

Creating an ActiveSync connection is a two-step process.

1. Create a partnership between the devices using a Serial connection.
2. When the partnership is created, you can then connect the devices using an Ethernet network.

What You Need

- Computer and a PanelView Plus CE terminal that are connected to an Ethernet network supporting DHCP.
- ActiveSync software, version 3.7 or later, installed on computer. You can download ActiveSync from the http://www.microsoft.com web site.
- 2711-NC13 or 2706-NC13 serial cable for connecting the PanelView Plus CE terminal to the computer with ActiveSync installed.

Create a Partnership with a Serial Connection

IMPORTANT To complete the ActiveSync installation, you must select the Serial Connection initially. After that you can switch between serial and Ethernet connections.

You must also make a valid ActiveSync connection at least once with the computer.

Install ActiveSync on a Computer

1. Install ActiveSync, version 3.7 or later, on your computer.
2. Connect the PanelView Plus CE terminal to the computer with ActiveSync installed.
   Use a 9-pin straight through cable (2711-NC13 or 2706-NC13) for a serial connection or an Ethernet cable.
3. Start ActiveSync.
   You will see the Get Connected screen.

Initiate Serial Connection on PanelView Plus CE Terminals

Select Start>Menu>Programs>Microsoft ActiveSync>Serial.
The Connecting to Async Connection dialog box appears.

Find ActiveSync Connection and Create a Partnership on a Computer

1. When the Connecting to Async Connection dialog box appears on the PanelView Plus CE terminal, select the Next button on the Getting Connected screen of your computer.

   If the Connecting to Async Connection dialog box closes before a connection is established, return to Initiating Connection from the PanelView Plus CE terminal.
2. Select Yes to create the new partnership.
   When the ActiveSync connection is created, a window opens allowing you to create a new partnership.
3. Enter the name and press Next.
   ActiveSync will prompt you for a device name.
4. Press the Next button.
   Select any options you want to synchronize.
5. Press the Next button and then the Finish button.

Terminate Connection on PanelView Plus CE Terminals

1. Click the ActiveSync connection utility on the taskbar.

   The Connection Status dialog box should appear.

2. Press the Disconnect button to terminate the connection, may take 30 seconds.

Connect via an Ethernet Connection

Now that a partnership is created using a serial connection, you can connect to the PanelView Plus CE using an Ethernet connection.

ActiveSync Setup on a Computer

Verify that ActiveSync is configured to accept an Ethernet connection. By default, the Ethernet connection is enabled. (It is only necessary to enable the Ethernet connection if it is disabled).

Connect with the Partnership on PanelView Plus CE Terminals

1. Select Start>Programs>Microsoft Active Sync>Ethernet.

   The ActiveSync dialog box opens. The name of the computer you connected to via the serial connection will appear.

2. Select Connect.

   The Connection Status dialog box opens. It remains open as long as the ActiveSync connection is active.

   Closing the dialog box will terminate the connection.

Firmware Upgrade Wizard

The Firmware Upgrade Wizard (FUW) lets you upgrade firmware in a PanelView Plus terminal. Using the FUW, you can:

- create a firmware upgrade card (CompactFlash card) that you then load in the card slot of the terminal to upgrade firmware.
- upgrade firmware in a terminal that is connected to your desktop computer using a Serial, Ethernet, or Network connection via RSLinx Enterprise software (for supported protocols).

The FUW is available in FactoryTalk View Studio software or with the Firmware Upgrade Kit.

Before starting the Firmware Upgrade Wizard (FUW), follow these steps to prepare the terminal for a successful upgrade.

1. Backup all .MER files on the terminal to an external storage card or network.
2. Delete all applications on the terminal.
3. Record any Ethernet communication settings, such as IP address, subnet masks, and gateways by selecting Terminal Settings>Networks and Communications>Network Connections>Network Adapters>IP Address.
4. Disable the Auto-start feature on the terminal by selecting Startup Options>FactoryTalk View ME Station Startup and select Go to Configuration Mode.
5. Reset the terminal.

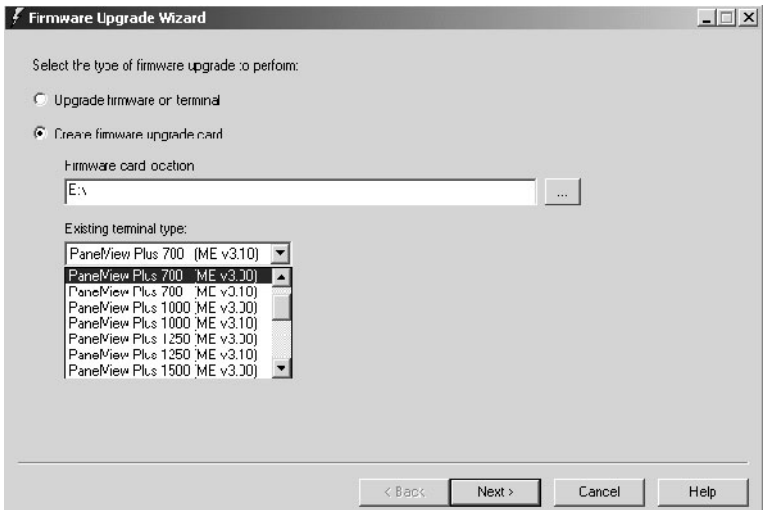
Upgrade Firmware with a CompactFlash Card

This section shows how to upgrade the firmware in the terminal using a CompactFlash card. This is a two step-process. First, you create a firmware upgrade card with the necessary firmware files. Second, you load this card in the target terminal to upgrade the firmware.

Create Firmware Upgrade Card

1. Start the Firmware Upgrade Wizard by selecting Start>Rockwell Software>RSView Enterprise>Firmware Upgrade Wizard.

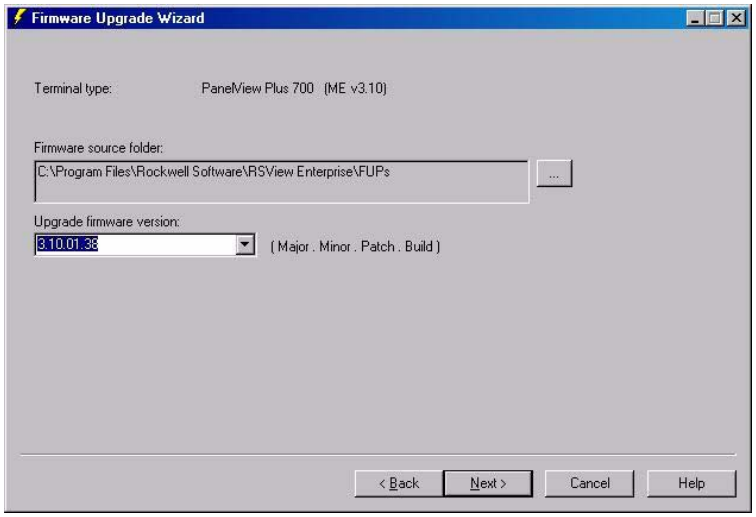
2. Select Create firmware upgrade card.
   - In the Firmware card location text box, select the destination for the CompactFlash files (folder on the hard drive or physical location of the CompactFlash card, for example, E:\).
   - From the Existing terminal list, select the type of terminal you are upgrading, then press Next.



3. From the Firmware source folder list, select the location of the firmware files.

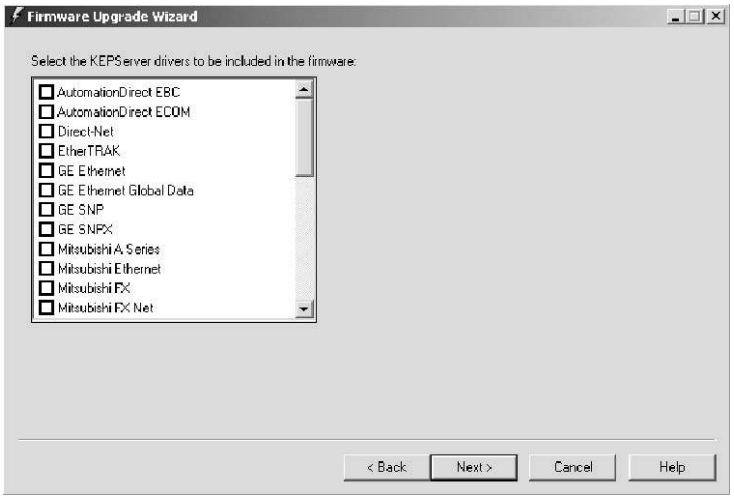
   The default location is C:\Program Files\Rockwell Software\RSView Enterprise\FUPs.

4. From the Upgrade firmware version list, select the version of the firmware you want to upgrade to, then press Next.



5. Select the appropriate KEPServer drivers and press Next.

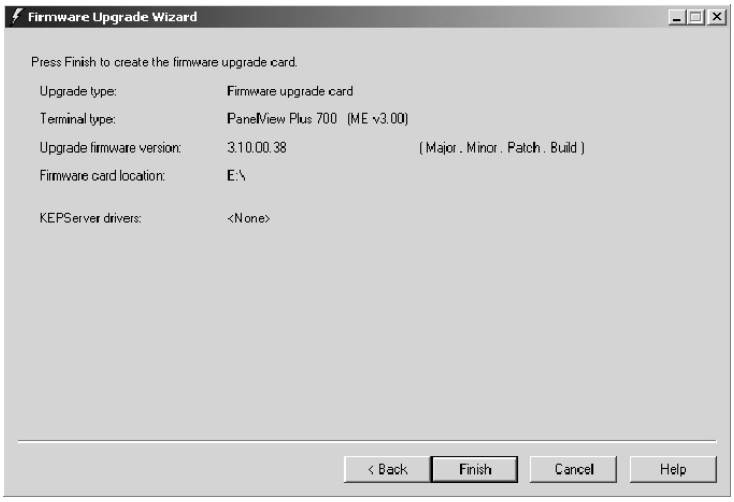
   If no KEPServer drivers are needed, just press Next.



TIP If the selected FUP file does not support the KEPServer drivers, this dialog box will not appear.

6. Select Finish to copy the firmware source files to the location specified in step 2.

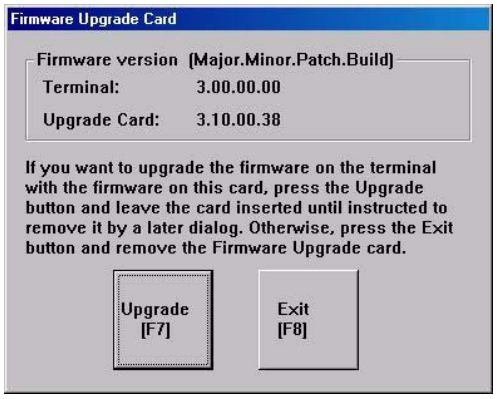
TIP If the files were created in a separate folder on a local hard drive, copy the files to the root directory of the CompactFlash card.



Upgrade Firmware in Terminal with Firmware Upgrade Card

1. Insert the CompactFlash card into the card slot of a powered terminal.

   A dialog box indicates the firmware upgrade is about to occur.



2. Press Upgrade to begin the firmware upgrade.

IMPORTANT Do not remove the CompactFlash card while the upgrade is in process.

If other terminals exist on the same Ethernet network, the following error may display:

Error registering name on network (may be duplicate). Change in system Control Panel and try again.

Ignore this error. It will be corrected during the upgrade. Press **OK** to acknowledge error and wait for terminal to reset.

TIP If a USB mouse is available, you can acknowledge this error by selecting OK.

3. On touch or touch-screen terminals, you must calibrate the touch screen by selecting pointers in all four corners of the screen and pressing the middle of the screen when prompted.

   Ignore the following message if it appears. It means FactoryTalk View ME is being installed. Do not touch the two buttons that appear with this message.
   Machine edition may be corrupted. Do you want to download firmware?

4. Remove the card and press F8 or Exit to reset the terminal.

   When the upgrade is complete, a dialog box appears requesting you to remove the CompactFlash card from the card slot.

   Communication settings are cleared when the terminal is upgraded. If Ethernet communications is used, reconfigure the Ethernet communication settings using the values recorded when preparing the terminal.

5. Replace the .MER files that you backed up before starting the upgrade or download a new .MER file to the terminal.

6. Load the .MER file and run the project.

TIP You can configure your application to start automatically on power cycle under Startup Options.

Upgrade Firmware with a Network (Ethernet) Connection

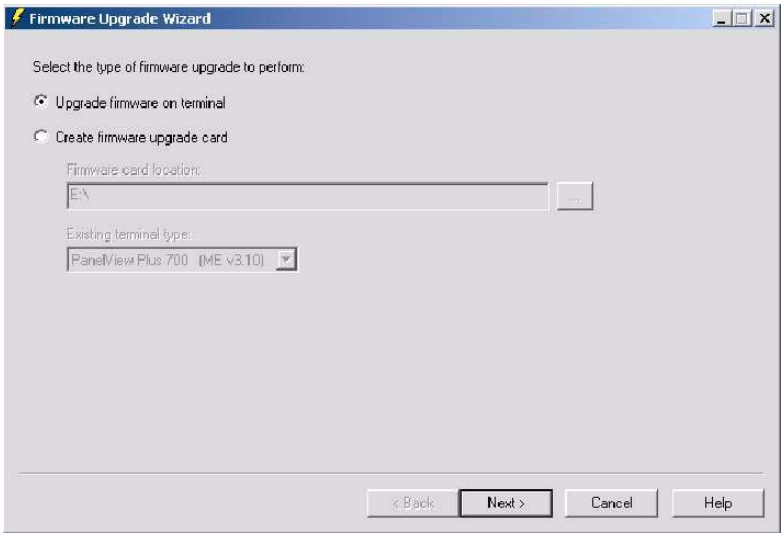
You can upgrade the firmware in a terminal that is connected to a desktop computer using a Serial, Ethernet, or Network with RSLinx Enterprise software connection.

- **Serial connection** requires a RAS connection to be set up on computer. During the RAS setup, you select the COM port.
- **Ethernet connection** requires that you enter the terminal's IP Address.
- **Network connection** requires RSLinx Enterprise software where you select the terminal on an existing network.

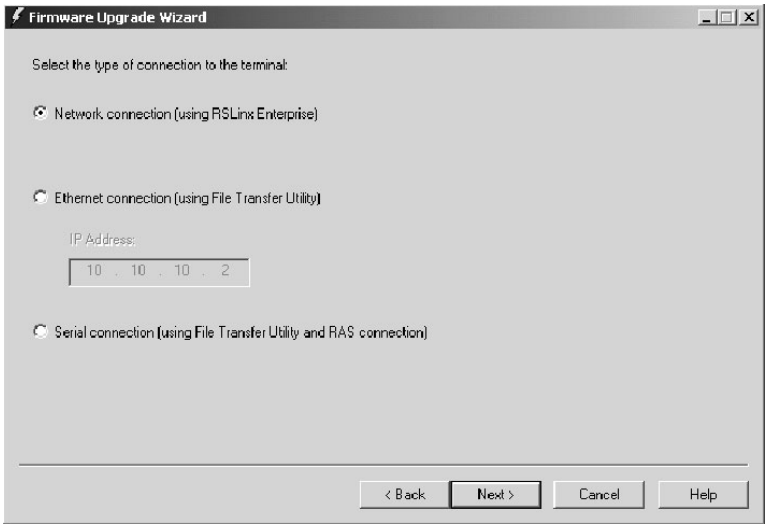
Both the Serial and Ethernet connection requires the File Transfer Utility running on the terminal.

This section shows how to upgrade firmware in a terminal using a Network connection via Ethernet communications.

1. Start the Firmware Upgrade Wizard by selecting Start>Rockwell Software>FactoryTalk View Enterprise>Firmware Upgrade Wizard.



2. Select Upgrade firmware on terminal and click OK.

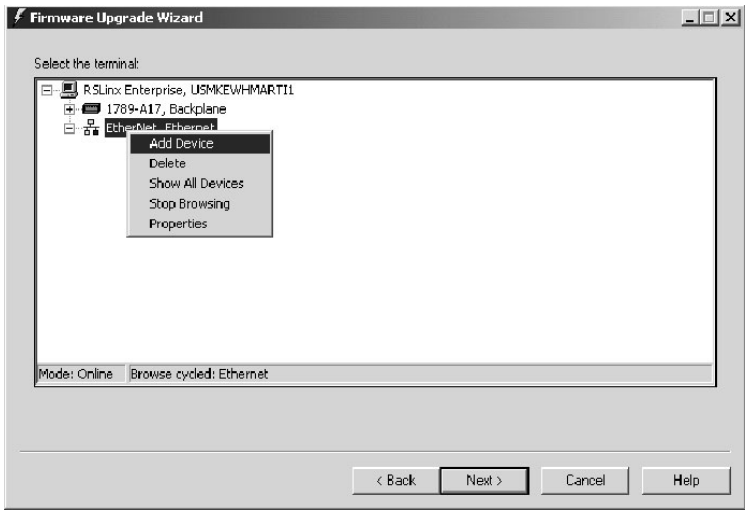


3. Select Network connection and click Next.

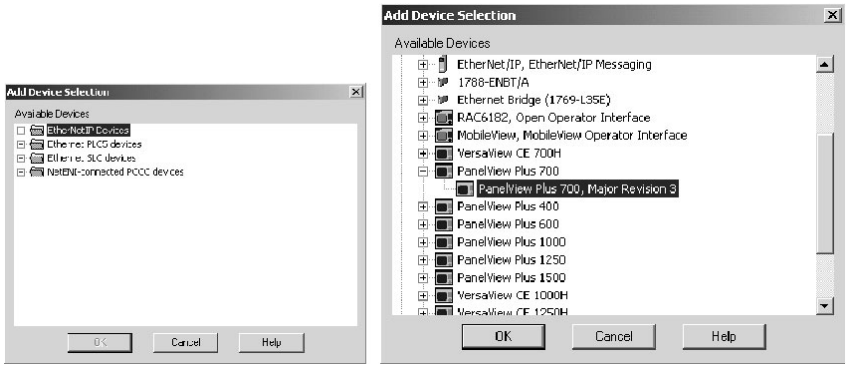
Use the Ethernet and Serial connections only if the firmware upgrade is unsuccessful.

4. Locate the terminal on your Ethernet network via its IP address.

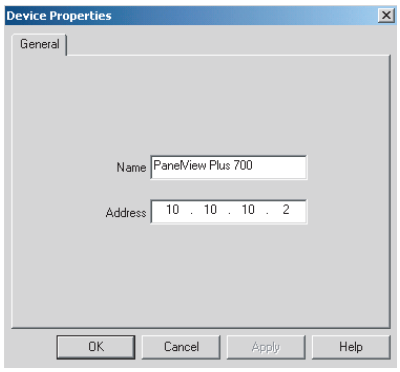
Skip to step 6 if you found the terminal. If you do not see the terminal, right-click the Ethernet driver and add the device to the browse tree.



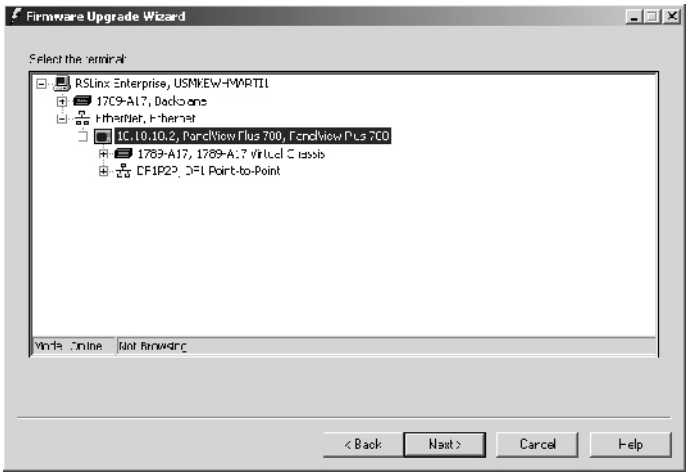
5. Double-click EthernetIP Devices and select the appropriate terminal and click OK.



6. Enter the IP address for the terminal and click OK.



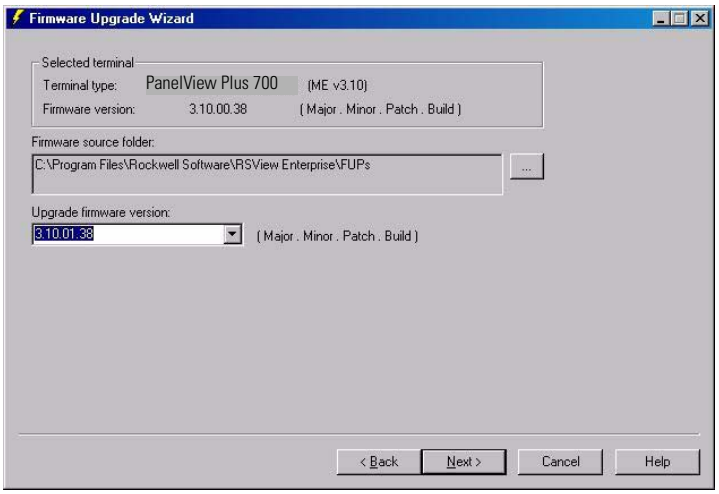
7. Select the terminal to be upgraded and click OK.



8. From the Firmware source folder text box, select the location of the firmware files.

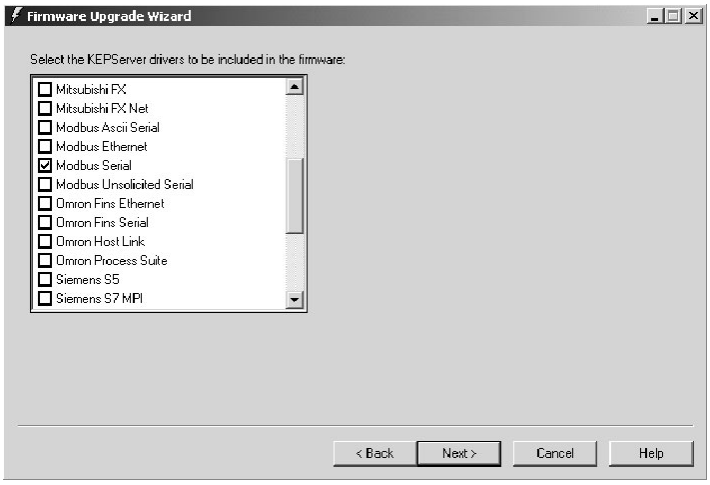
The default location is C:\Program Files\Rockwell Software\FactoryTalk View Enterprise\FUPs.

9. From the Upgrade firmware version list, select the version of the firmware you want to upgrade to, then click Next.



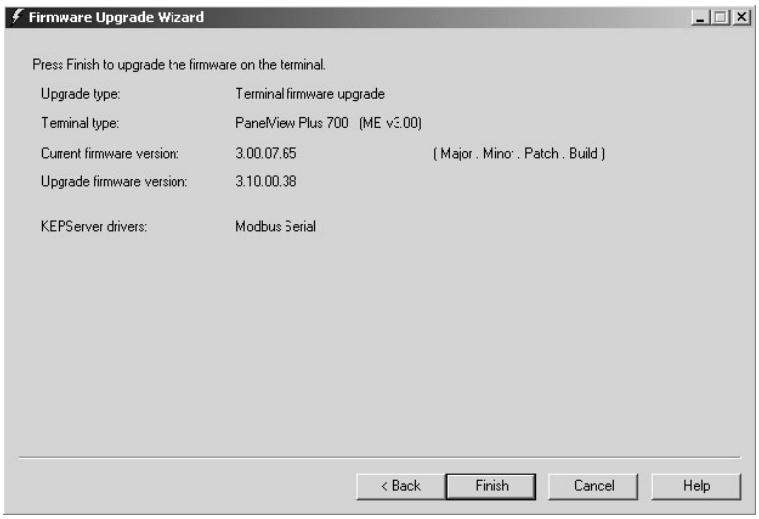
10. Select the appropriate KEPServer drivers and click Next.

If no KEPServer drivers are needed, just click Next.



TIP If the selected FUP file does not support the KEPServer drivers, this dialog box will not appear.

11. Click Finish to start the upgrade.

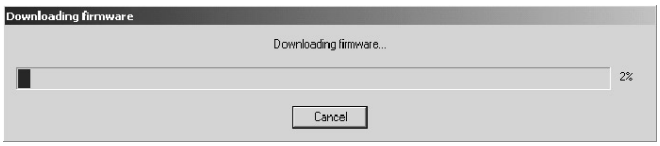


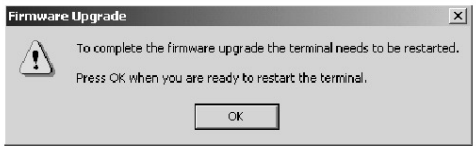
12. Click Yes to continue the upgrade process.

If the terminal was properly prepared for the upgrade, no applications should be running.

Firmware files are downloaded to the terminal. This may take several minutes to 15 minutes.

13. When the download is complete, click OK to reset the terminal.





If other terminals exist on the same Ethernet network, the following error may display:

Error registering name on network (may be duplicate). Change in system Control Panel and try again.

Ignore this error. It will be corrected during the upgrade. Press OK to acknowledge error and wait for terminal to reset.

TIP If a USB mouse is available, you can acknowledge the error by selecting OK.

14. On touch or touch-screen terminals, you must calibrate the touch screen by selecting pointers in all four corners of the screen and pressing the middle of the screen when prompted.

Ignore the following message if it appears. It means FactoryTalk View ME is being installed. Do not touch the two buttons that appear with the message.

Machine edition may be corrupted. Do you want to download firmware?

Communication settings are cleared when the terminal is upgraded. If Ethernet communications is used, reconfigure the Ethernet communication settings using the values recorded when preparing the terminal.

15. Replace the .MER files that you backed up before starting the upgrade or download the new .MER files to the terminal.

16. Load the .MER file and run the project.

TIP You can configure your application to start automatically on power cycle under Startup Options.

Upgrade the Operating System (OS)

The Operating System (OS) compressed binary image resides in a binary partition of the Internal (IDE) CompactFlash in the logic module for PanelView Plus CE terminals. There are two ways to upgrade the OS:.

- External CompactFlash card during a reboot
- LocalOSUpdate (LocalOSUpdate.exe)

External CompactFlash Card

Follow these steps to upgrade the OS using an external CompactFlash card.

1. Copy the operating system binary file, SYSTEM.BIN, to a CompactFlash card.
   The file must be named SYSTEM.BIN.
2. Remove power from the PanelView Plus CE terminal.
3. Insert the CompactFlash card into the external card slot on the terminal.
4. Cycle power to the PanelView Plus CE terminal.
   The terminal automatically reboots with the new operating system.

Local OS Update

1. Copy the operating system binary file to a CompactFlash card.
2. Insert the CompactFlash card into the external card slot of the PanelView Plus CE terminal.
3. At a CMD prompt on the PanelView Plus CE terminal, run:
   LocalOSUpdate <Pathname and Filename>

   Example: LocalOSUpdate "\Storage card2\NewOS.BIN"

   The terminal automatically reboots with the new operating system.
4. Verify the new operating system is loaded using the system application in the control panel.

Load PanelView Plus CE Components

You can load PanelView Plus CE Components by using an:

- ActiveSync connection.
- external CompactFlash card.

ActiveSync Connection

When the new operating system is running, load the PanelView Plus CE components as follows.

1. Establish an ActiveSync connection between your computer and the PanelView Plus CE terminal, using either a serial or Ethernet connection (Ethernet is recommended).
   Refer to page 191.

2. Open the PanelView Plus CE Install Utility folder on the PanelView Plus CE Accessory CD and run the InstallFromActiveSync.exe program.

   This program lets you select which features to install and automatically copies the files from the CD to the PanelView Plus CE terminal. You must run the program from its directory to make sure the program locates all the files correctly.

3. Select the desired components from the list of available components.

   Use the >> button to install everything.
   Once installed, components can be optionally removed to free space in the \Storage Card folder.

4. When satisfied with the selections, click Install/Remove.

   Depending on the options selected and the speed of your ActiveSync connection, the download process may take several minutes.
   For a serial ActiveSync connection at 19.2 Kbps, the download time can be 30 minutes. When the download is complete, you will see the number of files copied or deleted.

5. Restart the PanelView Plus CE terminal.

External CompactFlash Card

When the new operating system is running, load the PanelView Plus CE components as follows.

1. Open the PanelView Plus CE Install Utility folder on the PanelView Plus CE Accessory CD and copy the following to an FAT formatted CompactFlash card:
   - InstallFromStorageCard.exe
   - pvplusceinstall.ini
   - Storage Card File folder
2. Insert the CompactFlash card into the external card slot on the terminal.
3. Using Windows Explorer, browse the \Storage Card folder and run InstallFromStorageCard.exe.
4. Select the desired components from the list of available components.

   Use the **>>** button to install everything.
   Once installed, components can be optionally removed to free space in the \Storage Card folder.
5. When satisfied with the selections, click Install/Remove.

   When the operation is complete, you will see a message box reporting the number of files installed (or removed).
6. Restart the PanelView Plus CE terminal.

Troubleshoot the System

Chapter Objectives

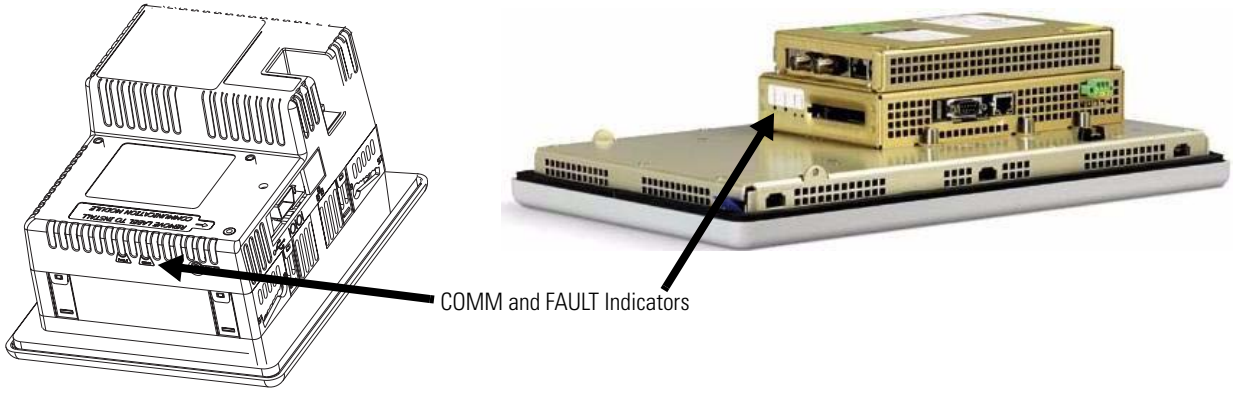
This chapter provides information on how to isolate and correct common operating problems with system components.

- Status indicators
- Isolate the problem
- Startup error messages
- Startup information messages
- Startup sequence
- Check terminal components
- Ethernet connection
- Application does not run
- File system errors
- System identification errors
- Configuration mode access
- Restart in safe mode

Status Indicators

The terminals have two status indicators to isolate operating problems.

- COMM indicator (green) for communication
- FAULT indicator (red) for hardware faults



Isolate the Problem

This section provides general troubleshooting information to assist you when trying to isolate problems.

Check for Adequate Power

A terminal that does not receive adequate power could result in unpredictable behavior. Refer to Appendix A, Specifications, for power requirements.

Check Indicators at Startup

After a successful startup, both status indicators on the terminal are off and controlled by the application running on the terminal.

When the terminal starts, the fault (red) indicator should be off except for a few brief flashes, and the comm (green) indicator on.

- If the indicators on the 700 to 1500 terminals remain off, the power supply or logic module has failed. Check the power cable. If the power is not within range, replace the power supply. If the power is within range, replace the logic module.
- If the indicators on the 400 and 600 terminals remain off, check the power cable.

Indicator States If Terminal Stops During Startup

Fault (Red) Indicator	Comm (Green) Indicator	Description
Blinking (1)	Off	Last firmware download failed. Reload firmware using Firmware Upgrade Wizard (FUW) utility.
	Blinking	EBC boot loader firmware failed or is missing. Reload firmware using Firmware Upgrade Wizard (FUW) utility.
	On	Windows CE OS firmware failed or is missing. Reload firmware using Firmware Upgrade Wizard (FUW) utility.
On (2)	Off	Fatal hardware error occurred. For the 700 to 1500 terminals, replace the logic module. For the 400 or 600 terminals, replace the terminal.
	Blinking	Fatal hardware error in display. For the 700 to 1500 terminals, replace the display module. For the 400 or 600 terminals, replace the terminal.

(1) Blinking red indicates a recoverable error.

(2) Solid red indicates a nonrecoverable or fatal error.

Check the Startup Messages for Errors

Record any error message that displays during startup. Refer to Startup Error Messages on page 211.

Check Voltages and Temperatures

On the 700 to 1500 terminals, check the battery voltage and the display temperature.

- Enter Configuration mode and select Terminal Settings>System Information>Terminal Information.
- For PanelView Plus CE terminals, you can also open the Hardware Monitor control panel application.

The battery voltage must be at least 2.75V DC. Replace the battery if the voltage is less than 2.75V DC.

The display temperatures should be less than 55 °C (131 °F). The CPU temperature should be less than 95 °C. If the temperatures are higher, check for obstructed airflow in the chassis and attempt to moderate the ambient temperatures within the enclosure and surroundings.

Check the System Event Log

Check the system event log for errors or unexpected reboots.

- Enter Configuration mode and select Terminal Settings>System Event Log.
- For PanelView Plus CE terminals, you can also open the Hardware Monitor control application and select the Event Log tab.

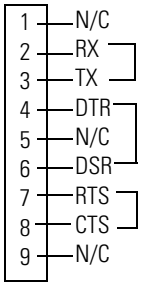
Perform Extended Diagnostics

Use extended diagnostics on the 700 to 1500 terminals to perform more extensive hardware testing at startup.

- Enter Configuration mode and select Terminal Settings>Startup Tests>Select Tests.
- For PanelView Plus CE terminals, you can also open the Extended Diagnostics control panel application.

Select one or more of the tests you want to run. Enable extended diagnostics and set the iteration or repeat count. Restart the terminal. The serial port test requires a loopback connector with these connections.

DB9 Connector (female)



Extended diagnostics are performed at every startup until disabled. A failure will momentarily halt startup and display an error message.

Startup Information Messages

Startup messages display in a specific sequence on the terminal during startup and typically display for a few seconds. These messages indicate the startup sequence of the terminal, but do not require that you perform any action.

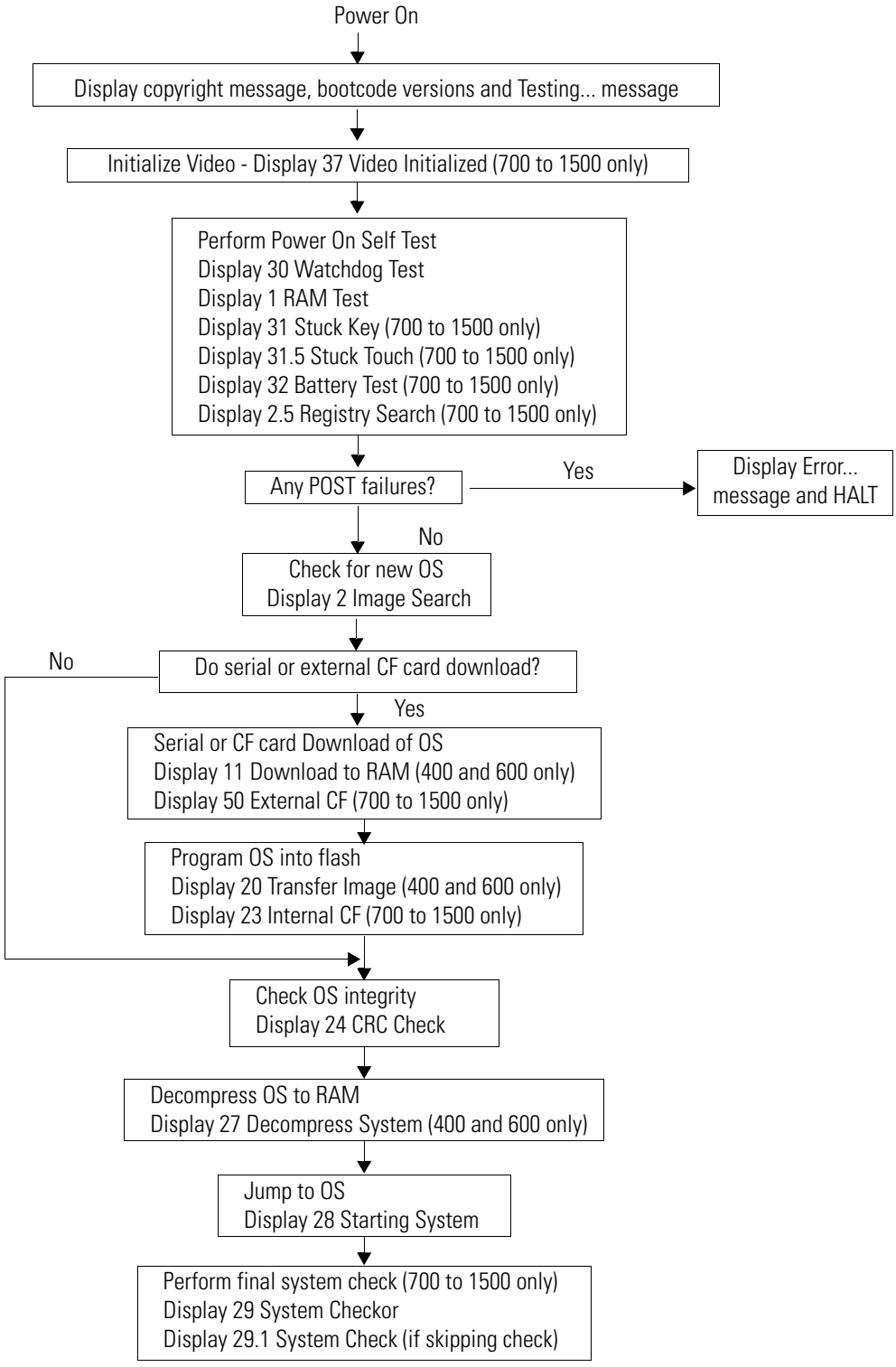
Message #	Displayed Message	Description
37 (1)	Video Initialized	Configures and initializes the graphics video system.
30	Watchdog Test	Tests the watchdog circuitry to verify system integrity.
1	RAM Test	Tests the RAM memory.
31 (1)	Stuck Key	Checks the integrity of the function key hardware.
31.5 (1)	Stuck Touch	Checks the integrity of the touch screen hardware.
32 (1)	Battery Test	Checks the integrity of the battery hardware.
2.5 (1)	Registry Search	Locates and loads the most recent, valid registry. Multiple copies of the registry are maintained. If power is lost during a registry update, a valid registry is available the next time power is applied to the terminal.
2	Image Search	Checks for new OS firmware upgrade on the external CompactFlash card and the serial port.
11 (2)	Downloading Image	Downloads a new OS firmware upgrade to internal RAM. Message may remain on screen for several minutes.
50 (1)	External CF	Transfers a new OS firmware upgrade from the external CompactFlash card to the terminal. Message may display for several minutes.
20 (2)	Transfer Image	Programs the OS firmware just downloaded into RAM. Message may remain on screen for several minutes.
23 (1)	Internal CF	Programs the OS firmware just downloaded into the internal flash memory. Message may display for several minutes.
24	CRC Check	Checks the integrity of the OS firmware.
27 (2)	Decompress System	Decompresses the compressed OS firmware into RAM.
28	Starting System	Launches the operating system (OS).
29	System Check ###	Checks internal file system integrity (### is percent progress indicator).
29.1	System Check	Disables internal file system integrity check. Contact technical support.

(1) The status number and message displays only on the 700 to 1500 terminals.

(2) The status number and message displays only on the 400 and 600 terminals.

Startup Sequence

This flow chart provides a sequence of startup operations for the terminal and shows system information messages that are displayed on the terminal.



Startup Error Messages

When an error occurs, the terminal displays the error number with a text message. The word ERROR! appears under this line in different languages.

Displayed Message
ERROR! FEHLER! ERREUR! ERRORE!

Error #	Displayed Message	Description	Recommended Corrective Action
1	RAM Test	RAM Test failure	Reset the terminal. 400 and 600: If error persists, replace the terminal. 700 to 1500: If error persists, reseat the SO-DIMM RAM module. If error still persists, replace the logic module.
14 (1)	RAM Header Check	OS firmware that is downloading is not compatible with hardware.	Check that you are using the correct version and type of firmware upgrade. Reset the terminal and upgrade with the correct firmware version.
20 (1)	Transfer Image	Programming the downloaded OS firmware into flash failed.	Reset the terminal and attempt the firmware upgrade again. If error persists, replace the terminal.
23	Download Task (1)	OS firmware that is downloading to the terminal is too large.	Check that you are using the correct version and type of firmware upgrade. Reset the terminal and upgrade with the correct firmware version.
	Internal CF (2)	Error programming the new OS firmware to internal CompactFlash.	Reload the firmware. If error persists, replace the internal CompactFlash. If error still persists, replace the logic module.
24	CRC Check	Checksum of the OS firmware failed.	Reload the firmware. 400 and 600: If error persists, replace the terminal. 700 to 1500: If error persists, replace the internal CompactFlash card. If error still persists, replace the logic module.
25 (1)	Invalid Prod Family	OS firmware that is downloading is not compatible with terminal.	Check that you are using the correct version and type of firmware upgrade. Reset the terminal and upgrade with the correct firmware version.
27 (1)	Decompress System	Error decompressing the OS firmware from flash to RAM.	Reload the firmware. If error persists, replace the terminal.
30	Watchdog Test	Watchdog test failure	Reload the firmware. 400 and 600: If error persists, replace the terminal. 700 to 1500: If error persists, replace the logic module.
31	Stuck Key	Function key failure	Check that nothing is pressed against a key. Reset the terminal without key presses. If error persists, replace display module.
31.5 (2)	Stuck Touch	Touch screen failure	Check that nothing is pressed against the touch screen. Reset the terminal without touch screen presses. If error persists, replace the display module.
32 (2)	Battery Test	Battery failure	Replace the battery. If error persists, replace the logic module.
33.5 (2)	NVRAM Access	Nonvolatile memory failure	Upgrade the system firmware to revision 3.10.03 or later.
3a (1)	Stuck Touch	Touch screen failure	Check that nothing is pressed against the touch screen. Reset the terminal without touch screen presses. If error persists, replace the terminal.
40	EXE Check	System OS firmware is missing or corrupt.	Reload the firmware. 400 and 600: If error persists, replace the terminal. 700 to 1500: If error persists, replace the internal CompactFlash card. If error still persists, replace the logic module.
50 (2)	External CF	Error loading the OS firmware from the external CompactFlash card.	Reload the firmware. If error persists, replace the external CompactFlash card and attempt the firmware upgrade again.

(1) The error number and message displays only on the 400 and 600 terminals.

(2) The error number and message displays only on the 700 to 1500 terminals.

Check Terminal Components

This section provides tips on how to isolate problems with the display, touch screen, keypad, attached keyboard, or mouse. If you are unable to resolve the problem, replace the display.

Resolve Problems with Display

Symptom	Recommended Action [1]	Page
The display is dim or unreadable.	Check the brightness setting on 700 to 1500 displays. • Enter Configuration mode and select Terminal Settings>Display>Display Intensity. • On PanelView Plus CE devices, you can also open the Display control panel application and select the Backlight tab.	82 131
	Check the contrast setting on 400 or 600 grayscale terminals. • Enter Configuration mode, and select Terminal Settings>Display>Display Contrast.	82
The backlight is turning off or dimming the display unexpectedly.	Check the screen saver settings. • Enter Configuration mode and select Terminal Settings>Display>Screen Saver. • On PanelView Plus CE devices, you can also open the Display control panel application and select the Screen Saver tab.	83 131
A startup error appears during startup.	Record the message and check the startup error messages table.	213

[1] If you are unable to resolve the problem, replace the display.

Resolve Problems with Touch Screen

Problem	Recommended Action [1]	Page
The touch screen is not operating correctly.	Calibrate the touch screen. • Enter Configuration mode and select Terminal Settings>Input Devices>Touch Screen>Calibration. • On PanelView Plus CE devices, you can also open the Touch control panel application and select the Calibration tab. The calibration requires four user screen touches. When the touches do not converge to a satisfactory calibration, you are asked repeatedly for additional screen touches; the calibration process never terminates. A touch screen that does not calibrate is not present or not functioning properly. Replace the 700 to 1500 display module or the 400 to 600 terminal.	88 126
The display may not have a touch screen.	Check the catalog number of the unit. Verify that your terminal has a touch screen by looking at the label on the terminal.	

Problem	Recommended Action [1]	Page
The screen cursor is not visible.	Verify that the cursor is enabled. • Enter Configuration mode and select Terminal Settings>Input Devices>Touch Screen>Cursor. • In PanelView Plus CE, open the Display control panel application and select the Cursor tab.	89 131
The touch screen does not accept touch input.	Attach a USB mouse to check whether the problem is with the touch screen or the application. • If the mouse works, but the touch screen does not, then the touch driver or touch screen is not functioning properly. • If both the mouse and the touch screen are not working, then it is an application problem.	
Touch input and dragging is inaccurate. The touch screen is present and working but requires calibration.	Calibrate the touch screen. • Enter Configuration mode and select Terminal Settings>Input Devices>Touch Screen>Calibration. • On PanelView Plus CE devices, you can also open the Touch control panel application and select the Calibration tab.	88 126

[1] If you are unable to resolve the problem, replace the 700 to 1500 display module or bezel.

Resolve Problems with Keypad

Problem	Recommended Action [1]	Page
The hold-off delay may be longer than expected or multiple key presses might be inhibited by multi-key lockout. Home, End, Page Up or Page Down are not supported when single key or multi-key lockout is enabled.	Check keypad settings. • Enter Configuration mode and select Terminal Settings>Input Devices>Keypad. • On PanelView Plus CE devices, you can also open the Keypad control panel application.	87 129
The keypad is not accepting key input.	Check the key input by attaching a USB keyboard. • If the keyboard works, but the keypad does not, then the keypad driver or keypad is not working. • If both the keypad and keyboard are not working, then the problem may be the application.	
Keys on the keypad of a PanelView Plus CE terminal are not mapped correctly.	Check the keypad mapping. • You can remap or disable the keys on the PanelView Plus CE terminal can using the Keypad Configuration Utility (KCU). Use the KCU to check the current keypad configuration. • Restart in Safe mode to use the default keypad mappings.	
On PanelView Plus CE terminals, problems with keypad input may be the fault of the application.	On PanelView Plus CE terminals only: • Press a key outside the application such as an edit box in the shell. If the keypad works outside the application, then the application is at fault. • Press Ctrl+Esc simultaneously to open the Start menu, cursor to run, type numbers and viewable characters into the Run dialog.	

[1] If you are unable to resolve the problem, replace the 700 to 1500 display module.

Resolve Problems with Mouse

Problem	Recommended Action	Page
The mouse is not operating correctly.	Check the USB cable and connection. Detach and then reattach the mouse. Cycle power to the terminal.	
The screen cursor may not be visible or the mouse settings may need adjusting.	Check if the screen cursor is disabled: • Enter Configuration mode and select Terminal Settings>Input Devices>Touch Screen>Cursor. • For a PanelView Plus CE terminal, you can also open the Display control panel application. Check the mouse settings. • Enter Configuration mode and select Terminal Settings>Input Devices>Mouse. • For a PanelView Plus CE terminal, you can also open the Mouse control panel application.	89 130 87 129
The mouse is a keyboard/mouse USB composite device.	Attach a standalone USB mouse.	
The USB mouse may not be working or noncompliant.	Replace the USB mouse. Try a different model or manufacturer. If attaching a new mouse resolves the problem, then the old mouse was not working or noncompliant. Refer to Appendix B for a list of valid USB devices that are compatible with the terminal. You can also check the Knowledgebase at http://support.rockwellautomation.com for a list of USB compatible devices.	229

Resolve Problems with Keyboard

Problem	Recommended Action	Page
The keyboard does not work.	Check the USB cable and connector. Detach and reattach the keyboard. Verify a good connection. Cycle power to the terminal.	
Keyboard keys may not be enabled as expected.	Check for enabled Alt-Ctrl keys. • Enter Configuration mode and select Terminal Settings>Input Devices>Keyboard.	86
The keyboard is not accepting key input.	Check the key input using the keypad. • If the keypad works, but the keyboard does not, then the keyboard driver or keyboard is not working. • If both the keypad and keyboard are not working, then the problem is probably with the application.	
On PanelView Plus CE terminals, problems with keyboard input may be the fault of the application.	On PanelView Plus CE terminals only: • Press a key outside the application such as an edit box in the shell. If the keypad works outside the application, then the application is at fault. • Press Ctrl+Esc simultaneously to open the Start menu, cursor to run, type numbers and viewable characters into the Run dialog.	
The keyboard is a keyboard/mouse USB composite device.	Attach a standalone USB keyboard.	
The USB keyboard may not be a compliant device.	Replace the USB keyboard. Try a different model or manufacturer. If a new keyboard resolves the problem, then the old keyboard was probably noncompliant. Refer to Appendix B for a list of valid USB devices that are compatible with the terminal. You can also check the Knowledgebase at http://support.rockwellautomation.com for a list of compatible USB devices.	229

Ethernet Connnection

This section provides tips on how to isolate Ethernet problems.

- **Check the status indicators at the Ethernet connector**. Green indicates a communication link and should be ON. Amber indicates data activity and should be flashing. Verify that there is a connection to the hub.
- **Check the cable connections and quality of cable.** Check for good connections and things such as quality, crimping, hub connection, and uplink ports.
- **Check the IP Address of the Built-in Ethernet Controller**. Enter Configuration mode and select Terminal Settings>Networks and Communications>Network Connections>Network Adapters. In PanelView Plus CE, open the Network and Dial-up Connections control panel application

  If DHCP is enabled, the device expects a valid IP address to be acquired within a several seconds after startup. The TCP/IP protocol automatically assigns 169.254.nnn.nnn when it fails to acquire an IP address from the server. In general, an IP address that begins with 169 will not support a network connection.

  A bad Ethernet connection and the absence of a valid IP address are typically reported in a Communication error message box with the Winsock critical error 10065 - No route to host.

- **Check for conflicting IP addresses**. If DHCP is not enabled, make sure the IP address you specify is not in conflict with the address of another device on the network.
- **Check the device name of the terminal**. Do not allow devices on the network with same host name. Enter Configuration mode and select Terminal Settings>Communications and Networks>Network Connections>Device Name. In PanelView Plus CE, open the System control panel application
- **Contact your Network Administrator to check peer or server settings**. The other side of the Ethernet connection may also be a problem.
- **Use the network utilities Ping.exe and Ipconfig.exe (CE Terminals only)**
- **Check the requirements of network applications (CE Terminals only).** Network applications may have specific requirements such as Proxy Settings for Internet Explorer and Ethernet Configuration for ActiveSync. In PanelView Plus CE, open the Communications control panel application.
- **Check the multi-homed devices (CE terminals only).** Multi-homed (more than one Ethernet node) devices have the same issues as those above but with more potential for confusion and ambiguity. Keep the Network connections as simple as possible.

Application Does Not Run

If the PanelView Plus application does not start, there may be a problem with the .MER FactoryTalk View ME file. Check for a startup screen and compatible version.

If a PanelView Plus application does not run on the terminal, there may be a problem with the FactoryTalk View ME application. Verify that a startup screen was configured and that the runtime file is a compatible version.

If a PanelView Plus CE application does not run at startup, try to run the application manually. If the application runs manually, then the operating system may be starting up with an invalid shortcut path. Check the shortcuts in the folder:

\Storage Card\Windows\StartUp

Check the syntax of each shortcut path in the Startup folder and verify that a valid target application exists.

Check that the application is not missing components or required DLLs. Remove and reload the application.

Configuration Mode Access

To access Configuration mode while an application is running, your FactoryTalk View ME application must contain a screen with a Goto Configure Mode button. When the application is running, you can press this button to access Configuration mode.

If a running application does not contain a Goto Configure Mode button, you can access configuration mode during startup.

1. Restart the terminal.
   The terminal goes through its startup sequence and will display a white box in the lower left corner of the display.
2. On touch screen terminals, press the white box.
   On keypad terminals, press the F1 key.

   The terminal enters Configuration Mode.

TIP If the terminal is configured to enter Configuration mode at startup and does not, then reload the firmware.

File System Errors

The file system on PanelView Plus CE terminals is checked at startup and errors are reported in a message box. Record the error information and always elect to correct the problem. Typically, the message box will reappear until the error is corrected.

File system errors are rare and can usually be corrected. The most common cause of lost clusters and file/directory size mismatches within a FAT file system is an unexpected power outage while writing to the file system. Always stop applications before removing power so that data is cleanly flushed out to the file system and the file system is brought to an orderly stop.

Although the FactoryTalk View ME application runs from RAM, applications such as data and event logging, and historical trending, write to flash memory and should be stopped before removing power.

Advanced Diagnostics for CE Terminals

Ping and ipconfig are invaluable for network debugging along with some knowledge of IP and the Winsock error codes.

- Try to ping the destination host.
- Check the destination address.
- Check whether you have a router configured in your network system (your WinSock implementation).
- Use the tracert command at the command prompt on the desktop to try and determine where the failure occurs along the route between your host and the destination host.
- Some utility programs are distributed on the Accessories CD. Others can be developed using the software development kit (SDK).
- Take advantage of alternate connectivity - mouse versus touch screen, keyboard versus keypad, serial communication, and alternate Ethernet connections.
- Enable the crash logger and examine the EXCEPTIONS.LOG file from the PanelView Plus CE terminal when suspecting an operating system or application crash.
- Store the current operating system on an external CompactFlash card. You can then use this card to update the terminal in case the operating system is out-of-date or corrupted.
- Store Autorun.exe utilities on an external CompactFlash card that can be easily run by inserting the card in the external CompactFlash card slot of the terminal.
- Know useful keyboard shortcuts so that you can navigate around the system without a mouse or touch screen.

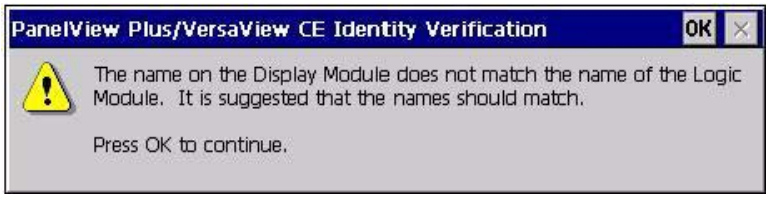
- Check the event log in the Hardware Monitor control panel application or under Terminal Settings>System Event Log in Configuration mode. Look for error conditions or reasons for unexpected reboots.
- Check the configuration settings in the PanelView Plus CE control panel applications or terminal Configuration mode.

System Identification Errors

The error messages in this section appear on startup if incorrect or invalid components are used with the 700 to 1500 terminals.

TIP Terminals manufactured after January 2007 switch displays without displaying the following error messages.

- This dialog appears if a PanelView Plus CE logic module is attached to a PanelView display module. We recommend that you use a PanelView Plus CE display module with a PanelView Plus CE logic module. This is a warning letting you continue to operate.



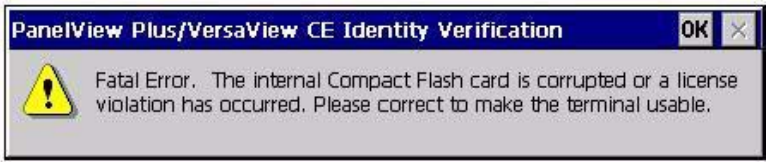
- This dialog appears if the PanelView Plus logic module contains a 2711P-RW*x* internal CompactFlash card for the PanelView Plus CE terminal.

After pressing OK, you will be asked to power off the terminal and insert a valid 2711P-RW*x* internal CompactFlash card for the PanelView Plus terminal.

- This dialog appears if the PanelView Plus CE logic module contains a 2711P-RW*x* internal CompactFlash card for the PanelView Plus terminal.

After clicking OK, you will be asked to power off the terminal and insert a valid 2711P-RW*x* internal CompactFlash card for the PanelView Plus CE terminal.

- This dialog appears if the internal CompactFlash in the PanelView Plus logic module is corrupt. This is a fatal error.



After clicking OK, you will be asked to power off the terminal and insert a valid 2711P-RW*x* internal CompactFlash card.

Restart in Safe Mode

On PanelView Plus CE terminals, use the default switch with the reset switch to start the terminal in Safe mode. This diagnostic mode reduces the system to a known state that permits recovery from a software problem. Safe mode ignores all user changes to the system and avoids any problems that are due to interactions with end-user software or changes. Once the system is running in Safe mode, you can repair the offending applications or changes that caused the problem.

When the PanelView Plus CE terminal is restarted in Safe mode, the following occurs:

- The Persistent Registry is ignored and the Default Registry is used. The Persistent Registry is restored at the next reboot unless the Default Registry is saved (flushed), in which case it becomes the new Persistent Registry.
- The \Windows\Startup folder is ignored, inhibiting most startup actions. All user applications that launch automatically at startup are shortcuts in the \Startup folder.
- Depending on the state of the system, the touch screen may be calibrated at startup.
- All custom key configurations (mappings) generated by the Keypad Configuration Utility (KCU) are ignored.

The switches that control safe mode are on the right side of the logic module above the CompactFlash card slot.

Follow these steps to restart in Safe mode.

1. Insert a thin probe into the hole marked default and press the switch.
2. Insert the probe into the hole marked reset and press the switch.

   The system will restart immediately into the Safe mode.

If you restart the PanelView Plus terminal in safe mode:

1. The default operating system registry is loaded.
2. The operating system boots but FactoryTalk View ME software is not started.
3. The operating system displays the ME may be corrupt diagnostic screen.

   Disregard this message. FactoryTalk View ME software is not corrupt; it has not been loaded on this boot cycle.
4. The next time you reset or power up the terminal, the system will start normally and run FactoryTalk View ME software.

TIP Safe mode indicates that the terminal passes all startup self tests and can successfully launch the operating system. Safe mode is not a diagnostic function for the FactoryTalk View ME application.

Maintenance

Chapter Objectives

This chapter provides information on the following topics:

- Clean the display
- Disposal information

Clean the Display Window

Use a protective antiglare overlay for easier cleaning of the display window.

ATTENTION

Use of abrasive cleaners or solvents may damage the display. Do not scrub or use brushes.

Follow these steps to clean the display window.

1. Disconnect power from the terminal at the power source.
2. Use a clean sponge or soft cloth with a mild soap or detergent to clean the display.
3. Dry the display with a chamois or moist cellulose sponge to avoid water spots.

Remove fresh paint splashes and grease before drying by rubbing lightly with isopropyl alcohol (70% concentration). Afterward, wash using a mild soap or detergent. Rinse with clean water.

Disposal Information

This section contains disposal information for the backlight assembly and the lithium battery in the 400 and 600 terminals.

Backlight Assembly Disposal

ATTENTION

The backlight assembly of 600 to 1500 terminals contains mercury. At the end of its life, this equipment should be collected separately from any unsorted municipal waste.

Battery Removal

The lithium battery in the 400 and 600 is non-replaceable and should be removed only at the end of product life.

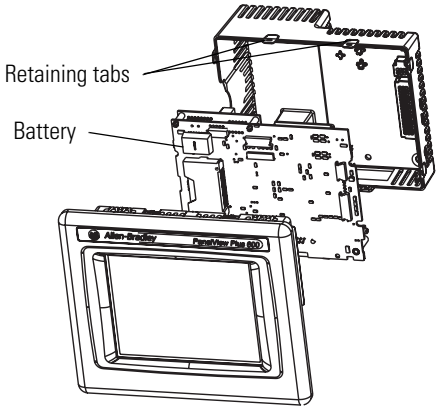
This product contains a hermetically sealed lithium battery which is permanently connected and should be removed only by trained professionals.

At the end of its life, the battery contained in this product should be collected separately from any unsorted municipal waste.

The collection and recycling of batteries helps protect the environment and contributes to the conservation of natural resources as valuable materials are recovered.

Follow these steps to remove the battery on the 400 and 600 terminals.

1. Disconnect power from the terminal.
2. Place the terminal, display side down, on a flat stable surface.
3. Detach the communication module, if attached, from the logic module by removing the three screws.
4. Unlatch the eight retaining tabs (two on each side) on the back cover and remove cover.
5. Locate the yellow battery on the logic board.
6. Remove the battery.



For information on battery replacement or removal for 700 to 1500 terminals, see Replace the Battery on page 153.

Specifications

Electrical

Attribute	Value
400 and 600 Input voltage, DC Power consumption, DC 700 to 1500 Input voltage, DC Power consumption, DC	 24V DC nom (18…30V DC) 25 W max (1.0 A at 24V DC) 24V DC nom (18…32V DC) 70 W max (2.9 A at 24V DC) 39 W typical (1.6A @ 24V DC)
400 and 600 Input voltage, AC Line frequency Power consumption, AC 700 to 1500 Input voltage, AC Line frequency Power consumption, AC Remote power 700 to 1500 (2711P-RSAC) Input voltage, AC Line frequency Power consumption, AC	 85…264V AC 47…63 Hz 60V A max 85…264V AC 47…63 Hz 160V A max, 65 VA typical 85…264V AC 47…63 Hz 120V A max
PCI slot max available power Supply, DC Supply, AC	 11 W 5 W

Environmental

Attribute	Value
Temperature, operating	0…55 °C (32…131 °F)
Temperature, non-operating	-25…70 °C (-13…158 °F)
Heat dissipation 400 and 600 700 to 1500	 85 BTU/hr 240 BTU/hr
Relative humidity	5…95% without condensation
Altitude, operating	2000 m (6561 ft)
Shock, operating	15 g at 11 ms
Shock, nonoperating	30 g at 11 ms

Vibration	10…57 Hz, 0.012 pk-pk displacement 57…500 Hz, 2 g pk acceleration
Enclosure Ratings	NEMA Type 12, 13, 4X (Indoor use only), IP54, IP65
Airborne Contaminants	For PVP/PVP-CE conformal-coated PCBA level products: ANSI/ISA S71.04 - 1985 Severity Level G3 EN60654-4:1998 Class 3

Display

Attribute	Value
Display type 400 and 600 grayscale 400…1500 color	 Grayscale passive matrix, film compensated super-twist nematic (FSTN) Color active matrix, thin-film transistor (TFT) with liquid crystal display (LCD)
Display size, diagonal 400 grayscale 400 color 600 700 1000 1250 and 1250 high-bright 1500	 3.8 in. 3.5 in. 5.5 in. 6.5 in. 10.4 in. 12.1 in. 15.0 in.
Display area (WxH) 400 grayscale 400 color 600 grayscale and color 700 1000 1250 and 1250 high-bright 1500	 77 x 58 mm (3.0 x 2.3 in.) 71 x 53 mm (2.8 x 2.1 in.) 112 x 84 mm (4.4 x 3.3 in.) 132 x 99 mm (5.2 x 3.9 in.) 211 x 158 mm (8.3 x 6.2 in.) 246 x 184 mm (9.7 x 7.2 in.) 304 x 228 mm (12.0 x 9.0 in.)
Resolution 400 grayscale and 400 color 600 700 1000 1250 and 1250 high-bright 1500	 320 x 240 320 x 240 640 x 480 640 x 480 800 x 600 1024 x 768
Luminance (typical) 400 grayscale 400 color 600 700 to 1500 1250 high-bright	 120 cd/m^2 Nits 200 cd/m^2 Nits 300 cd/m^2 Nits 300 cd/m^2 Nits 1000 cd/m^2 Nits

Backlight 400 600…1500 1250 High-bright	 LED CCFL 50,000 hours life, min. Backlight not replaceable
Touch screen Actuation rating Operating force	Analog resistive 1 million presses 10…110 g
Keypad function keys(1) Actuation rating Operating force	Function keys, numeric and navigation 1 million presses 340 g

(1) Number of function keys varies by terminal size.

Mechanical

Attribute	Value
Weight, approx., HxWxD (for base unit without modules)	
400 keypad(1) or keypad and touch	562 g (1.24 lb)
600 keypad or keypad and touch(1)	930 g (2.05 lb)
600 touch(1)	789 g (1.74 lb)
700 keypad or keypad and touch	1.9 kg (4.2 lb)
700 Touch	1.7 kg (3.8 lb)
1000 keypad or keypad and touch	2.9 kg (6.3 lb)
1000 touch	2.6 kg (5.7 lb)
1250 keypad or keypad and touch	3.4 kg (7.6 lb)
1250 touch and 1250 high-bright touch	3.2 kg (7.1 lb)
1500 keypad or keypad and touch	4.6 kg (10.0 lb)
1500 touch	4.2 kg (9.3 lb)
Dimensions, approx. HxWxD (for base unit without communication module)	
400 keypad or keypad and touch	152 x 185 x 90 mm (6.0 x 7.28 x 3.54 in.)
600 keypad or keypad and touch	167 x 266 x 98 mm (6.58 x 10.47 x 3.86 in.)
600 touch	152 x 185 x 98 mm (6.0 x 7.28 x 3.86 in.)
700 keypad or keypad and touch	193 x 290 x 55 mm (7.58 x 11.40 x 2.18 in.)
700 touch	179 x 246 x 55 mm (7.04 x 9.68 x 2.18 in.)
1000 keypad or keypad and touch	248 x 399 x 55 mm (9.77 x 15.72 x 2.18 in.)
1000 touch	248 x 329 x 55 mm (9.77 x 12.97 x 2.18 in.)
1250 keypad or keypad and touch	282 x 416 x 55 mm (11.12 x 16.36 x 2.18 in.)
1250 touch	282 x 363 x 55 mm (11.12 x 14.30 x 2.18 in.)
1250 touch High-bright	282 x 363 x 74 mm (11.12 x 14.30 x 2.90 in.)
1500 keypad or keypad and touch	330 x 469 x 65 mm (12.97 x 18.46 x 2.55 in.)
1500 touch	330 x 416 x 65 mm (12.97 x 16.37 x 2.55 in.)

(1) Add approximately 95 g (0.21 lb) for communication module.

General

Attribute	Value
Battery life 400 and 600 700 to 1500	 5 years min. at 25 °C (77 °F) 4 years min. at 25 °C (77 °F)
Clock	Battery-backed, +/-2 minutes per month
LED indicators	COMM (Green), Fault (Red)
Application flash memory 400 and 600, series A 400 and 600, series B or later 700 to 1500 logic modules, series A to D 700 to 1500 logic modules, series E or later 2711P-RW1 2711P-RW2 2711P-RW3 700-1500 CE logic modules, series E or later 2711P-RW6 2711P-RW7 2711P-RW8	 5 MB 10 MB 20 MB 26 MB 72 MB 195 MB 80 MB 203 MB 446 MB
External CompactFlash storage	512 MB max

Agency Certifications

Certifications [1]	Value
c-UL-us	UL Listed Industrial Control Equipment, certified for use in US and Canada. See File E10314. UL Listed Industrial Control Equipment for use in: • Class I, Div 2, Group A, B, C, D • Class I, Zone 2, Group IIC [2] • Class II, Div 2 Groups F, G • Class III Hazardous Locations
CE (EMC)	European Union 2004/108/EC Directive, compliant with: EN 61000-6-2; Industrial Immunity EN 61000-6-4; Industrial Emissions
CE (LVD)	European Union 2006/95/EC Low Voltage Directive, compliant with: EN 61131-2; Programmable Controllers
C-Tick	Australian Radiocommunications Act, compliant with: AS/NZS CISPR 11; Industrial Emissions
Marine [1]	Products identified with the suffix M in the catalog number, are certified to the requirements of one or more marine societies.

[1] See the Product Certification link on http://ab.com for declarations of conformity, certificates, and other certification details.

[2] Applies only to the 1250 high-bright display module.

Compatible USB Devices

The following table provides a list of compatible USB devices that can be used on the USB ports of the terminals.

Device	Vendor	Model	PanelView Plus 700 to 1500	PanelView Plus 400 and 600
USB Keyboard	Rockwell Automation	Cat. No. 6189-KBDEPU1U	Yes	Yes
	Ortek	MCK-600USB	Yes	Yes
	Dell	RT7D10	Yes	Yes
USB Keyboard/Mouse	Rockwell Automation	Cat. No. 6189-KBDEPC1U	Yes	No
USB Mouse	Logitec	Optical Mouse - M-BJ58	Yes	Yes
	Microsoft	Intellimouse D58-00026	Yes	Yes
	Atek	USB Mouse	Yes	No
	VersaView (Rockwell Automation)	USB Mouse	Yes	Yes
USB Hub	Belkin	USB 4-Port Hub - ESU021	Yes	Yes

Available Fonts for Terminal Applications

The following fonts are pre-installed on PanelViewPlus terminals:

- True Type fonts (scalable)
  - Tahoma.ttf (proportional)
  - Courier.ttf (fixed width)
  - Arial.ttf (proportional)
- 23 fonts of various sizes migrated from PanelView Standard and PanelView e terminals (various sizes)

To simplify the creation and downloading of .mer application files on these devices, use the above list of fonts when developing screens in FactoryTalk View Studio software.

Additional fonts are available in FactoryTalk View Studio software when developing application screens.

- If the font used to develop screens is not available on the target device, the closest font is selected.
- If bold or italics is used, and a separate bold or italics font is unavailable, then the target operating system will use an algorithm to produce these affects.

In either case, the device screens will look different than they do in FactoryTalk View Studio software.

Download Fonts to Terminal

To use additional fonts on a PanelView Plus device, copy any of the font files on the PanelView Plus CE Accessories CD or the Machine Editions Fonts CD to this directory on the computer where FactoryTalk View Studio software is installed:

c:\Documents and Settings\All Users\Documents\RSView Enterprise\ME\Runtime

You can now use the File Transfer Utility in FactoryTalk View Studio software to download the font files to the target device.

1. Select Tools>Transfer Utility.
2. Select Source File>True Type Fonts.
3. Select a font file to download to the device and press the Download button.

PanelView Plus CE Accessories CD

The following True Type fonts are included on the PanelView Plus CE Accessories CD:

- Times New Roman.ttf
- Symbol.ttf
- Wingdings.ttf

This CD is not supplied with PanelView Plus terminals.

Machine Edition Fonts CD

Additional fonts are available on the Machine Edition Fonts CD. This CD is available from your local distributor by requesting View-SP006.

For additional information, refer to the Rockwell Automation Knowledgebase at http://support.rockwellautomation.com.

Available Fonts

Fonts	File Name	Size (Bytes)
Arial		
Arial (Subset 1_30)	arial_1_30.ttf	153,720
Arial Black	arialk.ttf	117,028
Arial Bold	arialbd.ttf	288,496
Arial Bold Italic	arialbi.ttf	226,748
Arial Italic	ariali.ttf	207,808
Comic Sans MS		
Comic Sans MS	comic.ttf	126,364
Comic Sans MS Bold	comicbd.ttf	111,476
Courier New		
Courier New (Subset 1_30)	cour_1_30.ttf	162,460
Courier New Bold	courbd.ttf	312,920
Courier New Bold Italic	courbi.ttf	236,148
Courier New Italic	couri.ttf	245,032
Georgia		
Georgia	georgia.ttf	149,628
Georgia Bold	georgiab.ttf	141,032
Georgia Bold Italic	georgiaz.ttf	159,736
Georgia Italic	georgiai.ttf	157,388
Impact	impact.ttf	136,076
Kino	kino.ttf	28,872
MSLogo	mslogo.ttf	2,500
Symbol	symbol.ttf	69,464
Tahoma		
Tahoma (Subset 1_07)	tahoma_1_07.ttf	123,980
Tahoma Bold	tahomabd.ttf	295,432
Times New Roman		
Times New Roman (Subset 1_30)	times_1_30.ttf	184,976
Times New Roman Bold	timesbd.ttf	334,944
Times New Roman Bold Italic	timesbi.ttf	239,692
Times New Roman Italic	timesi.ttf	248,368

Fonts	File Name	Size (Bytes)
Trebuchet MS		
Trebuchet MS	trebuc.ttf	69,688
Trebuchet MS Bold	trebucbd.ttf	66,444
Trebuchet MS Bold Italic	trebucbi.ttf	66,348
Trebuchet MS Italic	trebucit.ttf	72,560
Verdana		
Verdana	verdana.ttf	149,752
Verdana Bold	verdanab.ttf	137,616
Verdana Bold Italic	verdanaz.ttf	154,800
Verdana Italic	verdanai.ttf	155,076
Webdings	webdings.ttf	118,752
Wingding	wingding.ttf	81,000
Chinese (Simplified) Locale Specific Support		
Simsun & NSimSun		
Simsun & NSimSun	simsun.ttc	10,500,400
Simsun & NSimSun (Subset 2_50)	simsun_2_50.ttc	3,051,024
Simsun & NSimSun (Subset 2_60)	simsun_2_60.ttc	3,578,692
Simsun & NSimSun (Subset 2_70)	simsun_2_70.ttc	6,975,948
Simsun & NSimSun (Subset 2_80)	simsun_2_80.ttc	8,116,188
Simsun & NSimSun (Subset 2_90)	simsun_2_90.ttc	9,066,640
SC_Song	sunfon.ttf	4,686,044
Chinese (Traditional) Locale Specific Support		
MingLiU & PMingLiU (Choose 1)		
MingLiU & PMingLiU	mingliu.ttc	8,822,400
MingLiU & PMingLiU (Subset 2_70)	mingliu_2_70.ttc	4,786,488
MingLiU & PMingLiU (Subset 2_80)	mingliu_2_80.ttc	5,772,700
MingLiU & PMingLiU (Subset 2_90)	mingliu_2_90.ttc	7,354,808
MSMing	msming.ttf	3,172,552
Japanese Locale Specific Support		
MS Gothic		
MS Gothic & P Gothic & UI Gothic	msgothic.ttc	8,272,028
MS Gothic & P Gothic & UI Gothic (Subset 1_50)	msgothic_1_50.ttc	4,456,536
MS Gothic & P Gothic & UI Gothic (Subset 1_60)	msgothic_1_60.ttc	6,057,400
MS Gothic & P Gothic & UI Gothic (Subset 1_70)	msgothic_1_70.ttc	3,795,500
MS Gothic & P Gothic & UI Gothic (Subset 1_80)	msgothic_1_80.ttc	5,438,776
MS Gothic & P Gothic & UI Gothic (Subset 1_90)	msgothic_1_90.ttc	6,408,352
MS Gothic & P Gothic (Subset 30)	msgothic30.ttc	4,197,524
MS Gothic & P Gothic (Subset 30_1_19)	msgothic30_1_19.ttc	3,304,056

Fonts	File Name	Size (Bytes)
Korean Locale Specific Support		
GL_CE	gl_ce.ttf	4,130,084
Gulim & GulimChe (Choose 1)		
Gulim & GulimChe (Subset 1_30)	gulim_1_30.ttc	3,010,268
Gulim & GulimChe (Subset 1_40)	gulim_1_40.ttc	4,683,896
Gulim & GulimChe (Subset 1_50)	gulim_1_50.ttc	7,128,756
Gulim & GulimChe (Subset 1_60)	gulim_1_60.ttc	9,360,100

Programmable Key Definitions

The tables in this appendix shows the Windows virtual key code mapping of each programmable function key on the PanelView Plus CE terminal.

Function Key	Virtual Key Mapping	Function Key	Virtual Key Mapping
F1	VK_F1	K1	RA + VK_F1
F2	VK_F2	K2	RA + VK_F2
F3	VK_F3	K3	RA + VK_F3
F4	VK_F4	K4	RA + VK_F4
F5	VK_F5	K5	RA + VK_F5
F6	VK_F6	K6	RA + VK_F6
F7	VK_F7	K7	RA + VK_F7
F8	VK_F8	K8	RA + VK_F8
F9	VK_F9	K9	RA + VK_F9
F10	VK_F10	K10	RA + VK_F10
F11	VK_F11	K11	RA + VK_F11
F12	VK_F12	K12	RA + VK_F12
F13	LS + VK_F1	K13	RS + VK_F1
F14	LS + VK_F2	K14	RS + VK_F2
F15	LS + VK_F3	K15	RS + VK_F3
F16	LS + VK_F4	K16	RS + VK_F4
F17	LS + VK_F5	K17	RS + VK_F5
F18	LS + VK_F6	K18	RS + VK_F6
F19	LS + VK_F7	K19	RS + VK_F7
F20	LS + VK_F8	K20	RS + VK_F8
F21	LS + VK_F9	K21	RS + VK_F9
F22	LS + VK_F10	K22	RS + VK_F10

The following table provides the Windows virtual-key code mapping for the Alt, Control, and Shift keys on the PanelView Plus CE terminal.

Alt, Control, and Shift Key Mapping

Keyboard Equivalent	Virtual Key Mapping
Control	VK_LCONTROL
Shift	VK_LSHIFT
Alt	VK_LMENU

Security Considerations

Ports 137 and 138 are normally open to support the NetBIOS protocol used by Windows CE.NET similar to other Microsoft and IBM network operating systems.

Port 80 is open when the Web server is optionally installed from the PanelView Plus extensions. Otherwise, Port 80 is normally closed.

The FTP server permits a remote computer to run arbitrary commands and read/write files. The FTP server is optionally installed from the VersaView extensions. Otherwise, there is no FTP server on the system.

Simple Network Management Protocol (SNMP) is not supported.

Internet Group Management Protocol (IGMP) is used for IPv4 multicast. A multicast is communication between a single sender and multiple receivers on a network. IGMP is used to exchange membership status data between IPv4 routers that support multicasting and members of multicast groups. A router is an intermediary device on a communication network that expedites message delivery by finding the most efficient route for a message packet within a network, or by routing packets from one subnetwork to another. A subnetwork is a separate part of an organization's network identified through IP addressing.

PanelView Plus CE terminals provide level 2 (full) support for IPv4 multicasting (IGMP version 2) as described in RFC 1112 and RFC 2236.

Security requires a comprehensive application of policies and technology, and an awareness of security needs and potential vulnerabilities. You may also want to consult with Rockwell GMS Network Services for additional assistance.

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Rockwell Automation Support

Rockwell Automation provides technical information on the Web to assist you in using its products. At http://www.rockwellautomation.com/support/, you can find technical manuals, a knowledge base of FAQs, technical and application notes, sample code and links to software service packs, and a MySupport feature that you can customize to make the best use of these tools.

For an additional level of technical phone support for installation, configuration, and troubleshooting, we offer TechConnect support programs. For more information, contact your local distributor or Rockwell Automation representative, or visit http://www.rockwellautomation.com/support/.

Installation Assistance

If you experience an anomoly within the first 24 hours of installation, review the information that's contained in this manual. You can contact Customer Support for initial help in getting your product up and running.

United States or Canada	1.440.646.3434
Outside United States or Canada	Use the Worldwide Locator at http://www.rockwellautomation.com/support/americas/phone_en.html, or contact your local Rockwell Automation representative.

New Product Satisfaction Return

Rockwell Automation tests all of its products to ensure that they are fully operational when shipped from the manufacturing facility. However, if your product is not functioning and needs to be returned, follow these procedures.

United States	Contact your distributor. You must provide a Customer Support case number (call the phone number above to obtain one) to your distributor to complete the return process.
Outside United States	Please contact your local Rockwell Automation representative for the return procedure.

Documentation Feedback

Your comments will help us serve your documentation needs better. If you have any suggestions on how to improve this document, complete this form, publication RA-DU002, available at http://www.rockwellautomation.com/literature/.

www.rockwellautomation.com

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Allen-Bradley

PanelView Plus Terminals

User Manual

PLC, Allen Bradley

- I/O Chassis, 7 Slot, 1756-A7
- Power Supply, 1756-PA72
- Control Logic Processor, 1756-L61
- Ethernet Module, 1756-ENBT
- Analog Input Module, 1756-IF8
- Analog Output Module, 1756-OFC6I
- AC Input Module, 1756-IA16
- Relay Output Module, 16-PT, 1756-OW161

I/O Chassis, 7 Slot, 1756-A7

Installation Instructions

ControlLogix Chassis-Series B

Catalog Numbers 1756-A4, -A7, -A10, -A13, -A17

Use this publication as a guide when installing a ControlLogix™ chassis.

To:	See page:
Prepare for Installation	7
Allow Sufficient Mounting Space	8
Install Your Chassis	9
Ground Your Chassis	10
Attach Your Power Supply and Install Your Modules	14
Use Mounting Dimensions	15
See Specifications	17

The ControlLogix system is a modular system that requires a 1756 I/O chassis to contain the various modules. Chassis are available with 4, 7, 10, 13, and 17 slots. You can place any module into any slot.

The backplane provides a high-speed communication path between modules. Multiple controller modules on the backplane can pass messages between one another. With multiple communication interface modules on the backplane, a message can be sent from across a link into a port on one module, routed across the backplane and out another module's port, and sent across another link to its ultimate destination.

Important User Information

Solid state equipment has operational characteristics differing from those of electromechanical equipment. *Safety Guidelines for the Application, Installation and Maintenance of Solid State Controls* (Publication SGI-1.1 available from your local Rockwell Automation sales office or online at http://www.ab.com/manuals/gi) describes some important differences between solid state equipment and hard-wired electromechanical devices. Because of this difference, and also because of the wide variety of uses for solid state equipment, all persons responsible for applying this equipment must satisfy themselves that each intended application of this equipment is acceptable.

In no event will Rockwell Automation, Inc. be responsible or liable for indirect or consequential damages resulting from the use or application of this equipment.

The examples and diagrams in this manual are included solely for illustrative purposes. Because of the many variables and requirements associated with any particular installation, Rockwell Automation, Inc. cannot assume responsibility or liability for actual use based on the examples and diagrams.

No patent liability is assumed by Rockwell Automation, Inc. with respect to use of information, circuits, equipment, or software described in this manual.

Reproduction of the contents of this manual, in whole or in part, without written permission of Rockwell Automation, Inc. is prohibited.

Throughout this manual we use notes to make you aware of safety considerations.

WARNING	Identifies information about practices or circumstances that can cause an explosion in a hazardous environment, which may lead to personal injury or death, property damage, or economic loss.
IMPORTANT	Identifies information that is critical for successful application and understanding of the product.
ATTENTION	Identifies information about practices or circumstances that can lead to personal injury or death, property damage, or economic loss. Attentions help you: • identify a hazard • avoid a hazard • recognize the consequence
SHOCK HAZARD	Labels may be located on or inside the drive to alert people that dangerous voltage may be present.
BURN HAZARD	Labels may be located on or inside the drive to alert people that surfaces may be dangerous temperatures.

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Environment and Enclosure

ATTENTION

This equipment is intended for use in a Pollution Degree 2 industrial environment, in overvoltage Category II applications (as defined in IEC publication 60664-1), at altitudes up to 2000 meters without derating.

This equipment is considered Group 1, Class A industrial equipment according to IEC/CISPR Publication 11. Without appropriate precautions, there may be potential difficulties ensuring electromagnetic compatibility in other environments due to conducted as well as radiated disturbance.

This equipment is supplied as "open type" equipment. It must be mounted within an enclosure that is suitably designed for those specific environmental conditions that will be present and appropriately designed to prevent personal injury resulting from accessibility to live parts. The interior of the enclosure must be accessible only by the use of a tool. Subsequent sections of this publication may contain additional information regarding specific enclosure type ratings that are required to comply with certain product safety certifications.

NOTE: See NEMA Standards publication 250 and IEC publication 60529, as applicable, for explanations of the degrees of protection provided by different types of enclosure. Also, see the appropriate sections in this publication, as well as the Allen-Bradley publication 1770-4.1 ("Industrial Automation Wiring and Grounding Guidelines"), for additional installation requirements pertaining to this equipment.

Prevent Electrostatic Discharge

ATTENTION

This equipment is sensitive to electrostatic discharge, which can cause internal damage and affect normal operation. Follow these guidelines when you handle this equipment:

- Touch a grounded object to discharge potential static.
- Wear an approved grounding wriststrap.
- Do not touch connectors or pins on component boards.
- Do not touch circuit components inside the equipment.
- If available, use a static-safe workstation.
- When not in use, store the equipment in appropriate static-safe packaging.

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European Hazardous Location Approval

European Zone 2 Certification (The following applies when the product bears the EEx Marking)

This equipment is intended for use in potentially explosive atmospheres as defined by European Union Directive 94/9/EC.

The LCIE (Laboratoire Central des Industries Electriques) certifies that this equipment has been found to comply with the Essential Health and Safety Requirements relating to the design and construction of Category 3 equipment intended for use in potentially explosive atmospheres, given in Annex II to this Directive. The examination and test results are recorded in confidential report No. 28 682 010.

Compliance with the Essential Health and Safety Requirements has been assured by compliance with EN 50021.

IMPORTANT

When using this product, also consider the following:

- This equipment is not resistant to sunlight or other sources of UV radiation.
- The secondary of a current transformer shall not be open-circuited when applied in Class I, Zone 2 environments.
- Equipment of lesser Enclosure Type Rating must be installed in an enclosure providing at least IP54 protection when applied in Class I, Zone 2 environments.
- This equipment shall be used within its specified ratings defined by Allen-Bradley.
- Provision shall be made to prevent the rated voltage from being exceeded by transient disturbances of more than 40% when applied in Class I, Zone 2 environments.

North American Hazardous Location Approval

The following information applies when operating this equipment in hazardous locations:	**Informations sur l'utilisation de cet équipement en environnements dangereux :**
Products marked "CL I, DIV 2, GP A, B, C, D" are suitable for use in Class I Division 2 Groups A, B, C, D, Hazardous Locations and nonhazardous locations only. Each product is supplied with markings on the rating nameplate indicating the hazardous location temperature code. When combining products within a system, the most adverse temperature code (lowest "T" number) may be used to help determine the overall temperature code of the system. Combinations of equipment in your system are subject to investigation by the local Authority Having Jurisdiction at the time of installation.	Les produits marqués "CL I, DIV 2, GP A, B, C, D" ne conviennent qu'à une utilisation en environnements de Classe I Division 2 Groupes A, B, C, D dangereux et non dangereux. Chaque produit est livré avec des marquages sur sa plaque d'identification qui indiquent le code de température pour les environnements dangereux. Lorsque plusieurs produits sont combinés dans un système, le code de température le plus défavorable (code de température le plus faible) peut être utilisé pour déterminer le code de température global du système. Les combinaisons d'équipements dans le système sont sujettes à inspection par les autorités locales qualifiées au moment de l'installation.

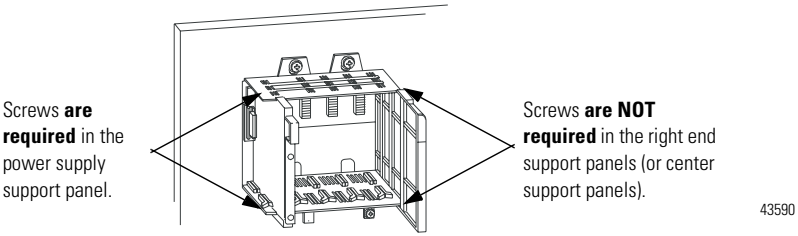
The following information applies when operating this equipment in hazardous locations:		**Informations sur l'utilisation de cet équipement en environnements dangereux :**	
WARNING	EXPLOSION HAZARD • Do not disconnect equipment unless power has been removed or the area is known to be nonhazardous. • Do not disconnect connections to this equipment unless power has been removed or the area is known to be nonhazardous. Secure any external connections that mate to this equipment by using screws, sliding latches, threaded connectors, or other means provided with this product. • Substitution of components may impair suitability for Class I, Division 2. • If this product contains batteries, they must only be changed in an area known to be nonhazardous.	**AVERTISSEMENT**	RISQUE D'EXPLOSION • Couper le courant ou s'assurer que l'environnement est classé non dangereux avant de débrancher l'équipement. • Couper le courant ou s'assurer que l'environnement est classé non dangereux avant de débrancher les connecteurs. Fixer tous les connecteurs externes reliés à cet équipement à l'aide de vis, loquets coulissants, connecteurs filetés ou autres moyens fournis avec ce produit. • La substitution de composants peut rendre cet équipement inadapté à une utilisation en environnement de Classe I, Division 2. • S'assurer que l'environnement est classé non dangereux avant de changer les piles.

Manufacturing Note

Due to a change in Rockwell Automation manufacturing processes only the power supply support panel requires screws in the top and bottom. Molded plastic latches hold center support and right end support panels on ControlLogix chassis.

There are screw holes in the center and right end locations, but screws are **NOT** needed in these locations. For more information, see Figure 1.

Figure 1



Prepare for Installation

Make sure you have these items.

- M4 or M5 (#10 or #12) mounting tab screws and washers
- drill
- documentation for ControlLogix modules that will be placed in the chassis
- phillips screwdriver

For each:	You need:
top mounting tab	• 1 phillips screw • 1 flat washer • 1 split lock-washer
bottom mounting tab	• 1 phillips screw • 1 star washer or 1 SEM screw(1)

(1) Phillips screw with attached star washer

This chassis	Uses this number of mounting tabs	
1756-A4, -A7	2 top	2 bottom
1756-A10	3 top	3 bottom
1756-A13	4 top	4 bottom
1756-A17	5 top	5 bottom

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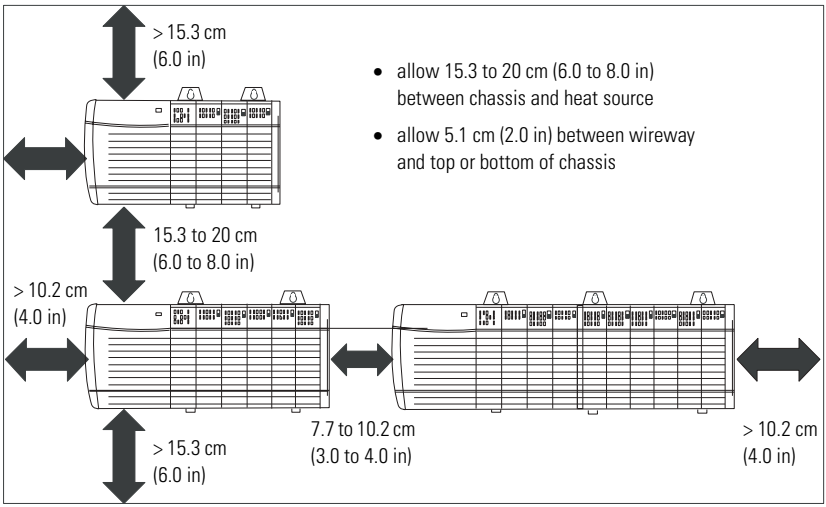
Allow Sufficient Mounting Space

IMPORTANT Make sure you meet these **minimum** spacing requirements.

Figure 2



Minimum Cabinet Size

IMPORTANT To meet the UL/CSA standards, the cabinet housing your ControlLogix chassis cannot be smaller than these **minimum** cabinet size requirements.

Chassis	Minimum Cabinet Size (W x H x D)
1756-A4	50.7 x 50.7 x 20.3 cm (20 x 20 x 8 in)
1756-A7	50.7 x 70 x 20.3 cm (20 x 24 x 8 in)
1756-A10	76.2 x 50.7 x 20.3 cm (30 x 20 x 8 in)
1756-A13	76.2 x 70 x 20.3 cm (30 x 24 x 8 in)
1756-A17	82.2 x 76.2 x 20.3 cm (36 x 30 x 8 in)

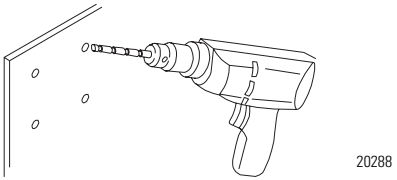
Install Your Chassis

ATTENTION

Do not drill holes for a chassis above an installed chassis. Metal chips from drilling can damage the backplane and cause intermittent operation.

1. Drill holes in the back panel of the enclosure for chassis mounting tabs. Refer to Use Mounting Dimensions on page 15, for assistance in hole placement.

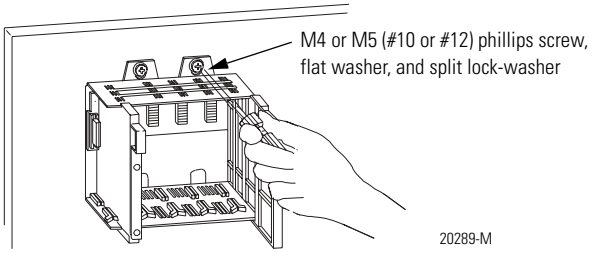
Figure 3



2. Scrape paint off the back panel for an electrical connection between the chassis and back panel.

3. Hold the chassis in place against the holes.

4. Install the hardware for the top mounting tabs and tighten.



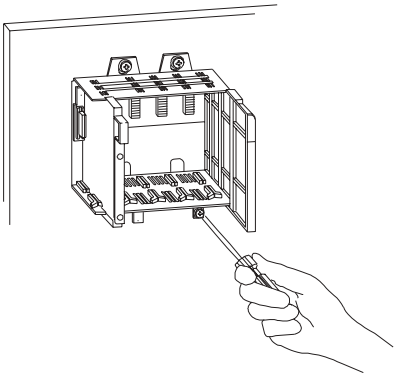
ATTENTION

If the chassis mounting tabs do not lay flat before the screws are tightened, use additional washers as shims so the chassis is not warped by tightening the screws.

Warping a chassis could damage the backplane and cause intermittent operation.

5. Leaving the far-left bottom tab open for functional ground, install the remaining tab screw(s).

Figure 4



This completes the installation your ControlLogix chassis. The following sections describe how to ground your chassis.

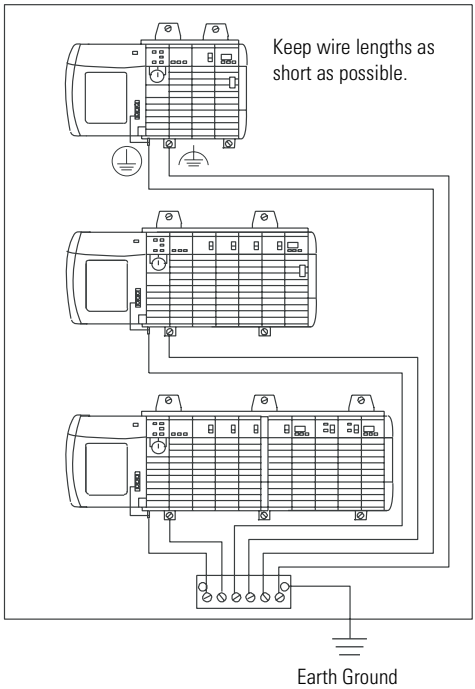
Ground Your Chassis

To properly ground your I/O chassis:	See page:
Verify Grounding Configuration	8
Install a Central Ground Bus	9
Connect Functional Ground	9
Connect Equipment Protective Earth Ground	10
Connect the Equipment Grounding Conductors to the Ground Bus	10
Connect Ground Bus to Grounding-Electrode System	11

Verify Grounding Configuration

This figure shows you how to run functional and equipment protective earth ground connections from the chassis and power supply to the ground bus. Using a ground bus is recommended because it reduces the electrical resistance at the connection.

Figure 5



For more information on installing and connecting protective earth ground to the ControlLogix power supply see each supply's installation instructions. There are multiple ControlLogix power supplies available–the supplies are described in the ControlLogix Selection Guide, publication 1756-SG001.

Install a Central Ground Bus

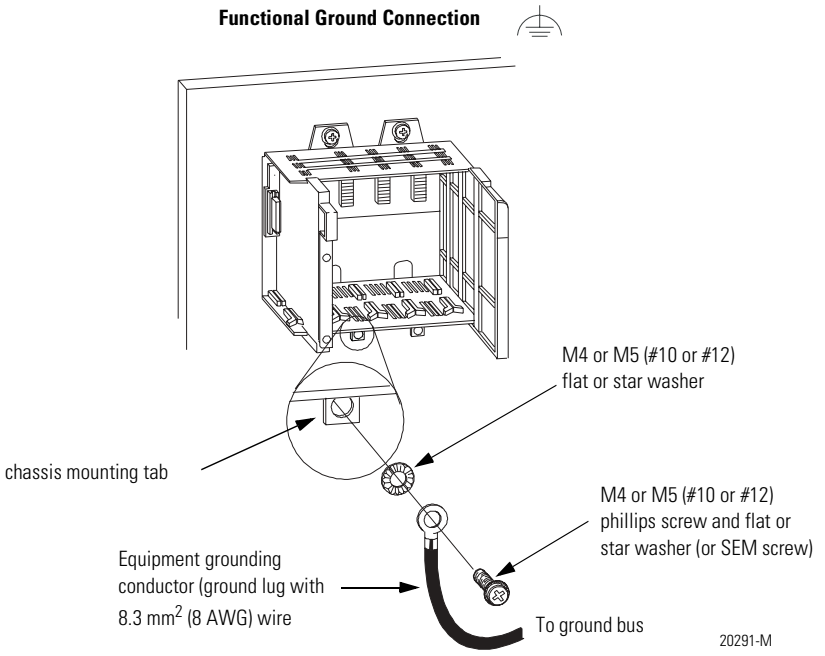
Each enclosure must contain a central ground bus. The ground bus is the common connection for each chassis within the enclosure and the enclosure itself.

For more information on installing a central ground bus, refer to the Industrial Automation Wiring and Grounding Guidelines, publication 1770-4.1

Connect Functional Ground

Keep wire lengths as short as possible, and use the following figure to connect functional ground to the chassis.

Figure 6

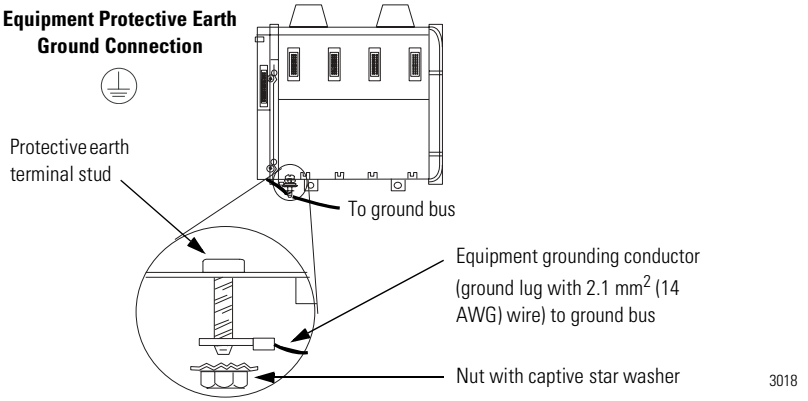


Connect Equipment Protective Earth Ground

Use Figure 7 to connect equipment protective earth ground to the chassis.

IMPORTANT Tighten the nut on the equipment protective earth ground terminal stud to a torque of 12 inch- pounds.

Figure 7

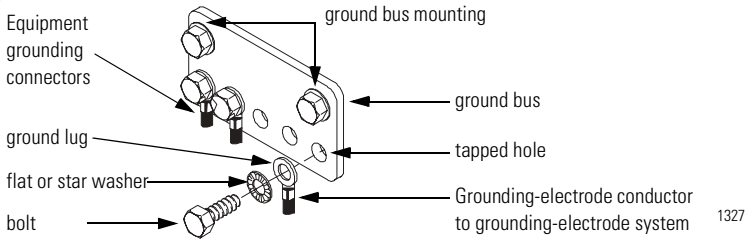


Connect the Equipment Grounding Conductors to the Ground Bus

Connect the equipment grounding conductors (functional and equipment protective earth ground) directly from each chassis to an individual bolt on the ground bus.

IMPORTANT Do not lay one ground lug directly on top of the other; this connection can become loose due to compression of the metal lugs. Place the first lug between a star washer and a nut with a captive star washer. After tightening the nut, place the second lug between the first nut and a second nut with a captive star washer.

Figure 8



Functional Ground

- use 2.54 cm (1 in) thick copper braid or 8.3 mm^2 (8 AWG) copper wire to connect equipment grounding conductor for each chassis, the enclosure, and a central ground bus mounted on the back-panel
- use a steel enclosure to guard against electromagnetic interference (EMI)
- make sure the enclosure door viewing window is a laminated screen or a conductive optical substrate (to block EMI)

Equipment Protective Earth Ground

- use a 2.1 mm^2 (14 AWG) copper wire for the equipment grounding conductors
- install a bonding wire for electrical contact between the door and the enclosure; do not rely on the hinge.

Connect Ground Bus to Grounding-Electrode System

The grounding-electrode system is at earth-ground potential and is the central ground for all electrical equipment and ac power within any facility. Use a grounding-electrode conductor to connect the ground bus to the grounding-electrode system.

Use at minimum 8.3 mm^2 (8 AWG) copper wire for the grounding-electrode conductor to guard against EMI. The National Electrical Code specifies safety requirements for the grounding-electrode conductor.

Attach Your Power Supply and Install Your Modules

Use the installation instructions/user manuals for your ControlLogix modules to install them in the chassis.

Use the installation instructions for your ControlLogix power supply to attach it to your chassis. To see the power supplies available for use in a ControlLogix system, see the ControlLogix Selection Guide, publication 1756-SG001.

ControlLogix documentation is available at:

http://www.ab.com/manuals/cl

http://www.theautomationbookstore.com

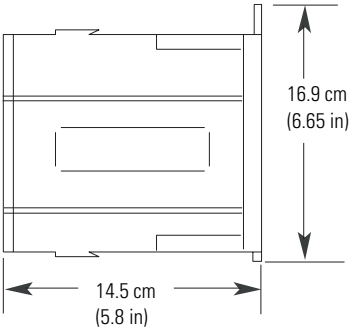
Use Mounting Dimensions

Use the dimension shown below to mount your chassis.

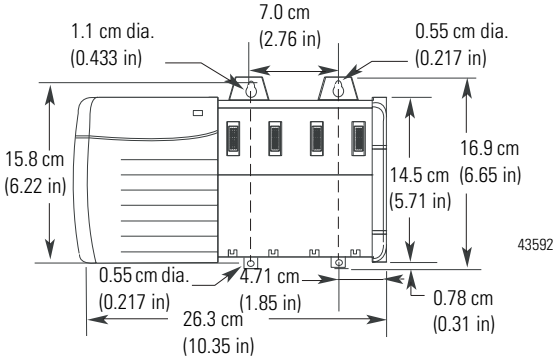
IMPORTANT The Series B Chassis is compatible with the 1756-PA72, -PB72, -PA75, -PB75, -PA75R and -PB75R power supplies.

Figure 9

Right-side view of all chassis



1756-A4 with power supply installed



1756-A7 with power supply installed

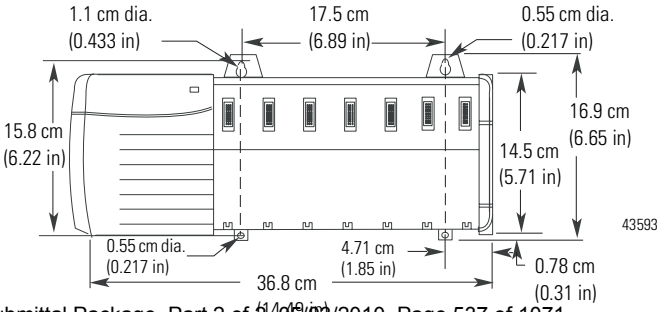


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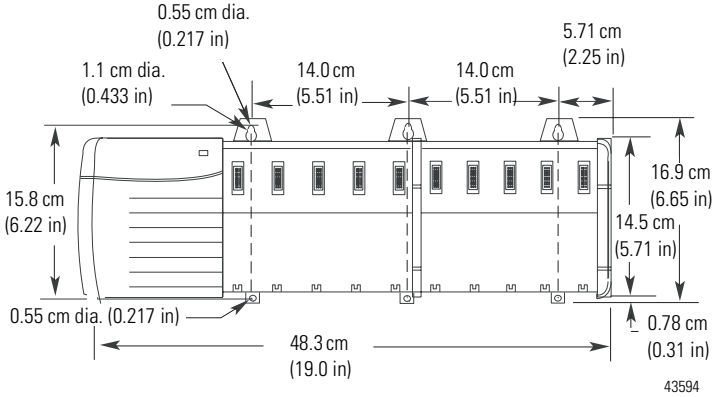
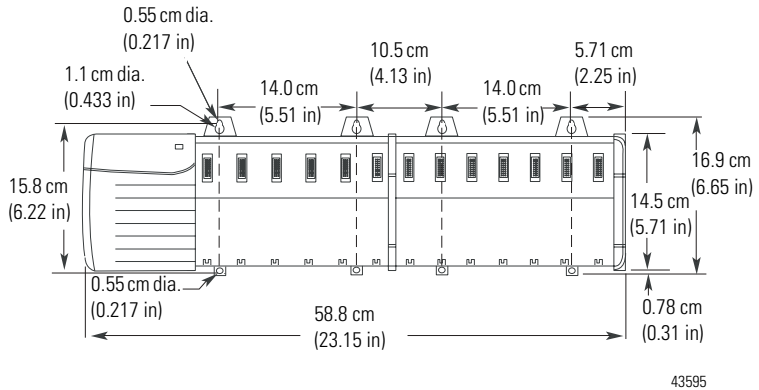
Figure 10

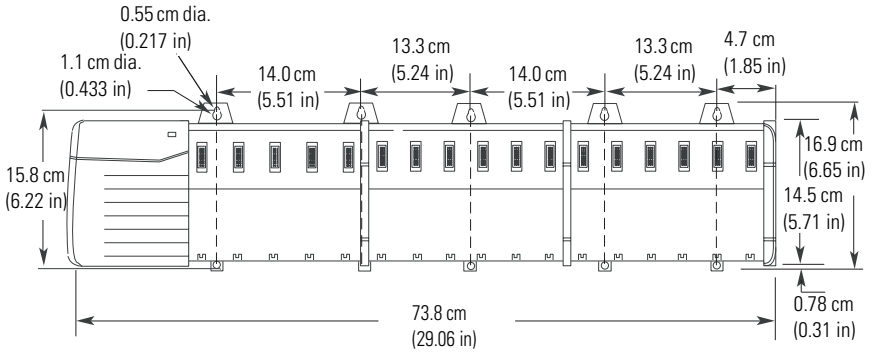
1756-A10 with power supply installed



1756-A13 with power supply installed



1756-A17 with power supply installed



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Specifications

	1756-A4	**1756-A7**	**1756-A10**
dimensions (with tabs) W x H x D	26.3 x 16.9 x 14.5 cm (10.35 x 6.65 x 5.71 in)	36.8 x 16.9 x 14.5 cm (14.49 x 6.65 x 5.71 in)	48.3 x 16.9 x 14.5 cm (19.0 x 6.65 x 5.71 in)
	1756-A13	**1756-A17**	
	58.8 x 16.9 x 14.5 cm (23.15 x 6.65 x 5.71 in)	73.8 x 16.9 x 14.5 cm (29.06 x 6.65 x 5.71 in)	
	1756-A4	**1756-A7**	**1756-A10**
minimum cabinet size W x H x D	50.7 x 50.7 x 20.3 cm (20 x 20 x 8 in)	50.7 x 70 x 20.3 cm (20 x 24 x 8 in)	76.2 x 50.7 x 20.3 cm (30 x 20 x 8 in)
	1756-A13	**1756-A17**	
	76.2 x 70 x 20.3 cm (30 x 24 x 8 in)	82.2 x 76.2 x 20.3 cm (36 x 30 x 8 in)	
	1756-A4	**1756-A7**	**1756-A10**
approximate weight (without modules)	0.75 kg (1.7 lbs)	1.1 kg (2.4 lbs)	1.45 kg (3.2 lbs)
	1756-A13	**1756-A17**	
	1.9 kg (4.2 lbs)	2.2 kg (4.8 lbs)	
module slots	**1756-A4**	**1756-A7**	**1756-A10**
	4	7	10
	1756-A13	**1756-A17**	
	13	17	
maximum backplane current (All chassis)		chassis/slot	
	5.1V dc	15 A/6 A	
	24V dc	2.8 A/2.8 A	
	3.3V dc	4 A/4 A	
type of mount (All chassis)	panel mount		
Environmental Conditions			
Operational Temperature	IEC 60068-2-1 (Test Ad, Operating Cold), IEC 60068-2-2 (Test Bd, Operating Dry Heat), IEC 60068-2-14 (Test Nb, Operating Thermal Shock): 0 to 60°C (32 to 140°F)		
Storage Temperature	IEC 60068-2-1 (Test Ab, Un-packaged Non-operating Cold), IEC 60068-2-2 (Test Bb, Un-packaged Non-operating Dry Heat), IEC 60068-2-14 (Test Na, Un-packaged Non-operating Thermal Shock): -40 to 85°C (-40 to 185°F)		

	Relative Humidity	IEC 60068-2-30 (Test Db, Un-packaged Non-operating Damp Heat): 5 to 95% non-condensing
	Vibration	IEC 60068-2-6 (Test Fc, Operating): 5g @ 10-500Hz
	Operating Shock	IEC 60068-2-27 (Test Ea, Unpackaged Shock): 30g
	Non-operating Shock	IEC 60068-2-27 (Test Ea, Unpackaged Shock): 50g
	Emissions	CISPR 11: Group 1, Class A
	ESD Immunity	IEC 61000-4-2: 6kV contact discharges 8kV air discharges
	Radiated RF Immunity	IEC 61000-4-3: 10V/m with 1kHz sine-wave 80%AM from 30MHz to 2000MHz 10V/m with 200Hz 50% Pulse 100%AM at 900Mhz 10V/m with 200Hz 50% Pulse 100%AM at 1890Mhz
	EFT/B Immunity	IEC 61000-4-4: ±4kV at 2.5kHz on power ports
	Conducted RF Immunity	IEC 61000-4-6: 10Vrms with 1kHz sine-wave 80%AM from 150kHz to 80MHz
	Enclosure Type Rating	None (open-style)
Certifications: (when product is marked)	UL	UL Listed Industrial Control Equipment
	CSA	CSA Certified Process Control Equipment
	CSA	CSA Certified Process Control Equipment for Class I, Division 2 Group A,B,C,D Hazardous Locations
	FM	FM Approved Equipment
	CE(1)	European Union 89/336/EEC EMC Directive, compliant with: EN 50082-2; Industrial Immunity EN 61326; Meas./Control/Lab., Industrial Requirements EN 61000-6-2; Industrial Immunity EN 61000-6-4; Industrial Emissions
	C-Tick(1)	Australian Radiocommunications Act, compliant with: AS/NZS CISPR 11; Industrial Emissions
	EEx(1)	European Union 94/9/EC ATEX Directive, compliant with: EN 50021; Potentially Explosive Atmospheres, Protection "n" (Zone 2)

(1) See the Product Certification link at www.ab.com for Declarations of Conformity, Certificates, and other certification details.

Rockwell Automation Support

Rockwell Automation provides technical information on the web to assist you in using our products. At http://support.rockwellautomation.com, you can find technical manuals, a knowledge base of FAQs, technical and application notes, sample code and links to software service packs, and a MySupport feature that you can customize to make the best use of these tools.

For an additional level of technical phone support for installation, configuration and troubleshooting, we offer TechConnect Support programs. For more information, contact your local distributor or Rockwell Automation representative, or visit http://support.rockwellautomation.com.

Installation Assistance

If you experience a problem with a hardware module within the first 24 hours of installation, please review the information that's contained in this manual. You can also contact a special Customer Support number for initial help in getting your module up and running:

United States	1.440.646.3223 Monday – Friday, 8am – 5pm EST
Outside United States	Please contact your local Rockwell Automation representative for any technical support issues.

New Product Satisfaction Return

Rockwell tests all of our products to ensure that they are fully operational when shipped from the manufacturing facility. However, if your product is not functioning and needs to be returned:

United States	Contact your distributor. You must provide a Customer Support case number (see phone number above to obtain one) to your distributor in order to complete the return process.
Outside United States	Please contact your local Rockwell Automation representative for return procedure.

www.rockwellautomation.com

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Power Supply, 1756-PA72

Installation Instructions

ControlLogix Power Supplies

Catalog Numbers 1756-PA72 Series C, 1756-PB72 Series C, 1756-PA75 Series B, 1756-PB75 Series B, 1756-PH75 Series B, 1756-PC75 Series B

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About the Power Supplies

ControlLogix power supplies are used with the 1756 chassis to provide 1.2V, 3.3V, 5V, and 24V DC power for all modules installed in the chassis. The non-redundant power supplies are mounted on the left end of the chassis, where they are plugged directly into the backplane.

Important User Information

Solid state equipment has operational characteristics differing from those of electromechanical equipment. Safety Guidelines for the Application, Installation and Maintenance of Solid State Controls (Publication SGI-1.1 available from your local Rockwell Automation sales office or online at http://literature.rockwellautomation.com) describes some important differences between solid state equipment and hard-wired electromechanical devices. Because of this difference, and also because of the wide variety of uses for solid state equipment, all persons responsible for applying this equipment must satisfy themselves that each intended application of this equipment is acceptable.

In no event will Rockwell Automation, Inc. be responsible or liable for indirect or consequential damages resulting from the use or application of this equipment.

The examples and diagrams in this manual are included solely for illustrative purposes. Because of the many variables and requirements associated with any particular installation, Rockwell Automation, Inc. cannot assume responsibility or liability for actual use based on the examples and diagrams.

No patent liability is assumed by Rockwell Automation, Inc. with respect to use of information, circuits, equipment, or software described in this manual.

Reproduction of the contents of this manual, in whole or in part, without written permission of Rockwell Automation, Inc., is prohibited.

Throughout this manual, when necessary, we use notes to make you aware of safety considerations.

WARNING	Identifies information about practices or circumstances that can cause an explosion in a hazardous environment, which may lead to personal injury or death, property damage, or economic loss.
IMPORTANT	Identifies information that is critical for successful application and understanding of the product.
ATTENTION	Identifies information about practices or circumstances that can lead to personal injury or death, property damage, or economic loss. Attentions help you identify a hazard, avoid a hazard and recognize the consequences.
SHOCK HAZARD	Labels may be on or inside the equipment (for example, drive or motor) to alert people that dangerous voltage may be present.
BURN HAZARD	Labels may be on or inside the equipment (for example, drive or motor) to alert people that surfaces may reach dangerous temperatures.

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Environment and Enclosure

ATTENTION

This equipment is intended for use in a Pollution Degree 2 industrial environment, in overvoltage Category II applications (as defined in IEC publication 60664-1), at altitudes up to 2000 m (6562 ft) without derating.

This equipment is considered Group 1, Class A industrial equipment according to IEC/CISPR Publication 11. Without appropriate precautions, there may be potential difficulties ensuring electromagnetic compatibility in other environments due to conducted as well as radiated disturbance.

This equipment is supplied as open-type equipment. It must be mounted within an enclosure that is suitably designed for those specific environmental conditions that will be present and appropriately designed to prevent personal injury resulting from accessibility to live parts. The enclosure must have suitable flame-retardant properties to prevent or minimize the spread of flame, complying with a flame spread rating of 5VA, V2, V1, V0 (or equivalent) if non-metallic. The interior of the enclosure must be accessible only by the use of a tool. Subsequent sections of this publication may contain additional information regarding specific enclosure type ratings that are required to comply with certain product safety certifications.

In addition to this publication, see:

- Industrial Automation Wiring and Grounding Guidelines, for additional installation requirements, Allen-Bradley publication 1770-4.1.
- NEMA Standards publication 250 and IEC publication 60529, as applicable, for explanations of the degrees of protection provided by different types of enclosure.

Prevent Electrostatic Discharge

ATTENTION

This equipment is sensitive to electrostatic discharge, which can cause internal damage and affect normal operation. Follow these guidelines when you handle this equipment:

- Touch a grounded object to discharge potential static.
- Wear an approved grounding wriststrap.
- Do not touch connectors or pins on component boards.
- Do not touch circuit components inside the equipment.
- Use a static-safe workstation, if available.
- Store the equipment in appropriate static-safe packaging when not in use.

Safety-related Programmable Electronic Systems

ATTENTION

Personnel responsible for the application of safety-related programmable electronic systems (PES) shall be aware of the safety requirements in the application of the system and shall be trained in using the system.

North American Hazardous Location Approval

The following information applies when operating this equipment in hazardous locations.	**Informations sur l'utilisation de cet équipement en environnements dangereux.**
Products marked "CL I, DIV 2, GP A, B, C, D" are suitable for use in Class I Division 2 Groups A, B, C, D, Hazardous Locations and nonhazardous locations only. Each product is supplied with markings on the rating nameplate indicating the hazardous location temperature code. When combining products within a system, the most adverse temperature code (lowest "T" number) may be used to help determine the overall temperature code of the system. Combinations of equipment in your system are subject to investigation by the local Authority Having Jurisdiction at the time of installation.	Les produits marqués "CL I, DIV 2, GP A, B, C, D" ne conviennent qu'à une utilisation en environnements de Classe I Division 2 Groupes A, B, C, D dangereux et non dangereux. Chaque produit est livré avec des marquages sur sa plaque d'identification qui indiquent le code de température pour les environnements dangereux. Lorsque plusieurs produits sont combinés dans un système, le code de température le plus défavorable (code de température le plus faible) peut être utilisé pour déterminer le code de température global du système. Les combinaisons d'équipements dans le système sont sujettes à inspection par les autorités locales qualifiées au moment de l'installation.

WARNING

EXPLOSION HAZARD -

- Do not disconnect equipment unless power has been removed or the area is known to be nonhazardous. Do not disconnect equipment unless power has been removed or the area is known to be nonhazardous.
- Do not disconnect connections to this equipment unless power has been removed or the area is known to be nonhazardous. Secure any external connections that mate to this equipment by using screws, sliding latches, threaded connectors, or other means provided with this product.
- Substitution of components may impair suitability for Class I, Division 2.
- If this product contains batteries, they must only be changed in an area known to be nonhazardous.

AVERTISSEMENT

RISQUE D'EXPLOSION –

- Couper le courant ou s'assurer que l'environnement est classé non dangereux avant de débrancher l'équipement.
- Couper le courant ou s'assurer que l'environnement est classé non dangereux avant de débrancher les connecteurs. Fixer tous les connecteurs externes reliés à cet équipement à l'aide de vis, loquets coulissants, connecteurs filetés ou autres moyens fournis avec ce produit.
- La substitution de composants peut rendre cet équipement inadapté à une utilisation en environnement de Classe I, Division 2.
- S'assurer que l'environnement est classé non dangereux avant de changer les piles.

European Hazardous Location Approval

1756-PB72 Series C, 1756-PB75 Series B (only)

European Zone 2 Certification (The following applies when the product bears the Ex or EEx Marking)

This equipment is intended for use in potentially explosive atmospheres as defined by European Union Directive 94/9/EC and has been found to comply with the Essential Health and Safety Requirements relating to the design and construction of Category 3 equipment intended for use in potentially explosive atmospheres, given in Annex II to this Directive.

Compliance with the Essential Health and Safety Requirements has been assured by compliance with EN 60079-15 and EN 60079-0.

WARNING

- This equipment must be installed in an enclosure providing at least IP54 protection when applied in Zone 2 environments.
- This equipment shall be used within its specified ratings defined by Allen-Bradley.
- Provisions shall be made to prevent the rated voltage from being exceeded by transient disturbances of more than 40% when applied in Zone 2 environments.
- This equipment must be used only with ATEX certified backplanes.
- Secure any external connections that mate to this equipment by using screws, sliding latches, threaded connectors, or other means provided with this product.
- Do not disconnect equipment unless power has been removed or the area is known to be nonhazardous.

ATTENTION

This equipment is not resistant to sunlight or other sources of UV radiation.

Before You Begin

Before you attempt to install a power supply, make sure you have the required tools.

Required Tools

- 1/8” slotted screwdriver
- 1/4” slotted (#2) or Phillips screwdriver
- Torque screwdriver
- Needle-nose pliers
- Crimping tool

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Install the Power Supply

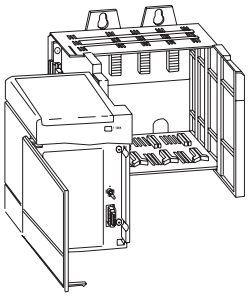
The chassis series you have determines what power supply you can use. The following table lists the chassis that is to be installed with a respective power supply.

Chassis Compatibility

Power Supply Cat. No.	Chassis Cat. No.
1756-PA72 Series C	1756-A4, 1756-A7, 1756-A10, 1756-A13, 1756-A17 Series A, B
1756-PB72 Series C	
1756-PA75 Series B	1756-A4, 1756-A7, 1756-A10, 1756-A13, 1756-A17 Series B only
1756-PB75 Series B	
1756-PC75 Series B	
1756-PH75 Series B	

Follow these steps to install the power supply.

1. Align the power-supply circuit board with the card guides on the left side of the chassis.



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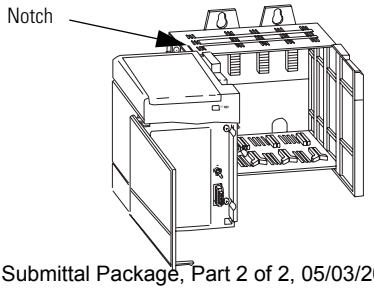
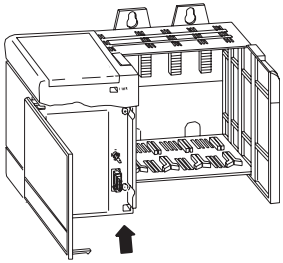
2. Guide the extended tab on the power-supply circuit board into the notch of the chassis.



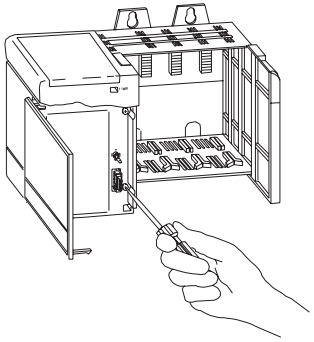
43614

3. Slide the power supply in until it is flush with the back of the chassis.



44144

4. Fasten the power supply to the chassis.

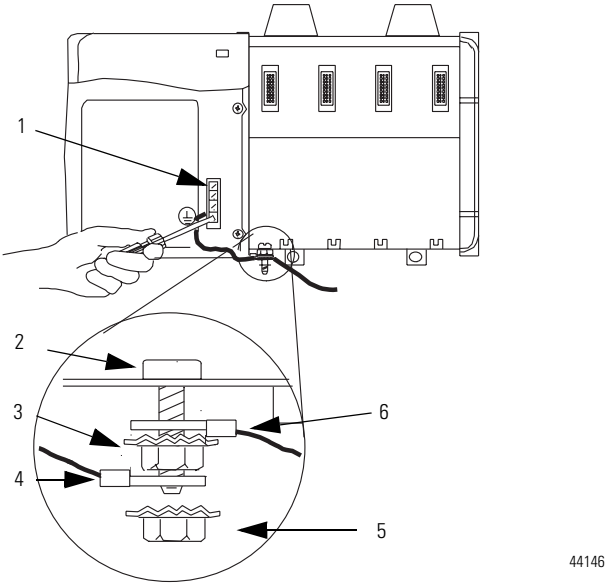


44145

Ground the Power Supply at Protective Earth Ground

The following steps describe how to connect the equipment-protective earth ground from the power supply to the chassis.

1. Connect the equipment-protective earth ground from the power supply to the chassis.
2. Connect the protective-earth ground from the chassis to the system earth ground.
3. Tighten the nut on the equipment-protective earth ground terminal stud to a torque of 1.4 N•m (12 lb•in).

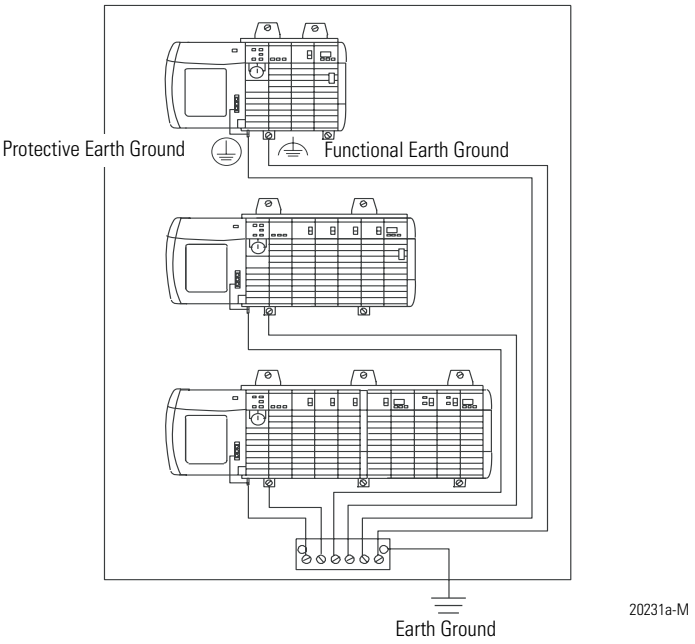


Item	Description
1	Wiring terminal block
2	Protective earth-ground terminal stud
3	Nut with captive star washer
4	Equipment grounding conductor (ground lug with 2.1 mm^2 [14 AWG] wire) protective earth ground from wiring terminal block to chassis
5	Nut with captive star washer
6	Equipment grounding conductor (ground lug with 2.1 mm^2 [14 AWG] wire) protective earth ground from chassis to ground bus

Verify the Grounding Configuration

Before continuing, verify that the Protective and Functional Earth grounds are connected to the system. We recommend that you use a ground bus to reduce the electrical resistance at the connection.

TIP Keep wire lengths as short as possible.



For more information on grounding the wiring to the ControlLogix chassis, refer to the ControlLogix Chassis–Series B Installation Instructions, publication 1756-IN080.

Connect the Power

WARNING

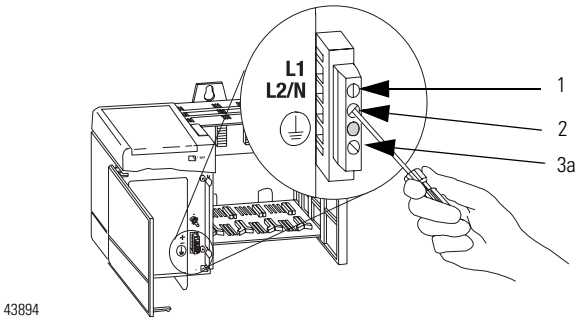
If you connect or disconnect wiring while the field-side power is on, an electrical arc can occur. This could cause an explosion in hazardous location installations. Be sure that power is removed or the area is nonhazardous before proceeding.

Use 2.5 mm^2 (14 AWG) 75 °C (167 °F) copper wire with 1.2 mm (3/64-in.) insulation to connect power. Follow these steps for each wire (high side (L1), low side (L2/N), and ground) to connect power.

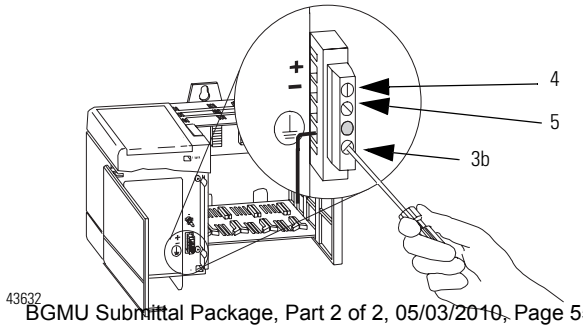
1. Turn the screw counterclockwise to open the wiring terminal.

IMPORTANT The third terminal from the top (between low side and ground) is not used on the 1756 power supplies.

1756-PA72 Series C, 1756-PA75 Series B (AC Power Supplies)



1756-PB72 Series C, 1756-PB75 Series B, 1756-PH75 Series B, 1756-PC75 Series B (DC Power Supplies)



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Power Supply Connections

Item	Description	
1	L1 - High side of line power	AC Power Supplies
2	L2/N- Low side of line power	
3 a	Protective earth-ground terminal	
3 b	Protective earth-ground terminal	DC Power Supplies
4	DC +	
5	DC -	

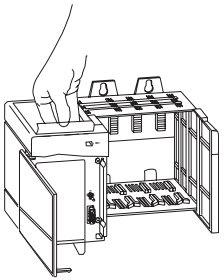
2. Insert the wire into the terminal.
3. Turn the screw clockwise to tighten the terminal on the wire.
4. Tighten the terminals to a torque of 0.8 N•m (7 lb•in).

Remove the Protective Label

ATTENTION

Make sure the chassis is mounted and all panel fabrication is complete before you remove the protective label. This label protects the power supply from metal shavings falling inside the power supply and damaging it during operation.

Remove the plastic label from the top of the power supply.



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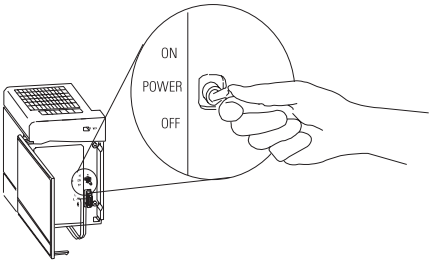
Activate the Power Supply

Flip the power switch to the up position to turn the power supply on.

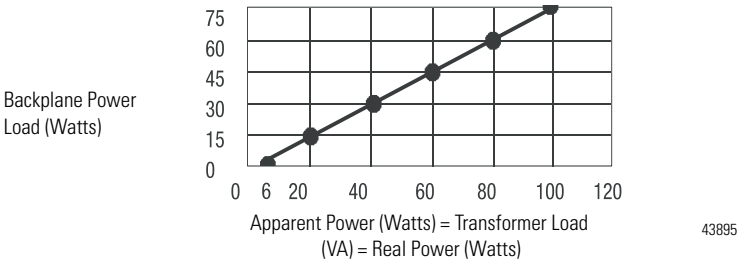


Determine the Input Power Requirements/Transformer Sizing

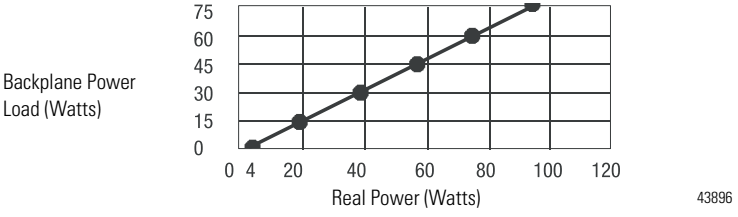
These graphs show the input power requirements for the power supplies, given the power they are providing to the modules in the chassis.

The vertical axis of each graph shows the backplane power consumed by all of the modules in the chassis; the horizontal axis shows input power requirements of the power supply.

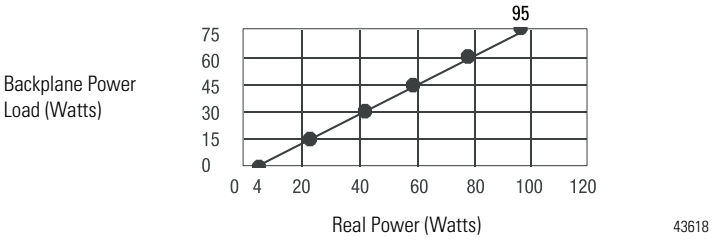
1756-PA72 Series C, 1756-PA75 Series B (AC)



1756-PB72 Series C, 1756-PB75 Series B (DC)



1756-PH75 Series B, 1756-PC75 Series B



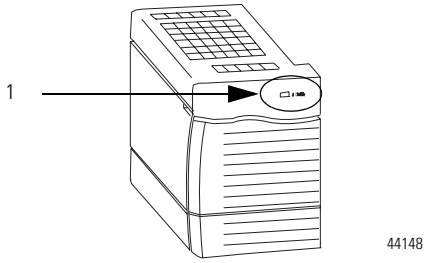
To use the graphs, complete this procedure.

1. Add all of the backplane power, that is, Watts, for all of the modules in the chassis.
2. Find the number from step 1 on the vertical axis.
3. Follow that value to the right until it intersects the line on the graph.
4. Find the associated input-power rating consumed by the power supply on the horizontal axis.

For example, if the power consumption of all of the modules in the chassis is 30 Watts, a 1756-PH75 series B power supply consumes approximately 42 Watts of Real Power.

Status Indicators

ControlLogix power supplies have a green status indicator that remains ON during normal operation.



Item	Description
1	Status indicator

If the indicator turns OFF during operation, follow these steps.

1. Verify that the line voltage is within the specified range.
2. If the indicator remains OFF, cycle line power OFF.
3. Loosen the screws holding the power supply to the chassis.

   See page 7 for the location of the screws on the power supply.
4. Slide the power supply out so that the rear connector is disconnected.
5. Reapply input power.
6. If the indicator:
   - turns ON:
     a. Verify that the module loads in the system are within the output rating of the power supply.
     b. Power down the power supply.
     c. Reinstall the power supply in the chassis.
   - turns OFF, return the power supply to your local Rockwell Automation distributor.

Specifications

AC Power Supplies

1756-PA72 Series C, 1756-PA75 Series B - Technical Specifications

Attribute	1756-PA72 Series C	1756-PA75 Series B
Dimensions (HxWxD), approx.	140 x 112 x 145 mm (5.5 x 4.4 x 5.7 in.)	
Weight, approx.	0.95 kg (2.10 lb)	
Module location	Left side of 1756 chassis	
Chassis	1756-A4, 1756-A7, 1756-A10, 1756-A13, 1756-A17	
Chassis compatibility	Series A Series B	Series B
Input voltage range	85…265V AC	
Input voltage, nom	120/240V AC	
Input frequency range	47…63 Hz	
Apparent input power	100VA	
Input power, max	100VA 100 W	
Output power, max(1)	75 W @ 60 °C (140 °F)	
Power dissipation	85.3 BTU/hr	
Power consumption	25 W @ 60 °C (140 °F)	
Hold up time(2)	5 cycles @ 85V AC, 50/60 Hz 6 cycles @ 120V AC, 50/60 Hz 6 cycles @ 200V AC, 50/60 Hz 6 cycles @ 240V AC, 50/60 Hz	
Inrush current, max	20 A	
Current capacity at 1.2V	1.5 A	
Current capacity at 3.3V	4 A	
Current capacity at 5.1V	10 A	13 A
Current capacity at 24V	2.8 A	
Overcurrent protection, max(3)	15 A, user-supplied	
Fusing(4)	Non-replaceable fuse is soldered in place	
Transformer load, max	100VA	
Isolation voltage	250V (continuous), reinforced insulation type Type tested at 3500V DC for 60 s, Power Input to Backplane.	
Wire size	2.5 mm^2 (14 AWG) solid or stranded copper wire rated at 75 °C (167 °F), or greater, 1.2 mm (3/64 in.) insulation max	

1756-PA72 Series C, 1756-PA75 Series B - Technical Specifications

Attribute	1756-PA72 Series C	1756-PA75 Series B
Wire category	1[5] on power ports	
North American temp code	T4	
Mounting screw torque	0.8 N•m (7 lb•in)	

(1) The combination of all output power (1.2V, 3.3V, 5.1V, and 24V) cannot exceed 75 W.

(2) The hold up time is all the time between input voltage removal and DC power failure.

(3) Use time-delay type overcurrent protection in all ungrounded conductors.

(4) This fuse is intended to guard against fire hazard due to short circuit conditions.

(5) Use this Conductor Category information for planning conductor routing. Refer to Industrial Automation Wiring and Grounding Guidelines, publication 1770-4.1.

1756-PA72 Series C, 1756-PA75 Series B - Environmental Specifications

Attribute	1756-PA72 Series C	1756-PA75 Series B
Operating temperature IEC 60068-2-1 (Test Ad, Operating Cold) IEC 60068-2-2 (Test Bd, Operating Dry Heat) IEC 60068-2-14 (Test Nb, Operating Thermal Shock)	0…60 °C (32…140 °F)	
Nonoperating temperature IEC 60068-2-1 (Test Ab, Unpackaged Nonoperating Cold) IEC 60068-2-2 (Test Bb, Unpackaged Nonoperating Dry Heat) IEC 60068-2-14 (Test Na, Unpackaged Nonoperating Thermal Shock)	-40…85 °C (-40…185 °F)	
Relative humidity IEC 60068-2-30 (Test Db, Unpackaged Nonoperating Damp Heat)	5…95% noncondensing	
Vibration IEC 60068-2-6 (Test Fc, Operating)	2 g @ 10…500 Hz	
Operating shock IEC 60068-2-27 (Test Ea, Unpackaged Shock)	30 g	
Nonoperating shock IEC 60068-2-27 (Test Ea, Unpackaged Shock)	50 g	
Emissions CISPR 11	Group 1, Class A	
ESD immunity IEC 61000-4-2	6 kV contact discharges 8 kV air discharges	

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1756-PA72 Series C, 1756-PA75 Series B - Environmental Specifications

Attribute	1756-PA72 Series C	1756-PA75 Series B
Radiated RF immunity IEC 61000-4-3	10V/m with 1 kHz sine-wave 80% AM from 80…2000 MHz 10V/m with 200 Hz 50% Pulse 100% AM at 900 MHz 10V/m with 200 Hz 50% Pulse 100% AM at 1890 MHz 3V/m with 1 kHz sine-wave 80% AM from 2000…2700 MHz	
Conducted RF immunity IEC 6100-4-6	10V rms with 1 kHz sine-wave 80% AM from 150 kHz…80 MHz	
EFT/B immunity IEC 61000-4-4	±4 kV at 5 kHz on power ports	
Surge transient immunity IEC 61000-4-5	±1 kV line-line (DM) and ±2 kV line-earth (CM) on power ports	
Oscillatory surge withstand IEEE C37.90.1	3 kV	
Enclosure type rating	None (open style)	
Voltage variation IEC 61000-4-11	30% dips for 1 period at 0° and 80° on AC supply ports 60% dips for 5 and 50 periods on AC supply ports ±10% fluctuations for 15 min on AC supply ports >95% interruptions for 250 periods on AC supply ports	

1756-PA72 Series C, 1756-PA75 Series B - Certifications(1)

Certifications(2)	1756-PA72 Series C	1756-PA75 Series B
UL	UL Listed Industrial Control Equipment. See UL File E65584	
CSA	Certified Process Control Equipment. See CSA File LR54689C	
CSA	Certified Process Control Equipment for Class I, Division 2 Group A,B,C,D Hazardous Locations. See CSA File LR69960C	
FM	Approved Equipment for use in Class 1 Division 2 Group A,B,C,D Hazardous Locations	
CE	European Union 2004/108/EC EMC Directive, compliant with: EN 61326-1; Meas./Control/Lab., Industrial Requirements EN61000-6-2; Industrial Immunity EN61000-6-4; Industrial Emissions EN61131-2; Programmable Controllers (Clause 8, Zone A,B, C) European Union 2006/95/EC LVD, complaint with: EN 61131-2; Programmable Controllers (Clause 11)	
C-Tick	Australian Radio Communications Act, compliant with: AS/NZS CISPR 11; Industrial Emissions	
TÜV	TÜV Certified for Functional Safety: up to and including SIL 2 **(1756-PA75 only)**	

(1) When product is marked.

(2) See the Product Certification link at http://www.ab.com for Declarations of Conformity, Certificates, and other certification details.

DC Power Supplies

1756-PB72 Series C, 1756-PB75 Series B, 1756-PC75 Series B, 1756-PH75 Series B - Technical Specifications

Attribute	1756-PB72 Series C	1756-PB75 Series B	1756-PC75 Series B	1756-PH75 Series B
Dimensions (HxWxD), approx.	140 x 112 x 145 mm (5.5 x 4.4 x 5.7 in.)			
Weight, approx.	0.95 kg (2.10 lb)			
Module location	Left side of 1756 chassis			
Chassis	1756-A4, 1756-A7, 1756-A10, 1756-A13, 1756-A17			
Chassis compatibility	Series A Series B	Series B		
Input voltage range	18…32V DC[1]		30…60V DC	90…143V DC
Input voltage, nom	24V DC		48V DC	125V DC
Input power, max	95 W			
Output power, max	75 W @ 60 °C (140 °F)[2]			
Power dissipation	68.2 BTU/hr			
Power consumption	20 W @ 60 °C (140 °F)			
Hold up time	35 ms @ 18V DC[3] 40 ms @ 24V DC 40 ms @ 32V DC		50 ms @ 30…60V DC[3]	50 ms @ 30…143V DC[3]
Inrush current, max	30 A		20 A	
Current capacity at 1.2V	1.5 A			
Current capacity at 3.3V	4 A			
Current capacity at 5.1V	10 A	13 A		
Current capacity at 24V	2.8 A			
User-supplied overcurrent protection, max	15 A[4]			
Fusing	Non-replaceable fuse is soldered in place[5]			
Isolation voltage	250V (continuous), reinforced insulation type Type tested at 3500V DC for 60 s, power input to backplane			
Wire category	1[6] on power ports			
Wire size	2.5 mm^2 (14 AWG) solid or stranded copper wire rated at 75 ° C (167 °F), or greater, 1.2 mm (3/64 in.) insulation max			

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1756-PB72 Series C, 1756-PB75 Series B, 1756-PC75 Series B, 1756-PH75 Series B - Technical Specifications

Attribute	1756-PB72 Series C	1756-PB75 Series B	1756-PC75 Series B	1756-PH75 Series B
North American temp code	T4			
IEC temp code	T4		N/A	
Mounting screw torque	0.8 N•m (7 lb•in)			

(1) Input may drop to 16V for a maximum of two minutes each hour for motor starting.

(2) The combination of all output power (1.2V, 3.3V, 5.1V, and 24V) cannot exceed 75 W.

(3) The hold up time is the time between input voltage removal and DC power failure.

(4) Use time-delay type overcurrent protection in all ungrounded conductors.

(5) This fuse is intended to guard against fire hazard due to short circuit conditions.

(6) Use this Conductor Category information for planning conductor routing. Refer to Industrial Automation Wiring and Grounding Guidelines, publication 1770-4.1.

1756-PB72 Series C, 1756-PB75 Series B, 1756-PC75 Series B, 1756-PH75 Series B - Environmental Specifications

Attribute	1756-PB72 Series C	1756-PB75 Series B	1756-PC75 Series B	1756-PH75 Series B
Operating temperature IEC 60068-2-1 (Test Ad, Operating Cold) IEC 60068-2-2 (Test Bd, Operating Dry Heat) IEC 60068-2-14 (Test Nb, Operating Thermal Shock)	0…60 °C (32…140 °F)			

1756-PB72 Series C, 1756-PB75 Series B, 1756-PC75 Series B, 1756-PH75 Series B - Environmental Specifications

Attribute	1756-PB72 Series C	1756-PB75 Series B	1756-PC75 Series B	1756-PH75 Series B
Nonoperating temperature IEC 60068-2-1 (Test Ab, Unpackaged Nonoperating Cold) IEC 60068-2-2 (Test Bb, Unpackaged Nonoperating Dry Heat) IEC 60068-2-14 (Test Na, Unpackaged Nonoperating Thermal Shock)	-40…85 °C (-40…185 °F)			
Relative humidity IEC 60068-2-30 (Test Db, Unpackaged Nonoperating Damp Heat)	5…95% noncondensing			
Vibration IEC 60068-2-6 (Test Fc, Operating)	2 g @ 10…500 Hz			
Operating shock IEC 60068-2-27 (Test Ea, Unpackaged Shock)	30 g			
Nonoperating shock IEC 60068-2-27 (Test Ea, Unpackaged Shock)	50 g			
ESD immunity IEC 61000-4-2	6 kV contact discharges 8 kV air discharges			
Emissions CISPR 11	Group 1, Class A			

1756-PB72 Series C, 1756-PB75 Series B, 1756-PC75 Series B, 1756-PH75 Series B - Environmental Specifications

Attribute	1756-PB72 Series C	1756-PB75 Series B	1756-PC75 Series B	1756-PH75 Series B
Radiated RF immunity IEC 61000-4-3	10V/m with 1 kHz sine-wave 80% AM from 80…2000 MHz 10V/m with 200 Hz 50% Pulse 100% AM at 900 MHz 10V/m with 200 Hz 50% Pulse 100% AM at 1890 MHz 3V/m with 1 kHz sine-wave 80% AM from 2000…2700 MHz		10V/m with 1 kHz sine-wave 80% AM from 80…2000 MHz 10V/m with 200 Hz 50% Pulse 100% AM at 900 MHz 10V/m with 200 Hz 50% Pulse 100% AM at 1890 MHz 1V/m with 1 kHz sine-wave 80% from 2000…2700 MHz	
Conducted RF immunity IEC 6100-4-6	10V rms with 1 kHz sine-wave 80% AM from 150 kHz…80 MHz			
EFT/B immunity IEC 61000-4-4	±4 kV at 5 kHz on power ports			
Surge transient immunity IEC 61000-4-5	±1 kV line-line (DM) and ±2 kV line-earth (CM) on power ports			
Oscillatory surge withstand IEEE C37.90.1	N/A		3 kV	
Enclosure type rating	None (open style)			
Voltage variation IEC 61000-4-11 IEC 61000-4-29	60% dips for 100 ms on DC supply ports 100% dips for 50 ms on DC supply ports ±20% fluctuations for 15 min on DC supply ports 5 s interruptions on DC supply ports 10 ms interruption on DC supply ports			

1756-PB72 Series C, 1756-PB75 Series B - Certifications[1]

Certifications[2]	1756-PB72 Series C	1756-PB75 Series B
c-UL-us	UL Listed Industrial Control Equipment, certified for US and Canada, See File E65584	
c-UL-us	UL Listed for Class 1, Division 2 Group A,B,C,D Hazardous Locations, certified for U.S. and Canada. See UL File E194810	
CSA	CSA Certified Process Control Equipment. See CSA File LR54689C	
CSA	CSA Certified Process Control Equipment for Class I, Division 2 Group A,B,C,D Hazardous Locations. See CSA File LR69960C	
FM	FM Approved Equipment for use in Class 1 Division 2 Group A, B, C, D Hazardous Locations	

1756-PB72 Series C, 1756-PB75 Series B - Certifications[1]

Certifications[2]	1756-PB72 Series C	1756-PB75 Series B
CE	European Union 2004/108/EC EMC Directive, compliant with: EN 61326-1; Meas./Control/Lab., Industrial Requirements EN 61000-6-2; Industrial Immunity EN 61000-6-4; Industrial Emissions EN61131-2; Programmable Controllers (Clause 8, Zone A, B, & C) European Union 2006/95/EC LVD, compliant with: EN 61131-2; Programmable Controllers (Clause 11)	
C-Tick	Australian Radio Communications Act, compliant with: AS/NZS CISPR 11; Industrial Emissions	
Ex	European Union 94/9/EC ATEX Directive, compliant with: EN 60079-15; Potentially Explosive Atmospheres, Protection "n" (II 3 G Ex nA IIC T4 X) EN 60079-0; General Requirements (Zone 2)	
TÜV	TÜV Certified for Functional Safety: up to and including SIL 2 **(1756-PB75 only)**	

(1) When product is marked.

(2) See the Product Certification link at http://www.ab.com for Declarations of Conformity, Certificates, and other certification details.

1756-PC75 Series B, 1756-PH75 Series B - Certifications[1]

Certifications[2]	1756-PC75 Series B	1756-PH75 Series B
UL	UL Listed Industrial Control Equipment. See UL File E65584	
CSA	CSA Certified Process Control Equipment. See CSA File LR54689C	
CSA	CSA Certified Process Control Equipment for Class I, Division 2 Group A,B,C,D Hazardous Locations. See CSA File LR69960C	
CE	European Union 2004/108/EC EMC Directive, compliant with: EN 61326-1; Meas./Control/Lab., Industrial Requirements EN 61000-6-2; Industrial Immunity EN 61000-6-4; Industrial Emissions EN61131-2; Programmable Controllers (Clause 8, Zone A, B, & C) European Union 2006/95/EC LVD, compliant with: EN 61131-2; Programmable Controllers (Clause 11)	
C-Tick	Australian Radio Communications Act, compliant with: AS/NZS CISPR 11; Industrial Emissions	
TÜV	TÜV Certified for Functional Safety: up to and including SIL 2	

(1) When product is marked.

(2) See the Product Certification link at http://www.ab.com for Declarations of Conformity, Certificates, and other certification details.

Additional Resources

These documents contain additional information concerning related Rockwell Automation products.

Resource	Description
1756-A4, 1756-A7, 1756-AI0, 1756-A13, 1756-A17 ControlLogix Chassis Installation Instructions, publication 1756-IN080	Provides information about installing a ControlLogix chassis and technical specifications.
Industrial Automation Wiring and Grounding Guidelines, publication 1770-4.1	Provides general guidelines for installing a Rockwell Automation industrial system.
Product Certifications website, http://www.ab.com	Provides declarations of conformity, certificates, and other certification details.
ControlLogix Selection Guide, publication 1756-SG001	Provides overview of the ControlLogix system and its products.

You can view or download publications at http://literature.rockwellautomation.com. To order paper copies of technical documentation, contact your local Rockwell Automation distributor or sales representative.

Rockwell Automation Support

Rockwell Automation provides technical information on the Web to assist you in using its products. At http://support.rockwellautomation.com, you can find technical manuals, a knowledge base of FAQs, technical and application notes, sample code and links to software service packs, and a MySupport feature that you can customize to make the best use of these tools.

For an additional level of technical phone support for installation, configuration and troubleshooting, we offer TechConnect support programs. For more information, contact your local distributor or Rockwell Automation representative, or visit http://support.rockwellautomation.com.

Installation Assistance

If you experience a problem within the first 24 hours of installation, please review the information that's contained in this manual. You can also contact a special Customer Support number for initial help in getting your product up and running.

United States	1.440.646.3434 Monday – Friday, 8 a.m. – 5 p.m. EST
Outside United States	Please contact your local Rockwell Automation representative for any technical support issues.

New Product Satisfaction Return

Rockwell Automation tests all of its products to ensure that they are fully operational when shipped from the manufacturing facility. However, if your product is not functioning and needs to be returned, follow these procedures.

United States	Contact your distributor. You must provide a Customer Support case number (call the phone number above to obtain one) to your distributor in order to complete the return process.
Outside United States	Please contact your local Rockwell Automation representative for the return procedure.

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www.rockwellautomation.com

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Control Logic Processor, 1756-L61

1756 ControlLogix Controllers Specifications

Controller Catalog Numbers 1756-L61, 1756-L62, 1756-L63, 1756-L64, 1756-L65, 1756-L61S, 1756-L62S, 1756-L63S, 1756-LSP, 1756-L63XT

CompactFlash Card Catalog Numbers 1784-CF64, 1784-CF128

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Environmental Specifications - 1756 Controllers

Attribute	1756-L61, 1756-L62, 1756-L63, 1756-L64, 1756-L65, 1756-L61S, 1756-L62S, 1756-L63S, 1756-LSP
Temperature, operating IEC 60068-2-1 (Test Ad, Operating Cold), IEC 60068-2-2 (Test Bd, Operating Dry Heat), IEC 60068-2-14 (Test Nb, Operating Thermal Shock)	0…60 °C (32…140 °F)
Temperature, storage IEC 60068-2-1 (Test Ab, Unpackaged Nonoperating Cold), IEC 60068-2-2 (Test Bb, Unpackaged Nonoperating Dry Heat), IEC 60068-2-14 (Test Na, Unpackaged Nonoperating Thermal Shock)	-40…85 °C (-40…185 °F)
Relative humidity IEC 60068-2-30 (Test Db, Unpackaged Nonoperating Damp Heat)	5...95% noncondensing
Vibration IEC 60068-2-6 (Test Fc, Operating)	2 g at 10…500 Hz
Shock, operating IEC 60068-2-27 (Test Ea, Unpackaged Shock)	30 g
Shock, nonoperating IEC 60068-2-27 (Test Ea, Unpackaged Shock)	50 g

1756 ControlLogix Controllers

The ControlLogix controller provides a scalable controller solution that is capable of addressing a large amount of I/O points.

The ControlLogix controller can be placed into any slot of a ControlLogix I/O chassis and multiple controllers can be installed in the same chassis. Multiple controllers in the same chassis communicate with each other over the backplane (just as controllers can communicate over networks) but operate independently.

ControlLogix controllers can monitor and control I/O across the ControlLogix backplane, as well as over I/O links. ControlLogix controllers can communicate over EtherNet/IP, ControlNet, DeviceNet, DH+, Remote I/O, and RS-232-C (DF1/DH-485 protocol) networks and many third party process and device networks. To provide communication for a ControlLogix controller, install the appropriate communication interface module into the chassis.

Feature	1756-L61, 1756-L62, 1756-L63, 1756-L64, 1756-L65	
Controller tasks	• 32 tasks • 100 programs/task • Event tasks: all event triggers	
Built-in communication ports	1 port RS-232 serial	
Communication options	• EtherNet/IP • ControlNet • DeviceNet	• Data Highway Plus • Remote I/O • SynchLink • Third party process and device networks
Serial port communication	• ASCII • DF1 full/half-duplex • DF1 radio modem	• DH-485 • Modbus via logic
Controller connections supported, max	250	
Network connections, per network module	• 100 ControlNet (1756-CN2/A) • 40 ControlNet (1756-CNB)	• 256 EtherNet/IP; 128 TCP (1756-EN2*x*) • 128 EtherNet/IP; 64 TCP (1756-ENBT)
Controller redundancy	Full support	
Integrated motion	SERCOS interface	Analog options: • Encoder input • LDT input • SSI input
Programming languages	• Relay ladder • Structured text	• Function block • SFC

Technical Specifications - 1756 ControlLogix Controllers

Attribute	1756-L61	1756-L62	1756-L63	1756-L64	1756-L65
User memory	2 MB	4 MB	8 MB	16 MB	32 MB
I/O memory	478 KB				
Optional flash memory	64 MB (cat. no. 1784-CF64) 128 MB (cat. no. 1784-CF128)				
Digital I/O, max	128,000				
Analog I/O, max	4000				
Total I/O, max	128,000				
Replacement battery	Series A: 1756-BA1, 1756-BATM, 1756-BATA Series B: 1756-BA2	Series A: 1756-BA1, 1756-BATM, 1756-BATA Series B: 1756-BA2	Series A: 1756-BA1, 1756-BATM, 1756-BATA Series B: 1756-BA2	1756-BA2	
Current draw @ 5V DC	1200 mA				
Current draw @ 24V DC	14 mA				
Power dissipation	3.5 W				
Thermal dissipation	11.9 BTU/hr				
Isolation voltage	30V (continuous), Basic Insulation Type, RS-232 to system Controllers tested to withstand 707V DC for 60 s				
Serial cables	1756-CP3 or 1747-CP3, right angle connector to controller, straight to serial port, 3 m				
SIL 2	Use standard ControlLogix controllers				
SIL 3	Use GuardLogix controllers (1756-L61S, 1756-L62S, 1756-L63S) and the Safety Partner (1756-LSP)				
Weight, approx.	Series A: 0.32 kg Series B: 0.35 kg (Series A: 0.71 lb Series B: 0.78 lb)	Series A: 0.32 kg Series B: 0.35 kg (Series A: 0.71 lb Series B: 0.78 lb)	Series A: 0.32 kg Series B: 0.35 kg (Series A: 0.71 lb Series B: 0.78 lb)	Series A: 0.32 kg Series B: 0.35 kg (Series A: 0.71 lb Series B: 0.78 lb)	Series A: 0.32 kg Series B: 0.35 kg (Series A: 0.71 lb Series B: 0.78 lb)
Slot width	1				
Module location	Chassis-based, any slot				
Chassis	1756-A4, 1756-A7, 1756-A10, 1756-A13, 1756-A17				
Power supply, standard	1756-PA72/C, 1756-PA75/B, 1756-PB72/C, 1756-PB75/B, 1756-PC75/B, 1756-PH75/B				
Power supply, redundant	1756-PA75R, 1756-PB75R, 1756-PSCA2				
Wire category	2 - on communication ports[1]				
North American temperature code	T4A				
IEC temperature code	T4	T4	T4	T4	T4
Enclosure type rating	None (open-style)				

[1] Use this conductor category information for planning conductor routing as described in the system level installation manual. See the Industrial Automation Wiring and Grounding Guidelines, publication 1770-4.1.

Certifications - 1756 ControlLogix Controllers

Certification[1]	1756-L61, 1756-L62, 1756-L63, 1756-L64, 1756-L65
c-UL-us	UL Listed Industrial Control Equipment, certified for US and Canada. See UL File E65584. UL Listed for Class I, Division 2 Group A,B,C,D Hazardous Locations, certified for U.S. and Canada. See UL File E194810.
CSA	CSA Certified Process Control Equipment. See CSA File LR54689C. CSA Certified Process Control Equipment for Class I, Division 2 Group A,B,C,D Hazardous Locations. See CSA File LR69960C.
ATEX	European Union 94/9/EC ATEX Directive, compliant with: EN 60079-15; Potentially Explosive Atmospheres, Protection "n" (Zone 2)
CE	European Union 2004/108/IEC EMC Directive, compliant with: • EN 61326-1; Meas./Control/Lab., Industrial Requirements • EN 61000-6-2; Industrial Immunity • EN 61000-6-4; Industrial Emissions • EN 61131-2; Programmable Controllers (Clause 8, Zone A & B)
C-Tick	Australian Radiocommunications Act, compliant with: AS/NZS CISPR 11; Industrial Emissions
FM	FM Approved Equipment for use in Class I Division 2 Group A,B,C,D Hazardous Locations
TÜV	TÜV Certified for Functional Safety: up to and including SIL 2

(1) When marked. See the Product Certification link at http://www.ab.com for Declarations of Conformity, Certificates, and other certification details.

For Australian Mining certification, use a 1756-BA1 battery. For guidelines, see your local distributor or sales office

1756 GuardLogix Controllers

A GuardLogix controller is a ControlLogix controller that also provides safety control. The GuardLogix system is a dual controller solution — you must use a 1756-L6*x*S primary controller and a 1756-LSP safety partner to achieve SIL 3/CAT. 4. A major benefit of this system is that it's still a single project, safety and standard together. The safety partner controller is a part of the system, is automatically configured, and requires no user setup.

During development, safety and standard have the same rules, multiple programmers, online editing, and forcing are all allowed. Once the project is tested and ready for final validation, you set the Safety Task to a SIL 3 integrity level, which is then enforced by the GuardLogix controller. When safety memory is locked and protected, the safety logic can't be modified and all safety functions operate with SIL 3 integrity. On the standard side of the GuardLogix controller, all functions operate like a regular Logix controller. Thus online editing, forcing, and other activities are all allowed.

With this level of integration, safety memory can be read by standard logic and external devices, like HMIs or other controllers, eliminating the need to condition safety memory for use elsewhere. The result is easy system-wide integration and the ability to display safety status on displays or marquees. Use Guard I/O modules for field device connectivity on Ethernet or DeviceNet networks, and for safety interlocking between GuardLogix controllers use Ethernet or ControlNet networks. Multiple GuardLogix controllers can share safety data for zone to zone interlocking, or a single GuardLogix controller can use remote distributed safety I/O between different cells/areas.

1756 GuardLogix Controllers Features

In addition to the standard features of a ControlLogix controller, the GuardLogix controller has these safety-related features.

Feature	1756-L61S, 1756-L62S, 1756-L63S, 1756-LSP	
Safety communication options	Standard and safety • EtherNet/IP • ControlNet • DeviceNet	
Network connections, per network module	• 100 ControlNet (1756-CN2/A) • 40 ControlNet (1756-CNB)	• 256 EtherNet/IP; 128 TCP (1756-EN2*x*) • 128 EtherNet/IP; 64 TCP (1756-ENBT)
Controller redundancy	Not supported	
Programming languages	Relay ladder	

Technical Specifications - 1756 GuardLogix Controllers

Attribute	1756-L61S	1756-L62S	1756-L63S	1756-LSP
User memory	2 MB	4 MB	8 MB	—
Safety memory	1 MB	1 MB	3.75 MB	—
I/O memory	478 KB			—
Optional flash memory[1]	64 MB (cat. no. 1784-CF64) 128 MB (cat. no. 1784-CF128)			—
Digital I/O, max	128,000			—
Analog I/O, max	4000			—
Total I/O, max	128,000			—
Replacement battery	1756-BA2			
Current draw @ 5V DC	1200 mA			
Current draw @ 24V DC	14 mA			
Power dissipation	3.5 W			
Thermal dissipation	11.9 BTU/hr			
Isolation voltage	30V (continuous), Basic Insulation Type, RS-232 to system Controllers tested to withstand 707V DC for 60 s			
Serial cables	1756-CP3 or 1747-CP3, right angle connector to controller, straight to serial port, 3 m			
SIL 2	Use standard ControlLogix controllers			
SIL 3	Use GuardLogix controllers (1756-L61S, 1756-L62S, 1756-L63S) and the Safety Partner (1756-LSP)			
Weight, approx.	0.32 kg (0.70 lb)	0.32 kg (0.70 lb)	0.32 kg (0.70 lb)	0.32 kg (0.70 lb)
Slot width	1			
Module location	Chassis-based, any slot			
Chassis	1756-A4, 1756-A7, 1756-A10, 1756-A13, 1756-A17			
Power supply, standard	1756-PA72/C, 1756-PA75/B, 1756-PB72/C, 1756-PB75/B, 1756-PC75/B, 1756-PH75/B			
Power supply, redundant	1756-PA75R, 1756-PB75R, 1756-PSCA2			
Wire category	2 - on communication ports[2]			
North American temperature code	T4A			
Enclosure type rating	None (open-style)			

[1] The GuardLogix controller does not support user program storage or retrieval by using a CompactFlash card.

[2] Use this conductor category information for planning conductor routing as described in the system level installation manual. See the Industrial Automation Wiring and Grounding Guidelines, publication 1770-4.1.

Certifications - 1756 GuardLogix Controllers

Certification[1]	1756-L61S, 1756-L62S, 1756-L63S, 1756-LSP
UL	UL Certified for Functional Safety up to and including SIL 3, see UL File E256621.[2]
c-UL-us	UL Listed Industrial Control Equipment, certified for US and Canada. See UL File E65584. UL Listed for Class I, Division 2 Group A,B,C,D Hazardous Locations, certified for U.S. and Canada. See UL File E194810.
CSA	CSA Certified Process Control Equipment. See CSA File LR54689C. CSA Certified Process Control Equipment for Class I, Division 2 Group A,B,C,D Hazardous Locations. See CSA File LR69960C.
CE	European Union 2004/108/EC EMC Directive, compliant with: • EN 61000-6-4; Industrial Emissions • EN 61326-1; Meas./Control/Lab., Industrial Requirements • EN 61000-6-2; Industrial Immunity • EN 61131-2; Programmable Controllers (Clause 8, Zone A & B)
C-Tick	Australian Radiocommunications Act, compliant with: AS/NZS CISPR 11; Industrial Emissions
FM	FM Approved Equipment for use in Class I, Division 2 Group A, B, C, D Hazardous Locations
TÜV	Functional Safety: SIL 1 to 3, according to IEC 61508; up to PL(e) according to ISO 13849-1:2006; Category 1 to 4, according to EN954-1; NFPA79; when used as described in the GuardLogix Controller Systems Safety Reference Manual, publication 1756-RM093.

(1) When marked. See the Product Certification link at http://www.ab.com for Declarations of Conformity, Certificates, and other certification details.

(2) When used with specified software versions.

1756 ControlLogix-XT Controllers

The ControlLogix-XT controllers function in the same way as the traditional ControlLogix controllers. The ControlLogix-XT products include control and communication system components that, when used with FLEX I/O-XT products, provide a complete control system solution that can be used in environments where temperatures range from -20...70 °C (-4...158 °F).

When used independently, the ControlLogix-XT system can withstand environments where the temperature ranges from -25...70 °C (-13...158 °F).

Environmental Specifications - 1756-L63XT Controller

Attribute	Value
Temperature, operating IEC 60068-2-1 (Test Ad, Operating Cold), IEC 60068-2-2 (Test Bd, Operating Dry Heat), IEC 60068-2-14 (Test Nb, Operating Thermal Shock)	-25…70 °C (-13…158 °F)
Temperature, storage IEC 60068-2-1 (Test Ab, Unpackaged Nonoperating Cold), IEC 60068-2-2 (Test Bb, Unpackaged Nonoperating Dry Heat), IEC 60068-2-14 (Test Na, Unpackaged Nonoperating Thermal Shock)	-40…85 °C (-40…185 °F)
Relative humidity IEC 60068-2-30 (Test Db, Unpackaged Nonoperating Damp Heat)	5...95% noncondensing
Vibration IEC 60068-2-6 (Test Fc, Operating)	2 g at 10…500 Hz
Shock, operating IEC 60068-2-27 (Test Ea, Unpackaged Shock)	30 g
Shock, nonoperating IEC 60068-2-27 (Test Ea, Unpackaged Shock)	50 g

Technical Specifications - 1756-L63XT Controller

Attribute	1756-L63XT
User memory	8 MB
I/O memory	478 KB
Optional flash memory	64 MB (cat. no. 1784-CF64) 128 MB (cat. no. 1784-CF128)
Digital I/O, max	128,000
Analog I/O, max	4000
Total I/O, max	128,000
Replacement battery	1756-BA2
Current draw @ 5V DC	1200 mA
Current draw @ 24V DC	14 mA
Power dissipation	3.5 W
Thermal dissipation	11.9 BTU/hr
Isolation voltage	30V (continuous), Basic Insulation Type, RS-232 to system Controllers tested to withstand 707V DC for 60 s, RS232 to system

Attribute	1756-L63XT
Serial cables	1756-CP3 or 1747-CP3, right angle connector to controller, straight to serial port, 3 m
SIL 2	Use standard ControlLogix controllers
SIL 3	Use GuardLogix controllers (1756-L61S, 1756-L62S, 1756-L63S) and the Safety Partner (1756-LSP)
Weight, approx.	0.35 kg (0.78 lb)
Slot width	1
Module location	Chassis-based, any slot
Chassis	1756-A5XT, 1756-A7LXT
Power supply, standard	1756-PBXT
Power supply, redundant	None
Wire category	2 - on communication ports[1]
North American temperature code	T4A
IEC temperature code	T4
Enclosure type rating	None (open-style)

[1] Use this conductor category information for planning conductor routing as described in the system level installation manual. See the Industrial Automation Wiring and Grounding Guidelines, publication 1770-4.1.

Certifications - 1756-L63XT Controller

Certification[1]	1756-L63XT
c-UL-us	UL Listed Industrial Control Equipment, certified for US and Canada. See UL File E65584. UL Listed for Class I, Division 2 Group A,B,C,D Hazardous Locations, certified for U.S. and Canada. See UL File E194810.
ATEX	European Union 94/9/EC ATEX Directive, compliant with: EN 60079-15; Potentially Explosive Atmospheres, Protection "n" (Zone 2)
CE	European Union 2004/108/EC EMC Directive, compliant with: • EN 61000-6-4; Industrial Emissions • EN 61326-1; Meas./Control/Lab., Industrial Requirements • EN 61000-6-2; Industrial Immunity • EN 61131-2; Programmable Controllers (Clause 8, Zone A & B)
C-Tick	Australian Radiocommunications Act, compliant with: AS/NZS CISPR 11; Industrial Emissions

[1] When marked. See the Product Certification link at http://www.ab.com for Declarations of Conformity, Certificates, and other certification details.

Controller Memory Use

The following equations provide an estimate of the memory needed for a controller. These numbers are rough estimates.

Controller tasks	_____ * 4000	=	_____ bytes (minimum 1 task)
Digital I/O points	_____ * 400	=	_____ bytes
Analog I/O points	_____ * 2600	=	_____ bytes
DeviceNet modules(1)	_____ * 7400	=	_____ bytes
Other communication modules(2)	_____ * 2000	=	_____ bytes
Motion axis	_____ * 8000	=	_____ bytes
FactoryTalk alarm instruction	_____ * 1000	=	_____ bytes (per alarm)
FactoryTalk subscriber	_____ * 10000	=	_____ bytes

(1) The first DeviceNet module is 7400 bytes. Additional DeviceNet modules are 5800 bytes each.

(2) Count all the communication modules in the system, not just those in the local chassis. This includes device connection modules, adapter modules, and ports on PanelView terminals.

For redundant controller systems, double the memory estimate you calculate. For example, if you estimate you need 2 MB of memory, select a controller with 4 MB of memory.

Reserve 20...30% of the controller memory to accommodate growth.

Controller Compatibility

Control Distributed I/O Modules

The controller can control these distributed I/O modules via the I/O Configuration tree in RSLogix 5000 programming software.

I/O Modules	EtherNet/IP	ControlNet	DeviceNet	Remote I/O
Chassis-based I/O				
1746 SLC I/O	No	No	No	Yes
1756 ControlLogix I/O	Yes	Yes	No	No
1769 Compact I/O	No	No	Yes	No
1771 Universal I/O	No	Yes	No	Yes
In-Cabinet I/O				
1734 POINT I/O	Yes	Yes	Yes	No
1734D POINTBlock I/O	No	No	Yes	No
1790, 1790D, 1790P CompactBlock LDX I/O	No	No	Yes	No
1791D, 1791P, 1791R CompactBlock I/O	No	No	Yes	No
1794 FLEX I/O	Yes	Yes	Yes	Yes
1797 FLEX Ex I/O	No	Yes	No	No
On-Machine I/O				
1732 ArmorBlock I/O	Yes	No	Yes	No
1738 ArmorPoint I/O	Yes	Yes	Yes	No
1792D ArmorBlock MaXum I/O	No	No	Yes	No
1799 Embedded I/O	No	No	Yes	No

Control Safety I/O Modules

The GuardLogix controller can control these safety I/O modules in a safety system.

I/O Modules	EtherNet/IP	ControlNet	DeviceNet
In-Cabinet I/O			
1791DS CompactBlock Guard I/O	No	No	Yes
1791ES CompactBlock Guard I/O	Yes	No	No
1734 Point Guard I/O	Yes	No	No
On-Machine I/O			
1732DS ArmorBlock Guard I/O	No	No	Yes

Communicate with Display Devices

The controller can communicate with these display devices.

Display Devices	EtherNet/IP	ControlNet	DeviceNet	DH+	Remote I/O	RS-232 (DF1)	DH-485
Industrial Computers							
Rockwell Automation industrial computers (all)[1]	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Graphic Terminals							
PanelView Plus and PanelView CE terminals	Yes	Yes	Yes	Yes	Yes	Yes	Yes
PanelView Standard terminals	Yes	Yes	Yes	Yes	Yes	Yes	Yes
PanelView "e" terminals	No	Yes	No	Yes	Yes	No	No
Message Displays							
InView message displays	Yes	Yes	Yes	Yes	Yes	Yes	Yes

(1) Includes: Rockwell Automation integrated display rotating media (HDD) and solid state (SSD) computers, Rockwell Automation non-display computers, and Rockwell Automation integrated display computers with keypad.

Communicate with Other Controllers

The controller can communicate with these programmable controllers.

Controller	EtherNet/IP	ControlNet	DeviceNet	DH+	RS-232 (DF1)	DH-485[1]
1756 ControlLogix, 1756 GuardLogix	Yes	Yes	Yes	Yes	Yes	Yes
1768, 1769 CompactLogix	Yes	Yes	Yes	No	Yes	Yes
1789 SoftLogix5800	Yes	Yes	Yes	No	Yes	No
1794 FlexLogix	Yes	Yes	Yes	No	Yes	Yes
PowerFlex with DriveLogix	Yes	Yes	Yes	No	Yes	Yes
1785 PLC-5	Yes[2] [3]	Yes	Yes[4]	Yes	Yes	—
1747 SLC	Yes[5]	Yes	Yes[4]	Yes	Yes	Yes
1761 MicroLogix	Yes	No	Yes[4]	No	Yes	Yes
1762 MicroLogix	Yes	No	Yes[4]	No	Yes	Yes
1763 MicroLogix	Yes	No	Yes[4]	No	Yes	Yes
1764 MicroLogix	Yes	No	Yes[4]	No	Yes	Yes
1772 PLC-2	—	—	—	Yes	Yes	—
1775 PLC-3	—	—	—	Yes	Yes	—
5250 PLC-5/250	—	—	No	Yes	Yes	—

(1) The 1756-DH485 module supports full DH-485 functionality.

(2) The Ethernet PLC-5 controller must be series C, firmware revision N.1 or later; series D, firmware revision E.1 or later; or series E, firmware revision D.1 or later.

(3) The 1785-ENET Ethernet communication interface module must be series A, firmware revision D or later.

(4) The PLC-5, SLC, and MicroLogix processors appear as I/O points to the Logix controller. Use the appropriate DeviceNet interface for the controller.

(5) Use a 1747-L55*x* controller with OS501 or greater.

Communicate with Other Communication Devices

The controller can communicate with these communication devices.

Communication Device	EtherNet/IP	ControlNet	DeviceNet	DH+
Linking device (ControlLogix controllers only)	1788-EN2DN	1788-CN2DN 1788-CN2FF	1788-EN2DN 1788-CN2DN	—
PCMCIA card	—	1784-PCC	1784-PCD	1784-PCMK
PCI card	—	1784-PCIC 1784-PCICS	1784-PCID 1784-PCIDS 1784-CPCIDS	—
Drives SCANport module	—	1203-FM1 1203-FB1[1]	—	—
Communication module	—	1203-CN[2] 1770-KFC15 1770-KFCD15 1747-KFC15	1770-KFD 1770-KFG	—
Communication card	—	1784-PKTCS 1784-KTCS 1784-KTCX15	1784-PKTX 1784-PKTXD	—
USB communication device	—	1784-U2CN	1784-U2DN	1784-U2DHP

[1] Use a CIP generic MSG instruction to communicate with the 1203-FM1 SCANport module on a DIN rail that is remote to the controller. The remote DIN rail also requires a 1794-ACN15 or 1794ACNR15 ControlNet adapter module.

[2] Use the generic module configuration to configure the 1203-CN1 module and a CIP generic MSG instruction to communicate with the module.

Redundancy

The ControlLogix controller supports controller redundancy. In a redundant controller system, you need these components:

- Two 1756 chassis each with the same:
  - number of slots.
  - modules in the same slots.
  - redundancy firmware revisions in each module.
  - Two additional ControlNet nodes outside the redundant chassis pair.

You need **one** of the following redundancy modules:

- One 1756-RM module per chassis, which supports:
  - two 1756-L61, 1756-L62, 1761-L63 controllers or one 1756-L64 controller.
  - maximum of seven communication modules, which can be 1756-CN2 series B, 1756-CN2R series B, and 1756-EN2T modules.
  - one 1756-RMC*x* cable.
- One 1757-SRM module per chassis, which supports:
  - one 1756-L61, 1756-L62, 1756-L63, 1756-L64 controller
  - maximum of seven communication modules, which can be 1756-CNB series D or E, 1756-CNBR series D or E, 1756-ENBT, and 1756-EWEB modules
  - one 1757-SRC*x* cable

Technical Specifications - 1756, 1757 Redundancy Modules

Attribute	1756-RM	1757-SRM
Voltage, max	—	30V AC/DC
Current, max	—	100 mA
Current draw @ 1.2V DC	4 mA	—
Current draw @ 3.3V DC	—	750 mA
Current draw @ 5V DC	1200 mA	1000 mA
Current draw @ 24V DC	120 mA	90 mA
Power dissipation	9.0 W	9.6 W
Thermal dissipation	31 BTU/hr	38.49 BTU/hr
Connector cables	1756-RMC1, 1 m (3.28 ft) 1756-RMC3, 3 m (9.84 ft) 1756-RMC10, 10 m (32.81 ft)	1757-SRC1, 1 m (3.28 ft) 1757-SRC3, 3 m (9.84 ft) 1757-SRC10, 10 m (32.81 ft) 1757-SRC50, 50 m (164.04 ft) 1757-SRC100, 100 m (328.08 ft)
Slot width	1 slot	2 slot
Module location	Chassis-based, any slot	Chassis-based, any slot. Recommended defaults: slots 5-6 in 10-slot and 17-slot chassis, slots 4-5 in 7-slot and 13-slot chassis
Chassis	1756-A4, 1756-A7, 1756-A10, 1756-A13, 1756-A17	

Attribute	1756-RM	1757-SRM
Power supply, standard	1756-PA72/C, 1756-PA75/B, 1756-PB72/C, 1756-PB75/B, 1756-PC75/B, 1756-PH75/B	
Power supply, redundant	1756-PA75R, 1756-PB75R, 1756-PSCA2	
Wire size	—	Relay Terminals: 0.3... 2.1 mm^2 (22...14 AWG) solid or stranded shielded copper wire rated at 75 °C (167 °F) or greater 1.2 mm (3/64 in.) insulation max
Wire category	—	3 - on relay terminals(1)
Wire type	—	Copper
North American temperature code	T4	T4A
IEC temperature code	—	T4

(1) Use this conductor category information for planning conductor routing as described in the system level installation manual. See the Industrial Automation Wiring and Grounding Guidelines, publication 1770-4.1.

Certifications - 1756, 1757 Redundancy Modules

Certification(1)	1756-RM, 1757-SRM
c-UL-us	UL Listed Industrial Control Equipment, certified for US and Canada. See UL File E65584. UL Listed for Class I, Division 2 Group A,B,C,D Hazardous Locations, certified for U.S. and Canada. See UL File E194810.
CSA	CSA Certified Process Control Equipment. See CSA File LR54689C. CSA Certified Process Control Equipment for Class I, Division 2 Group A,B,C,D Hazardous Locations. See CSA File LR69960C.
ATEX	European Union 94/9/EC ATEX Directive, compliant with: EN 60079-15; Potentially Explosive Atmospheres, Protection “n” (Zone 2)
CE	European Union 2004/108/IEC EMC Directive, compliant with: • EN 61326-1; Meas./Control/Lab., Industrial Requirements • EN 61000-6-2; Industrial Immunity • EN 61000-6-4; Industrial Emissions • EN 61131-2; Programmable Controllers (Clause 8, Zone A & B)
C-Tick	Australian Radiocommunications Act, compliant with: AS/NZS CISPR 11; Industrial Emissions
FM	FM Approved Equipment for use in Class I Division 2 Group A,B,C,D Hazardous Locations
TÜV	TÜV Certified for Functional Safety: up to and including SIL 2

(1) When marked. See the Product Certification link at http://www.ab.com for Declarations of Conformity, Certificates, and other certification details.

Environmental Specifications - 1756-RMXT Redundancy Module

Attribute	1756-RMXT
Temperature, operating IEC 60068-2-1 (Test Ad, Operating Cold), IEC 60068-2-2 (Test Bd, Operating Dry Heat), IEC 60068-2-14 (Test Nb, Operating Thermal Shock)	-25…70 °C (-13…158 °F)
Temperature, storage IEC 60068-2-1 (Test Ab, Unpackaged Nonoperating Cold), IEC 60068-2-2 (Test Bb, Unpackaged Nonoperating Dry Heat), IEC 60068-2-14 (Test Na, Unpackaged Nonoperating Thermal Shock)	-40…85 °C (-40…185 °F)
Relative humidity IEC 60068-2-30 (Test Db, Unpackaged Nonoperating Damp Heat)	5...95% noncondensing
Vibration IEC 60068-2-6 (Test Fc, Operating)	2 g at 10…500 Hz
Shock, operating IEC 60068-2-27 (Test Ea, Unpackaged Shock)	30 g
Shock, nonoperating IEC 60068-2-27 (Test Ea, Unpackaged Shock)	50 g

Technical Specifications - 1756-RMXT Redundancy Module

Attribute	1756-RMXT
Current draw @ 1.2V DC	4 mA
Current draw @ 5.1V DC	1.2 A
Current draw @ 24V DC	120 mA
Power dissipation	9.0 W
Thermal dissipation	31 BTU/hr
Connector cables	1756-RMC1, 1 m (3.28 ft) 1756-RMC3, 3 m (9.84 ft) 1756-RMC10, 10 m (32.81 ft)
Slot width	1 slot
Module location	Chassis-based, any slot
Chassis	1756-A5XT, 1756-A7LXT
Power supply, standard	1756-PBXT
Power supply, redundant	None
North American temperature code	T4

Certifications - 1756-RMXT Redundancy Module

Certification[1]	1756-RMXT
c-UL-us	UL Listed Industrial Control Equipment, certified for US and Canada. See UL File E65584. UL Listed for Class I, Division 2 Group A,B,C,D Hazardous Locations, certified for U.S. and Canada. See UL File E194810.
CSA	CSA Certified Process Control Equipment. See CSA File LR54689C. CSA Certified Process Control Equipment for Class I, Division 2 Group A,B,C,D Hazardous Locations. See CSA File LR69960C.
CE	European Union 2004/108/IEC EMC Directive, compliant with: • EN 61326-1; Meas./Control/Lab., Industrial Requirements • EN 61000-6-2; Industrial Immunity • EN 61000-6-4; Industrial Emissions • EN 61131-2; Programmable Controllers (Clause 8, Zone A & B)
C-Tick	Australian Radiocommunications Act, compliant with: AS/NZS CISPR 11; Industrial Emissions
FM	FM Approved Equipment for use in Class I Division 2 Group A,B,C,D Hazardous Locations

(1) When marked. See the Product Certification link at http://www.ab.com for Declarations of Conformity, Certificates, and other certification details.

ControlLogix Connections

A ControlLogix system uses connections to establish communication links between devices. The types of connections include:

- controller-to-local I/O modules or local communication modules.
- controller-to-remote I/O or remote communication modules.
- controller-to-remote I/O (rack-optimized) modules.
- produced and consumed tags.
- messages.
- controller access by RSLogix 5000 programming software.
- controller access by RSLinx software for HMI or other applications.

You indirectly determine the number of connections the controller uses by configuring the controller to communicate with other devices in the system. The limit of connections may ultimately reside in the communication module you use for the connection. If a message path routes through a communication module, the connection related to the message also counts towards the connection limit of that communication module.

The 1756 controller supports 250 connections. To calculate the total connections for a controller, consider the connections to local I/O modules and the connections to remote modules. Use the following table to tally **local** connections.

Connection Type	Device Quantity	Connections per Device	Total Connections
Local I/O module (always a direct connection)		1	
1756-M16SE, 1756-M08SE, 1756-M03SE SERCOS motion module 1756-M02AE, 1756-M02AS, 1756-HYD02 analog motion module		3	
1756-CN2, 1756-CN2R communication module 1756-CNB, 1756-CNBR communication module 1756-CN2RXT communication module		0	
1756-EN2F, 1756-EN2T communication module 1756-ENBT, 1756-EWEB communication module 1756-EN2TXT communication module		0	
1756-DNB communication module		2	
1756-DHRIO communication module 1756-RIO 1756-DHRIOXT		1	
1756-DH485 communication module		1	
Total			

Regardless of how you configure local I/O modules (rack-optimized or direct connect), the controller establishes a direct connection for each local I/O module.

Remote connections depend on the communication module. The number of connections the module itself supports determines how many connections the controller can access through that module. Use the following table to tally **remote** connections for the controller.

Connection Type	Device Quantity	Connections per Device	Total Connections
Remote ControlNet communication module Configured as a direct (none) connection Configured as a rack-optimized connection		0 **or** 1	
Remote I/O module over a ControlNet network (direct connection)		1	
Remote Ethernet communication module Configured as a direct (none) connection Configured as a rack-optimized connection		0 **or** 1	
Remote I/O module over an EtherNet/IP network (direct connection)		1	
Remote device over a DeviceNet network (accounted for in rack-optimized connection for local 1756-DNB module)		0	
Other remote communication adapter		1	
Safety input module		1	
Safety output module		2	
Produced tag		1	
Each consumer		1	
Consumed tag		1	
Cached message		1	
Block-transfer message		1	
Total			

ControlLogix Controller Accessories

1784 Industrial CompactFlash Cards

CompactFlash cards offer nonvolatile memory (flash) to permanently store a user program and tag data on a ControlLogix controller. You install the 1784 CompactFlash card in a socket on the controller. You can manually trigger the controller to save to or load from nonvolatile memory or configure the controller to load from nonvolatile memory on power up.

The GuardLogix controller does not support user program storage or retrieval by using a CompactFlash card.

Environmental Specifications - 1784-CF64, 1784-CF128

Attribute	1784-CF64, 1784-CF128
Temperature, operating IEC 60068-2-1 (Test Ad, Operating Cold), IEC 60068-2-2 (Test Bd, Operating Dry Heat), IEC 60068-2-14 (Test Nb, Operating Thermal Shock)	-25…70 °C (-13…158 °F)
Temperature, storage IEC 60068-2-1 (Test Ab, Unpackaged Nonoperating Cold), IEC 60068-2-2 (Test Bb, Unpackaged Nonoperating Dry Heat), IEC 60068-2-14 (Test Na, Unpackaged Nonoperating Thermal Shock)	-40…85 °C (-40…185 °F)
Relative humidity IEC 60068-2-30 (Test Db, Unpackaged Nonoperating Damp Heat)	5...95% noncondensing
Vibration IEC 60068-2-6 (Test Fc, Operating)	2 g at 10…500 Hz
Shock, operating IEC 60068-2-27 (Test Ea, Unpackaged Shock)	30 g
Shock, nonoperating IEC 60068-2-27 (Test Ea, Unpackaged Shock)	50 g

Technical Specifications - 1784-CF64, 1784-CF128

Attribute	1784-CF64	1784-CF128
Memory	64 MB	128 MB
Weight, approx.	14.2 g (0.5 oz)	

Certifications - 1784-CF64, 1784-CF128

Certification[1]	1784-CF64, 1784-CF128
CE	European Union 2004/108/EC EMC Directive, compliant with: • EN 61000-6-4; Industrial Emissions • EN 61326-1; Meas./Control/Lab., Industrial Requirements • EN 61000-6-2; Industrial Immunity • EN 61131-2; Programmable Controllers (Clause 8, Zone A & B)
C-Tick	Australian Radiocommunications Act, compliant with: AS/NZS CISPR 11; Industrial Emissions

(1) When marked. See the Product Certification link at http://www.ab.com for Declarations of Conformity, Certificates, and other certification details.

1756 ControlLogix Batteries

Each ControlLogix controller ships with a battery. The 1756-L6*x* controllers have nonvolatile memory if you install a 1784-CF64 or 1784-CF128 industrial CompactFlash card. With nonvolatile memory, the controller can be used without a battery. If you do not use a battery, current tag data will be at the state it was when the nonvolatile memory was saved.

These tables summarize battery life, replacement battery compatibility, and recommendations for use of an externally mounted battery assembly.

Attribute	1756-BA1	1756-BA2	1756-BATM(1)	1756-BATA
Description	Lithium battery (0.59 g)	Lithium battery (0.59 g)	Externally mounted battery assembly	Replacement lithium battery for 1756-BATM (5 g max lithium per each D cell; contains 2 D cells)
ControlLogix controllers	1756-L61, 1756-L62, 1756-L63 controllers, series A	1756-L61, 1756-L62, 1756-L63 controllers, series B 1756-L64, 1756-L65 controllers	1756-L61, 1756-L62, 1756-L63 controllers, series A	1756-BATM battery module
GuardLogix controllers	—	1756-L61S, 1756-L62S, 1756-L63S	—	—

(1) The 1756-BATM externally mounted battery assembly is highly recommended for use with all series A 1756-L6*x* controllers and provides longer battery life than the 1756-BA1 battery. The 1756-BATM includes one 1756-BATA lithium battery assembly and a 1 m (3.28 ft) cable to connect housing to controller.

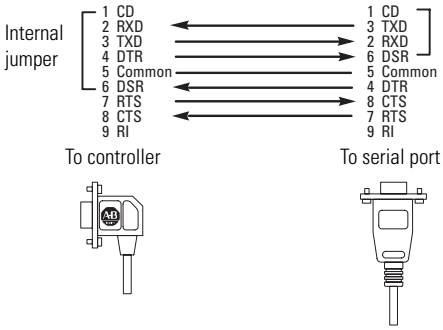
1756 ControlLogix Replacement Batteries—Legacy Controllers

Attribute	1756-BA1	1756-BATM(1)	1756-BATA
Description	Lithium battery (0.59 g)	Externally mounted battery assembly	Replacement lithium battery for 1756-BATM (5 g max lithium per each D cell; contains 2 D cells)
Supported controllers	1756-L55M*x* controllers(2) 1756-L60M03SE controller	1756-L55M*x* controllers(2) 1756-L60M03SE controller	1756-BATM battery module

(1) The 1756-BATM externally mounted battery assembly is recommended for use with all 1756-L55*x* controllers and provides longer battery life than the 1756-BA1 battery. The 1756-BATM includes one 1756-BATA lithium battery assembly and a 1 m (3.28 ft) cable to connect housing to controller.

(2) The 1756-L55M22, 1756-L55M23, and 1756-L55M24 controllers have nonvolatile memory and can be used without a battery.

Serial Communication Cables



Attribute	1756-CP3	1747-CP3
Connector type	Female 9-pin D-shell	
Connector angle	Right angle connector to controller, straight to serial port	
Length	3 m (118 in.)	

Notes:

Rockwell Automation Support

Rockwell Automation provides technical information on the Web to assist you in using its products. At http://support.rockwellautomation.com, you can find technical manuals, a knowledge base of FAQs, technical and application notes, sample code and links to software service packs, and a MySupport feature that you can customize to make the best use of these tools.

For an additional level of technical phone support for installation, configuration, and troubleshooting, we offer TechConnect support programs. For more information, contact your local distributor or Rockwell Automation representative, or visit http://support.rockwellautomation.com.

Installation Assistance

If you experience a problem within the first 24 hours of installation, please review the information that's contained in this manual. You can also contact a special Customer Support number for initial help in getting your product up and running.

United States	1.440.646.3434 Monday – Friday, 8am – 5pm EST
Outside United States	Please contact your local Rockwell Automation representative for any technical support issues.

New Product Satisfaction Return

Rockwell Automation tests all of its products to ensure that they are fully operational when shipped from the manufacturing facility. However, if your product is not functioning and needs to be returned, follow these procedures.

United States	Contact your distributor. You must provide a Customer Support case number (call the phone number above to obtain one) to your distributor in order to complete the return process.
Outside United States	Please contact your local Rockwell Automation representative for the return procedure.

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Publication 1756-TD001A-EN-E - May 2009

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Installation Instructions

ControlLogix EtherNet/IP Bridge Module

Catalog Number 1756-ENBT

Use this document as a guide to install the module. Note that this document describes hardware installation only. For configuration information, refer to the EtherNet/IP Modules User Manual, publication number ENET-UM001, available online at www.rockwellautomation.com/literature.

The following table lists the contents of this document and where to find specific information.

Topic	See Page
Important User Informationl	2
Identify Module Components	7
Prepare the Chassis for Module Installation	8
Determine Module Slot Location	9
Install the Module in the Chassis	10
Remove or Replace the Module (when applicable)	11
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Publication 1756-IN019C-EN-P - November 2004

Important User Information

Solid state equipment has operational characteristics differing from those of electromechanical equipment. *Safety Guidelines for the Application, Installation and Maintenance of Solid State Controls* (Publication SGI-1.1 available from your local Rockwell Automation sales office or online at http://www.ab.com/manuals/gi) describes some important differences between solid state equipment and hard-wired electromechanical devices. Because of this difference, and also because of the wide variety of uses for solid state equipment, all persons responsible for applying this equipment must satisfy themselves that each intended application of this equipment is acceptable.

In no event will Rockwell Automation, Inc. be responsible or liable for indirect or consequential damages resulting from the use or application of this equipment.

The examples and diagrams in this manual are included solely for illustrative purposes. Because of the many variables and requirements associated with any particular installation, Rockwell Automation, Inc. cannot assume responsibility or liability for actual use based on the examples and diagrams.

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Throughout this manual, when necessary we use notes to make you aware of safety considerations.

WARNING	Identifies information about practices or circumstances that can cause an explosion in a hazardous environment, which may lead to personal injury or death, property damage, or economic loss.
IMPORTANT	Identifies information that is critical for successful application and understanding of the product.
ATTENTION	Identifies information about practices or circumstances that can lead to personal injury or death, property damage, or economic loss. Attentions help you: • identify a hazard • avoid a hazard • recognize the consequence
SHOCK HAZARD	Labels may be located on or inside the equipment (e.g., drive or motor) to alert people that dangerous voltage may be present.
BURN HAZARD	Labels may be located on or inside the equipment (e.g., drive or motor) to alert people that surfaces may be dangerous temperatures.

Environment and Enclosure

ATTENTION

This equipment is intended for use in a Pollution Degree 2 industrial environment, in overvoltage Category II applications (as defined in IEC publication 60664-1), at altitudes up to 2000 meters without derating.

This equipment is considered Group 1, Class A industrial equipment according to IEC/CISPR Publication 11. Without appropriate precautions, there may be potential difficulties ensuring electromagnetic compatibility in other environments due to conducted as well as radiated disturbance.

This equipment is supplied as "open type" equipment. It must be mounted within an enclosure that is suitably designed for those specific environmental conditions that will be present and appropriately designed to prevent personal injury resulting from accessibility to live parts. The interior of the enclosure must be accessible only by the use of a tool. Subsequent sections of this publication may contain additional information regarding specific enclosure type ratings that are required to comply with certain product safety certifications.

NOTE: See NEMA Standards publication 250 and IEC publication 60529, as applicable, for explanations of the degrees of protection provided by different types of enclosure. Also, see the appropriate sections in this publication, as well as the Allen-Bradley publication 1770-4.1 ("Industrial Automation Wiring and Grounding Guidelines"), for additional installation requirements pertaining to this equipment.

Prevent Electrostatic Discharge

ATTENTION

This equipment is sensitive to electrostatic discharge, which can cause internal damage and affect normal operation. Follow these guidelines when you handle this equipment:

- Touch a grounded object to discharge potential static.
- Wear an approved grounding wriststrap.
- Do not touch connectors or pins on component boards.
- Do not touch circuit components inside the equipment.
- If available, use a static-safe workstation.
- When not in use, store the equipment in appropriate static-safe packaging.

Removal and Insertion Under Power

WARNING

When you insert or remove the module while backplane power is on, an electrical arc can occur. This could cause an explosion in hazardous location installations.

Be sure that power is removed or the area is nonhazardous before proceeding. Repeated electrical arcing causes excessive wear to contacts on both the module and its mating connector. Worn contacts may create electrical resistance that can affect module operation.

European Hazardous Location Approval

If you install the module in a European Zone 2 location, consider:

European Zone 2 Certification (The following applies when the product bears the EEx Marking)

This equipment is intended for use in potentially explosive atmospheres as defined by European Union Directive 94/9/EC.

The LCIE (Laboratoire Central des Industries Electriques) certifies that this equipment has been found to comply with the Essential Health and Safety Requirements relating to the design and construction of Category 3 equipment intended for use in potentially explosive atmospheres, given in Annex II to this Directive. The examination and test results are recorded in confidential report No. 28 682 010.

Compliance with the Essential Health and Safety Requirements has been assured by compliance with EN 50021.

IMPORTANT

When using this product, also consider the following:

- This equipment is not resistant to sunlight or other sources of UV radiation.
- The secondary of a current transformer shall not be open-circuited when applied in Class I, Zone 2 environments.
- Equipment of lesser Enclosure Type Rating must be installed in an enclosure providing at least IP54 protection when applied in Class I, Zone 2 environments.
- This equipment shall be used within its specified ratings defined by Allen-Bradley.
- Provision shall be made to prevent the rated voltage from being exceeded by transient disturbances of more than 40% when applied in Class I, Zone 2 environments.

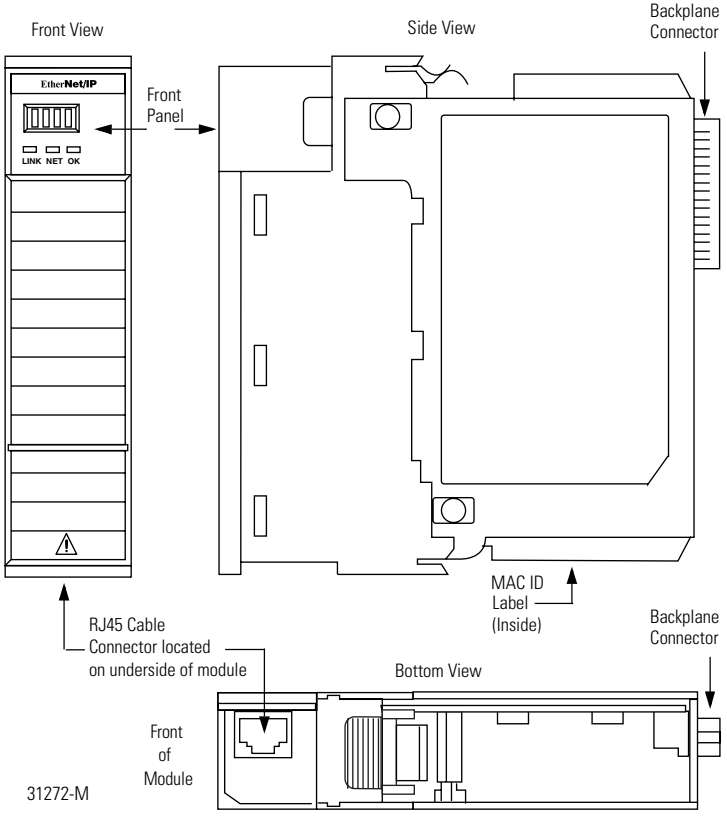
North American Hazardous Location Approval

The following information applies when operating this equipment in hazardous locations:	**Informations sur l'utilisation de cet équipement en environnements dangereux:**
Products marked "CL I, DIV 2, GP A, B, C, D" are suitable for use in Class I Division 2 Groups A, B, C, D, Hazardous Locations and nonhazardous locations only. Each product is supplied with markings on the rating nameplate indicating the hazardous location temperature code. When combining products within a system, the most adverse temperature code (lowest "T" number) may be used to help determine the overall temperature code of the system. Combinations of equipment in your system are subject to investigation by the local Authority Having Jurisdiction at the time of installation.	Les produits marqués "CL I, DIV 2, GP A, B, C, D" ne conviennent qu'à une utilisation en environnements de Classe I Division 2 Groupes A, B, C, D dangereux et non dangereux. Chaque produit est livré avec des marquages sur sa plaque d'identification qui indiquent le code de température pour les environnements dangereux. Lorsque plusieurs produits sont combinés dans un système, le code de température le plus défavorable (code de température le plus faible) peut être utilisé pour déterminer le code de température global du système. Les combinaisons d'équipements dans le système sont sujettes à inspection par les autorités locales qualifiées au moment de l'installation.

The following information applies when operating this equipment in hazardous locations:		**Informations sur l'utilisation de cet équipement en environnements dangereux:**	
WARNING	EXPLOSION HAZARD • Do not disconnect equipment unless power has been removed or the area is known to be nonhazardous. • Do not disconnect connections to this equipment unless power has been removed or the area is known to be nonhazardous. Secure any external connections that mate to this equipment by using screws, sliding latches, threaded connectors, or other means provided with this product. • Substitution of components may impair suitability for Class I, Division 2. • If this product contains batteries, they must only be changed in an area known to be nonhazardous.	**AVERTISSEMENT**	RISQUE D'EXPLOSION • Couper le courant ou s'assurer que l'environnement est classé non dangereux avant de débrancher l'équipement. • Couper le courant ou s'assurer que l'environnement est classé non dangereux avant de débrancher les connecteurs. Fixer tous les connecteurs externes reliés à cet équipement à l'aide de vis, loquets coulissants, connecteurs filetés ou autres moyens fournis avec ce produit. • La substitution de composants peut rendre cet équipement inadapté à une utilisation en environnement de Classe I, Division 2. • S'assurer que l'environnement est classé non dangereux avant de changer les piles.

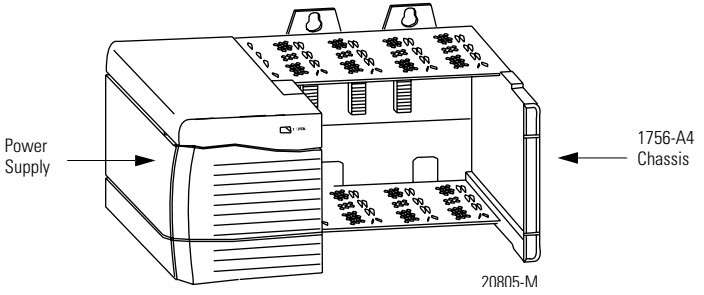
Identify Module Components

Use the following figure to identify the external features of the module.



Prepare the Chassis for Module Installation

Before you install the module, you must install and connect a ControlLogix chassis and power supply.

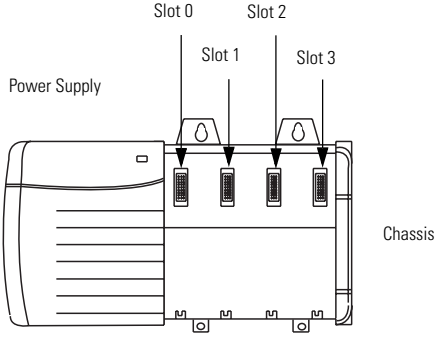


For information on installing these products, refer to the publications listed below.

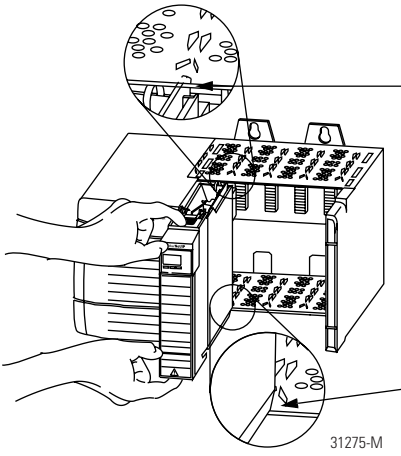
Chassis Type	Chassis Installation	Power Supply	Power Supply Installation
Series B: 1756-A4, -A7, -A10, -A13	Pub. No. 1756-IN080	1756-PA72/B	Pub. No. 1756-5.67
		1756-PB72/B	
		1756-PA75/A	Pub. No. 1756-5.78
		1756-PB75/A	

Determine Module Slot Location

You can install the module in any slot in the ControlLogix chassis. You can also install multiple 1756-ENBT modules in the same chassis. The figure below shows chassis slot numbering in a 4-slot chassis. Slot 0 is the first slot and is always the leftmost slot in the rack (the first slot to the right of the power supply).



Install the Module in the Chassis

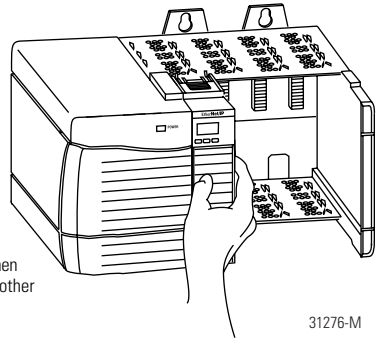


1

Align the circuit board with top and bottom guides in the chassis.

2

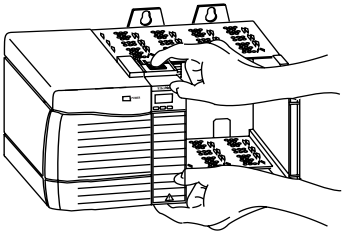
Slide the module into the chassis. Make sure the module backplane connector properly connects to the chassis backplane.



3

The module is properly installed when it is flush with the power supply or other installed modules.

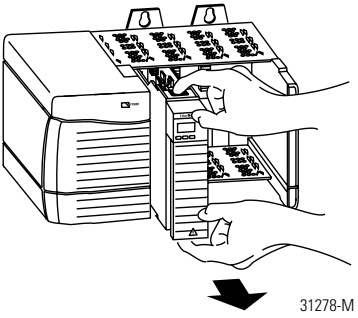
Remove or Replace the Module (when applicable)



31277-M

1

Push on upper and lower module tabs to disengage them.



31278-M

2

Slide module out of chassis.

IMPORTANT

If you are replacing an existing module with an identical one, and you want to resume identical system operation, you must install the new module in the same slot.

Install or Remove the Module Under Power

This module is designed to be installed or removed while chassis power is applied.

WARNING

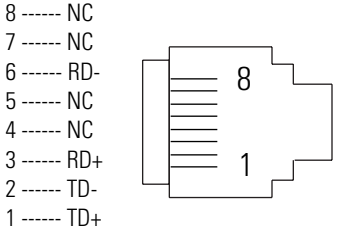
When you insert or remove a module while backplane power is on, an electrical arc may occur. An electrical arc can cause personal injury or property damage by:

- sending an erroneous signal to your system's field device causing unintended machine motion or loss of process control
- causing an explosion in a hazardous environment

Repeated electrical arcing causes excessive wear to contacts on both the module and its mating connector. Worn contacts may create electrical resistance that can affect module operation.

Wire the Ethernet Connector

Use an RJ45 connector to connect to the EtherNet/IP network. Wire the connector according to the following illustration:



RJ 45

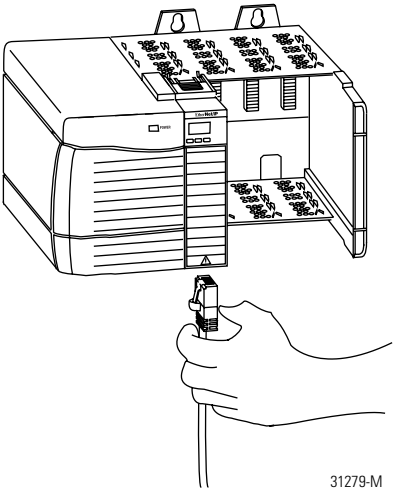
For detailed EtherNet/IP connection information, see the EtherNet/IP Media Planning and Installation Guide, publication number ENET-IN001.

Connect the Module to the EtherNet/IP Network

WARNING

If you connect or disconnect the Ethernet cable with power applied to this module or any device on the network, an electrical arc can occur. This could cause an explosion in hazardous location installations. Be sure that power is removed or the area is nonhazardous before proceeding.

Attach the RJ45 connector to the Ethernet port on the bottom of the module as shown below:

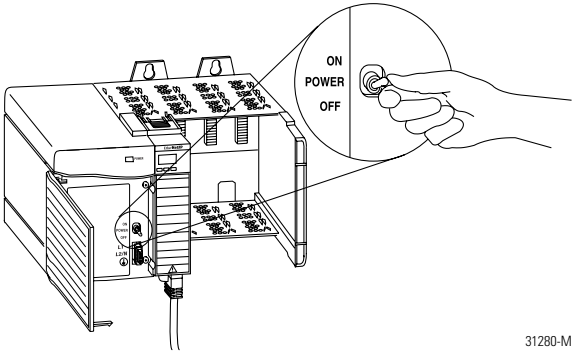


IMPORTANT

We recommend connecting the module to the network via a 100MB Ethernet switch, which will reduce collisions and lost packets and increase network bandwidth. For detailed EtherNet/IP connection information, see the following publications:

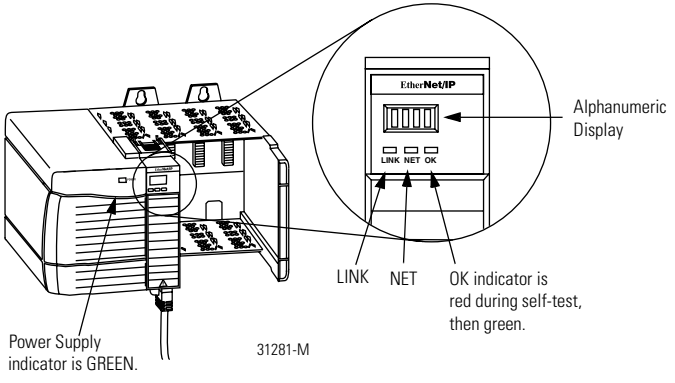
- EtherNet/IP Performance and Application Guide, publication ENET-AP001
- EtherNet/IP Media Planning and Installation Guide, publication ENET-IN001

Apply Chassis Power



Check Power Supply and Module Status

Check the LED indicators and alphanumeric display to determine if the power supply and module are operating properly.



The alphanumeric display should cycle through the following states: "TEST - PASS - OK - REV x.x," where "x.x" is the module's firmware revision. The display then alternates between "OK" and the module's EtherNet/IP address.

Troubleshoot the Module

If the alphanumeric display and LED indicators do not sequence through the expected states refer to the following troubleshooting tables. The three bi-color (red/green) LED status indicators on the 1756-ENBT module provide diagnostic information about the module and its connections to the network.

NET (Network) Status Indicator

The Network Status LED provides the following information:

State	Status	Description
Off	Not Powered, No IP Address	Module is not powered, or does not have an IP address. • Verify there is chassis power and the module is completely inserted into the chassis and backplane. • Make sure the module has been configured.
Flashing Green	No Connections	Module has obtained an IP address, but has no established connections.
Green	CIP Connections	Module has an IP address and at least one established connection.
Flashing Red	Connection Timeout	One or more of the connections in which the module is the target has timed out.
Red	Duplicate IP Address	Module has detected that its IP address is already in use. Assign a unique IP address to the module.

Link Status Indicator

The Link Status LED provides the following information:

State	Status	Description
Off	No data transmission	Module is not ready to communicate.
Green	Ready	Module is ready to communicate.
Flashing Green	Data transmission in progress	Module is communicating over the network.

OK Status Indicator

The OK Status LED provides the following module information:

State	Status	Description
Off	No Power	Module does not have 24V DC power. Verify there is chassis power and the module is completely inserted into chassis and backplane.
Flashing Green	Standby	Module is not configured.
Green	Operational	Module is operating correctly.
Flashing Red	Minor Fault	A recoverable fault has been detected. This could be caused by an error in the configuration.
Red	Major Fault	An unrecoverable fault has been detected. Recycle power to the module. If this does not clear the fault, replace the module.
Flashing Red and Green	Self Test	Module performing power-up self-test.

Where to Find Information on Configuring the Module

To configure your module, refer to the configuration chapter of your EtherNet/IP Modules User Manual, publication number ENET-UM001, available online at www.rockwellautomation.com/literature.

Specifications

Module Location	Any slot in the ControlLogix chassis
Backplane Current (mA) at 5V.1V dc	700mA
Backplane Current (mA) at 24V	3mA
Isolation Voltage, Continuous	30V Tested to 707V dc for 60 seconds
Power Dissipation, Max.	3.65W
Conductors Wire Size Category	 802.3 compliant - shielded or unshielded twisted pair 2[1]
Ethernet Connector	RJ45 Cat. 5
User Manual	ENET-UM001
Environmental Conditions	
Operating Temperature	IEC 60068-2-1 (Test Ad, Operating Cold), IEC 60068-2-2 (Test Bd, Operating Dry Heat), IEC 60068-2-14 (Test Nb, Operating Thermal Shock): 0 to 60°C (32 to 140°F)
Storage Temperature	IEC 60068-2-1 (Test Ab, Un-packaged Non-operating Cold), IEC 60068-2-2 (Test Bb, Un-packaged Non-operating Dry Heat), IEC 60068-2-14 (Test Na, Un-packaged Non-operating Thermal Shock): –40 to 85°C (–40 to 185°F)
Relative Humidity	IEC 60068-2-30 (Test Db, Un-packaged Non-operating Damp Heat): 5 to 95% non-condensing
Vibration	IEC60068-2-6 (Test Fc, Operating): 2g @ 10-500Hz
Shock, Operating	IEC60068-2-27 (Test Ea, Unpackaged shock): 30g

Shock, Non-operating	IEC60068-2-27 (Test Ea, Unpackaged shock): 50g
Emissions	CISPR 11: Group 1, Class A
ESD Immunity	IEC 61000-4-2: 6kV contact discharges 8kV air discharges
Radiated RF Immunity	IEC 61000-4-3: 10V/m with 1kHz sine-wave 80%AM from 30MHz to 2000MHz 10V/m with 200Hz 50% Pulse 100%AM at 900Mhz 10V/m with 200Hz 50% Pulse 100%AM at 1890Mhz
EFT/B Immunity	IEC 61000-4-4: ±2kV at 5kHz on communications ports
Surge Transient Immunity	IEC 61000-4-5: ±2kV line-earth(CM) on communications ports
Conducted RF Immunity	IEC 61000-4-6: 10Vrms with 1kHz sine-wave 80%AM from 150kHz to 80MHz
Enclosure Type Rating	None (open-style)

Certifications[2] (when product is marked)	UL UL Listed Industrial Control Equipment CSA CSA Certified Process Control Equipment CSA CSA Certified Process Control Equipment for Class I, Division 2 Group A,B,C,D Hazardous Locations FM FM Approved Equipment for use in Class I Division 2 Group A,B,C,D Hazardous Locations CE European Union 89/336/EEC EMC Directive, compliant with: EN 50082-2; Industrial Immunity EN 61326; Meas./Control/Lab., Industrial Requirements EN 61000-6-2; Industrial Immunity EN 61000-6-4; Industrial Emissions C-Tick Australian Radiocommunications Act, compliant with: AS/NZS CISPR 11; Industrial Emissions EEx European Union 94/9/EEC ATEX Directive, compliant with: EN 50021; Potentially Explosive Atmospheres, Protection “n” (Zone 2) EtherNet/IP ODVA conformance tested to EtherNet/IP specifications

[1] Use this Conductor Category information for planning conductor routing. Refer to publication 1770-4.1, “Industrial Automation Wiring and Grounding Guidelines”.

[2] See the Product Certification link at www.ab.com for Declarations of Conformity, Certificates, and other certification details.

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Allen-Bradley

ControlLogix Analog I/O Modules

1756-IF16,- IF6CIS, -IF6I, -IF8, -IR6I, -IT6I, -IT6I2, -OF4, -OF6CI, -OF6VI, -OF8

User Manual

BGMU Submittal Package, Part 2 of 2, 05/03/2010, Page 615 of 1071

Rockwell Automation

Important User Information

Because of the variety of uses for the products described in this publication, those responsible for the application and use of these products must satisfy themselves that all necessary steps have been taken to assure that each application and use meets all performance and safety requirements, including any applicable laws, regulations, codes and standards. In no event will Rockwell Automation™ be responsible or liable for indirect or consequential damage resulting from the use or application of these products.

Any illustrations, charts, sample programs, and layout examples shown in this publication are intended solely for purposes of example. Since there are many variables and requirements associated with any particular installation, Rockwell Automation does not assume responsibility or liability (to include intellectual property liability) for actual use based upon the examples shown in this publication.

Allen-Bradley™ publication SGI-1.1, *Safety Guidelines for the Application, Installation and Maintenance of Solid-State Control* (available from your local Rockwell Automation office), describes some important differences between solid-state equipment and electromechanical devices that should be taken into consideration when applying products such as those described in this publication.

Reproduction of the contents of this copyrighted publication, in whole or part, without written permission of Rockwell Automation, is prohibited.

Throughout this publication, notes may be used to make you aware of safety considerations. The following annotations and their accompanying statements help you to identify a potential hazard, avoid a potential hazard, and recognize the consequences of a potential hazard:

WARNING

Identifies information about practices or circumstances that can cause an explosion in a hazardous environment, which may lead to personal injury or death, property damage, or economic loss.

ATTENTION

Identifies information about practices or circumstances that can lead to personal injury or death, property damage, or economic loss.

IMPORTANT

Identifies information that is critical for successful application and understanding of the product.

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EtherNet/IP is a trademark under license of the Open DeviceNet Vendor Association.

Introduction

This release of this document contains updated information. Changes are designated by change bars in margin, as shown.

New and Revised Information

Table Summary of Changes.1 lists the new and revised information included in this release of the ControlLogix digital I/O modules user manual.

Table Summary of Changes.1 New and Revised Information

In this section:	This information changed or was added:
Chapter 2	Triggering Event Tasks
Chapter 3	• Electronic Keying • 1756-IF6I module count information in integer mode
Module-specific chapters (i.e. Chapter 4 through Chapter 8)	Module block diagrams and input/output circuit diagrams
Chapter 5	Full description of ControlLogix Sourcing Current Loop Input Module (1756-IF6CIS)
Chapter 6	• Full description of ControlLogix Thermocouple Input Module (1756-IT6I2) • Wire Off Detection with the 1756-IR6I module
Appendix A	• Specifications for 1756-IF6CIS module • Specifications for 1756-IT6I2 module • Updated Open Circuit Detection specification for the 1756-IR6I module
Appendix C	Differences when using message instructions in RSLogix™ 5000, v 9 or earlier versus using RSLogix 5000, v10 or greater.
Appendix E	Additional specification information
Glossary	After Appendix C

Other changes have been made throughout this manual and, although not significant enough to warrant mention in the table above, they are marked by change bars.

Notes:

About This User Manual

What This Preface Contains

This preface describes how to use this manual. The following table describes what this preface contains and its location.

For information about:	See page:
Who Should Use This Manual	Preface-1
Purpose of This Manual	Preface-1
Related Products and Documentation	Preface-3

Who Should Use This Manual

You must be able to program and operate a Rockwell Automation ControlLogix controller to efficiently use your analog I/O modules.

We assume that you know how to do this in this manual. If you do not, refer to the Logix5000 Controller documentation before you attempt to use this module. Table Preface.2 lists related documentation.

Purpose of This Manual

This manual describes how to install, configure, and troubleshoot your ControlLogix analog I/O module.

What This Manual Contains

Table Preface.1 lists describes the sections contained in this manual.

Table Preface.1

Section:	Title:	Description:
Chapter 1	What Are ControlLogix Analog I/O Modules?	A general overview of the ControlLogix analog I/O modules and how they are used
Chapter 2	Analog I/O Operation Within the ControlLogix System	Description of how ControlLogix analog I/O modules work with in a ControlLogix system
Chapter 3	Using ControlLogix Analog I/O Module Features	Listing of the features that are common to all ControlLogix analog I/O modules
Chapter 4	Non-Isolated Analog Voltage/Current Input Modules (1756-IF16, -IF8)	Listing of the features that are specific to the 1756-IF16 and 1756-IF8 modules
Chapter 5	Sourcing Current Loop Input Module (1756-IF6CIS) and Isolated Analog Voltage/Current Input Module (1756-IF6I)	Listing of the features that are specific to the 1756-IF6CIS and 1756-IF6I modules
Chapter 6	Temperature Measuring Analog Modules (1756-IR6I, 1756-IT6I & 1756-IT6I2)	Listing of the features that are specific to the 1756-IR6I and 1756-IT6I modules
Chapter 7	Non-Isolated Analog Output Modules (1756-OF4 & 1756-OF8)	Listing of the features that are specific to the 1756-OF8 and 1756-OF8 modules.
Chapter 8	Isolated Analog Output Modules (1756-OF6CI & 1756-OF6VI)	Listing of the features that are specific to the 1756-OF6CI and 1756-OF6VI modules
Chapter 9	Installing ControlLogix I/O Modules	Step-by-step description of how to install and wire ControlLogix analog I/O modules
Chapter 10	Configuring ControlLogix Analog I/O Modules	Description of how to configure ControlLogix analog I/O modules with RSLogix 5000™
Chapter 11	Calibrating the ControlLogix Analog I/O Modules	Description of how to calibrate ControlLogix analog I/O modules with RSLogix 5000
Chapter 12	Troubleshooting Your ControlLogix Analog I/O Module	Description of how to use LED status indicators and RSLogix 5000 to troubleshoot any problems with your ControlLogix analog I/O modules
Appendix A	Specifications	Listing of all modules' specifications
Appendix B	Tag Definitions	Description of how to use the RSLogix 5000 tag editor to change a module's configuration
Appendix C	Using Ladder Logic To Perform Run Time Services and Reconfiguration	Description of uses for ladder logic in your ControlLogix analog I/O module applications
Appendix D	Power Supply Sizing Chart	Information necessary to check the power your ControlLogix chassis is using.

Related Products and Documentation

The following table lists related ControlLogix products and documentation:

Table Preface.2
Related Documentation

Catalog number:	Document title:	Publication number:
1756-A4, -A7, -A10, -A13	ControlLogix Chassis Installation Instructions	1756-IN080
1756-PA72/B, -PB72/B	ControlLogix Power Supply Installation Instructions	1756-5.67
1756-PA75, -PB75	ControlLogix Power Supply Installation Instructions	1756-5.78
1756-Series	ControlLogix Module Installation Instructions (Each module has separate installation document.)	Multiple 1756-IN numbers
1756-Series	ControlLogix Digital I/O Modules User Manual	1756-UM058
1756-CNB, -CNBR	ControlLogix ControlNet™ Interface Module User Manual	1756-6.5.3
1756-DNB	ControlLogix DeviceNet Interface Module User Manual	1756-6.5.19
1756-DHRIO	ControlLogix Data Highway Plus Communication Interface Module User Manual	1756-UM514
1756-ENET	ControlLogix Ethernet Communication Interface Module User Manual	1756-UM051
1756-ENBT	ControlLogix EtherNet/IP™ Bridge Module User Manual	1756-UM050
1756-IF4FXOF2F	ControlLogix High Speed Analog I/O Module User Manual	1756-UM005
1756-Lx	ControlLogix Selection Guide	1756-SG001
1756-Lx	ControlLogix System User Manual	1756-UM001
1756-Lx, 1769-Lx, 1789-Lx, 1794-Lx, PowerFlex 700S	Logix5000 Controllers Quick Reference	1756-QR107
1756-Lx, 1769-Lx, 1789-Lx, 1794-Lx, PowerFlex 700S	Logix5000 Controllers Common Procedures Programming Manual	1756-PM001
1756-Lx, 1769-Lx, 1789-Lx, 1794-Lx, PowerFlex 700S	Logix5000 Controllers Motion Instruction Set Reference Manual	1756-RM007
1756-Lx, 1769-Lx, 1789-Lx, 1794-Lx, PowerFlex 700S	Logix5000 Controllers General Instructions Reference Manual	1756-RM003
Allen-Bradly I/O catalog numbers	I/O Products System Overview	CIG-SO001

For more information on these products, contact your local Rockwell Automation distributor or sales office.

The documentation listed in Table Preface.2 is available at the following locations:

- http://www.ab.com/manuals/cl
- http://www.theautomationbookstore.com

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Glossary

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What Are ControlLogix Analog I/O Modules?

What This Chapter Contains

This chapter describes the ControlLogix analog modules and what you must know and do before you begin to use them.

For information about:	See page:
What are ControlLogix Analog I/O Modules?	1-1
Using an I/O Module in the ControlLogix System	1-3
Features of the ControlLogix Analog I/O Modules	1-4
Using Module Identification and Status Information	1-5
Preventing Electrostatic Discharge	1-6
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What are ControlLogix Analog I/O Modules?

ControlLogix analog I/O modules are interface modules that convert analog signals to digital values for inputs and convert digital values to analog signals for outputs. Controllers can then use these signals for control purposes.

Using the producer/consumer network model, ControlLogix analog I/O modules produce information when needed while providing additional system functions.

Table 1.1 lists the features available on ControlLogix analog I/O modules that allow greater system applicability.

Table 1.1 ControlLogix Analog I/O Module Features

Feature:	Description:
Removal and insertion under power (RIUP)	This system feature allows you to remove and insert modules and RTB while power is applied. For more information on RIUP, see page 1-6.
Producer/consumer communications model	These communications are an intelligent data exchange between modules and other system devices in which each module produces data without having been polled.
Rolling timestamp of data	15-bit module-specific rolling timestamp with millisecond resolution which indicates when data was sampled/applied. This timestamp may be used to calculate the interval between channel or field side updates
Multiple data formats	Analog I/O modules offer the option of IEEE 32-bit floating point or 16-bit integer data formats.
Module resolution	Analog input modules use 16-bit resolution, and analog output modules offer 13 to 16-bit output resolution, depending on the module type, to detect data changes.
On-board features	Features such as scaling to engineering units, alarming and under/overrange detection increase the modules' complexity and effectiveness.
Calibration	ControlLogix analog I/O module ships from the factory with factory calibration. You can recalibrate the module calibration on a channel-by-channel or module-wide basis to increase accuracy in customer-specific applications, if necessary.
Coordinated System Time (CST) timestamp of data	64-bit system clock (i.e. Coordinated System Time [CST]) places a timestamp on the transfer of data between the module and its owner-controller within the local chassis
UL, CSA, FM, CE, C-Tick, EEx, TUV Agency Certification	Full agency certification for in any application that requires approval of the agencies listed. Agency certification varies depending on catalog number. To see a complete listing of the certifications associated with each catalog number, see Appendix A.

Using an I/O Module in the ControlLogix System

ControlLogix modules mount in a ControlLogix chassis and use a Removable Terminal Block (RTB) or a Bulletin 1492 Interface Module[1] cable that connects to an IFM to connect all field-side wiring. Before you install and use your module you should have already:

- installed and grounded a 1756 chassis and power supply[2]. To install these products, refer to the publications listed in Table Preface.2 on page Preface-3.
- ordered and received an RTB or IFM and its components for your application.

IMPORTANT RTBs and IFMs are not included with your module purchase.

Table 1.2 Types of ControlLogix Analog I/O

Catalog Number:	Description:	RTB Used:	Module Specific Information in Section:
1756-IF16	16-point non-isolated analog current/voltage input module	36 pin	Chapter 4
1756-IF8	8-point non-isolated analog current/voltage input module	36 pin	
1756-IF6CIS	6-point sourcing current loop input module	20 pin	Chapter 5
1756-IF6I	6-point isolated analog current/voltage input module	20 pin	
1756-IR6I	6-point isolated RTD input module	20 pin	Chapter 6
1756-IT6I	6-point isolated Thermocouple/mV input module	20 pin	
1756-IT6I2	6-point isolated Enhanced Thermocouple/mV input module	20 pin	
1756-OF4	4-point non-isolated analog current/voltage output module	20 pin	Chapter 7
1756-OF8	8-point non-isolated analog current/voltage output module	20 pin	
1756-OF6CI	6-point isolated analog current output module	20 pin	Chapter 8
1756-OF6VI	6-point isolated analog voltage output module	20 pin	

(1) The Bulletin 1492 IFM may not be used in any application that requires agency certification of the ControlLogix system. Use of the IFM violates the UL, CSA and FM certifications of a ControlLogix digital I/O module. Also, to see what IFMs are used with each ControlLogix analog I/O module, see Appendix F.

(2) In addition to standard ControlLogix power supplies, ControlLogix Redundant Power Supplies are also available for your application. For more information on these supplies see the ControlLogix Selection Guide, publication 1756-SG001 or contact your local Rockwell Automation distributor or sales representative.

Features of the ControlLogix Analog I/O Modules

Figure 1.1

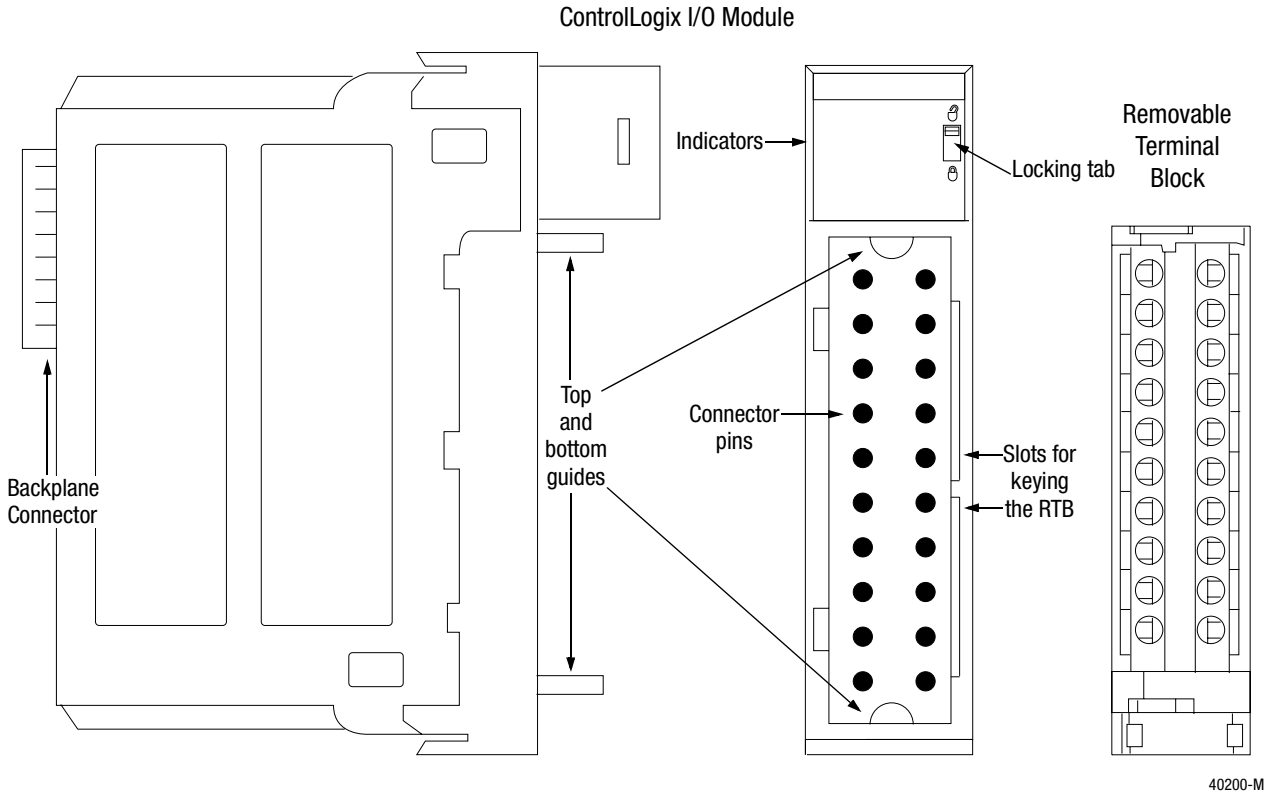

Table 1.3 lists descriptions of the physical features shown in Figure 1.1.

Table 1.3 Physical Features on the ControlLogix Digital I/O Modules

Physical Feature:	Description:
Backplane connector	The backplane connector interface for the ControlLogix system connects the module to the ControlBus backplane.
Connector pins	Input/output, power and grounding connections are made to the module through these pins with the use of an RTB or IFM.
Locking tab	The locking tab anchors the RTB or IFM cable on the module, maintaining wiring connections.
Slots for keying	Mechanically keys the RTB to prevent inadvertently making the wrong wire connections to your module.
Status indicators	Indicators display the status of communication, module health and input/output devices. Use these indicators to help in troubleshooting.
Top and bottom guides	Guides provide assistance in seating the RTB or IFM cable onto the module.

Using Module Identification and Status Information

Each ControlLogix I/O module maintains specific identification information that separates it from all other modules. This information assists you in tracking all the components of your system.

For example, you can track module identification information to be aware of exactly what modules are located in any ControlLogix rack at any time. While retrieving module identity, you can also retrieve the module's status.

Each module maintains the following information:

Table 1.4 Module Identification and Status Information

Module Identification:	Description:
Product Type	Module's product type, such as Digital I/O or Analog I/O module
Catalog Code	Module's catalog number
Major Revision	Module's major revision number
Minor Revision	Module's minor revision number

Status	Module's status. Returns the following information:
	• Controller ownership (if any)
	• Whether module has been configured
	• Device Specific Status, such as:
	  • Self-Test
	  • Flash update in progress
	  • Communications fault
	  • Not owned (outputs in program mode)
	  • Internal fault (need flash update)
	  • Run mode
	  • Program mode (output mods only)
	• Minor recoverable fault
	• Minor unrecoverable fault
	• Major recoverable fault
	• Major unrecoverable fault

Vendor ID	Module manufacturer vendor, for example Allen-Bradley
Serial Number	Module serial number
Length of ASCII Text String	Number of characters in module's text string
ASCII Text String	Number of characters in module's text string

IMPORTANT You must perform a WHO service to retrieve this information.

Preventing Electrostatic Discharge

This module is sensitive to electrostatic discharge.

ATTENTION

This equipment is sensitive to electrostatic discharge, which can cause internal damage and affect normal operation. Follow these guidelines when you handle this equipment:

- Touch a grounded object to discharge potential static.
- Wear an approved grounding wriststrap.
- Do not touch connectors or pins on component boards.
- Do not touch circuit components inside the equipment.
- If available, use a static-safe workstation.
- When not in use, store the equipment in appropriate static-safe packaging.

Removal and Insertion Under Power

These modules are designed to be installed or removed while chassis power is applied.

WARNING

When you insert or remove the module while backplane power is on, an electrical arc can occur. This could cause an explosion in hazardous location installations.

Be sure that power is removed or the area is nonhazardous before proceeding. Repeated electrical arcing causes excessive wear to contacts on both the module and its mating connector. Worn contacts may create electrical resistance that can affect module operation.

Chapter Summary and What's Next

In this chapter you read about what ControlLogix analog I/O modules are. Chapter 2 describes Analog I/O Operation Within the ControlLogix System.

Analog I/O Operation Within the ControlLogix System

What This Chapter Contains

This chapter describes how analog I/O modules work within the ControlLogix system.

For information about:	See page:
Ownership and Connections	2-1
Using RSNetWorx™ and RSLogix 5000	2-2
Direct Connections	2-3
Input Module Operation	2-3
Input Modules in a Local Chassis	2-4
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Ownership and Connections

Every I/O module in the ControlLogix system must be owned by a ControlLogix controller to be useful. This owner-controller stores configuration data for every module that it owns and can be located locally or remotely, relative to the I/O module's position. The owner sends the I/O module configuration data to define the module's behavior and begin operation within the control system. Each ControlLogix I/O module must continuously maintain communication with its owner to operate normally.

Typically, each module in the system will have only 1 owner. Input modules can have more than 1 owner. Output modules, however, are limited to a single owner. For more information on the increased flexibility provided by multiple owners and the ramifications of using multiple owners, see page 2-13.

Using RSNetWorx™ and RSLogix 5000

The I/O configuration portion of RSLogix5000 generates the configuration data for each I/O module in the control system, whether the module is located in a local or remote chassis. A remote chassis, also known as networked, contains the I/O module but not the module's owner-controller. Remote chassis can be connected to the controller via a scheduled ControlNet or EtherNet/IP network.

Configuration data is transferred to the controller during the program download and subsequently transferred to the appropriate I/O modules.

I/O modules in the local chassis, and modules in a remote chassis this connected via the EtherNet/IP network, are ready to run as soon as the configuration data has been downloaded. However, you must run RSNetWorx for ControlNet to enable I/O modules in a scheduled ControlNet chassis.

Running RSNetWorx transfers configuration data to I/O modules on scheduled ControlNet and establishes a Network Update Time (NUT) for ControlNet that is compliant with the desired communications options specified for each module during configuration.

Anytime a controller references an I/O module in a scheduled ControlNet chassis, you must run RSNetWorx to configure ControlNet. Follow these general guidelines when configuring I/O modules:

1. Configure all I/O modules for a given controller using RSLogix 5000 and download that information to the controller.

2. If the I/O configuration data references a module in a remote chassis connected by scheduled ControlNet, run RSNetWorx.

IMPORTANT You **must** run RSNetWorx whenever a new module is added to a scheduled ControlNet chassis. When a module is permanently removed from a remote chassis, we recommend that RSNetWorx be run to optimize the allocation of network bandwidth.

Direct Connections

A **direct connection** is a real-time data transfer link between the controller and the device that occupies the slot that the configuration data references. ControlLogix analog I/O modules use direct connections only.

When module configuration data is downloaded to an owner-controller, the controller attempts to establish a direct connection to each of the modules the data references.

If a controller has configuration data referencing a slot in the control system, the controller periodically checks for the presence of a device there. When a device's presence is first detected, the controller automatically sends the configuration data and one of the following events occurs:

- If the data is appropriate to the module found in the slot, a connection is made and operation begins.
- If the configuration data is not appropriate, the data is rejected and an error message displays in the software. In this case, the configuration data can be inappropriate for any of a number of reasons.

  For example, a module's configuration data may be appropriate except for a mismatch in electronic keying that prevents normal operation.

The controller maintains and monitors its connection with a module. Any break in the connection, such as removal of the module from the chassis while under power, causes the controller to set fault status bits in the data area associated with the module. You can use ladder logic to monitor this data area and detect module failures.

Input Module Operation

In traditional I/O systems, controllers poll input modules to obtain their input status. In the ControlLogix system, however, the owner-controller does not poll analog input modules after a connection is established. The modules multicast their data periodically. Multicast frequency depends on the options chosen during configuration and where in the control system that input module physically resides.

An input module's communication, or multicasting, behavior varies depending upon whether it operates in the local chassis or in a remote chassis, based on the network type. The following sections detail the differences in data transfers between these set-ups.

Input Modules in a Local Chassis

When a module resides in the same chassis as the owner-controller, the following two configuration parameters will affect how and when the input module multicasts data:

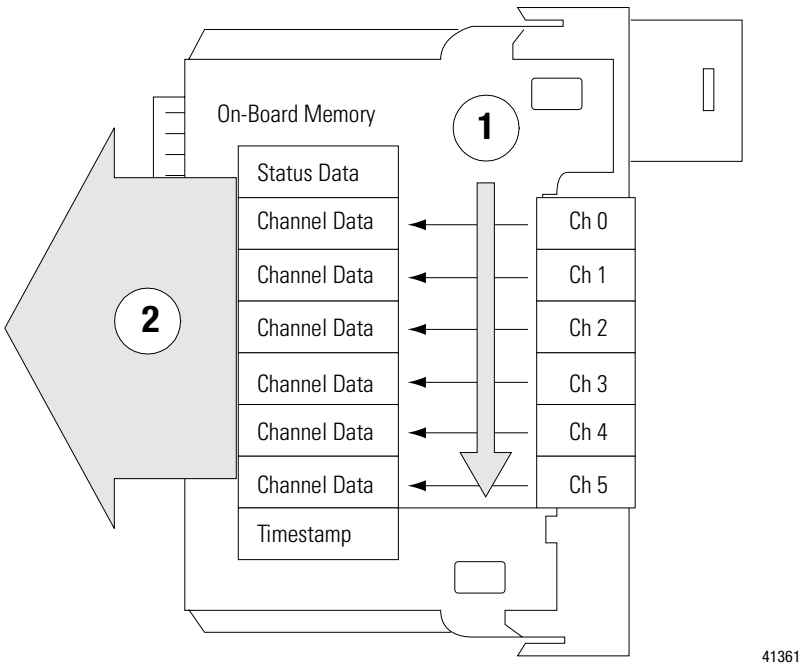
- Real Time Sample (RTS)
- Requested Packet Interval (RPI)

Real Time Sample (RTS)

This configurable parameter instructs the module to perform the following operations:

1. **Scan all** of its input channels and store the data into on-board memory
2. Multicast the updated channel data (as well as other status data) to the backplane of the local chassis

Figure 2.1



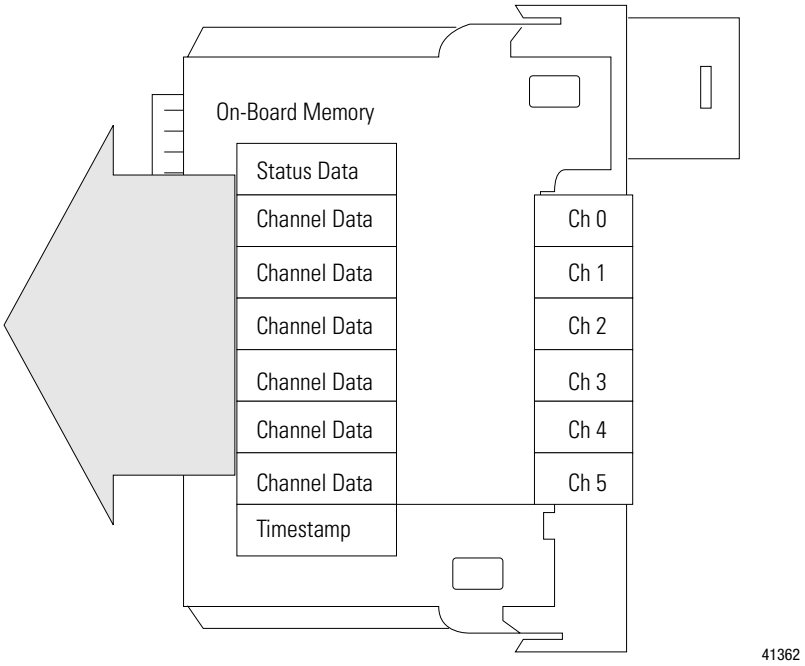
IMPORTANT The RTS value is set during the initial configuration using RSLogix 5000. This value can be adjusted anytime.

Requested Packet Interval (RPI)

This configurable parameter also instructs the module to multicast its channel and status data to the local chassis backplane.

The RPI instructs the module to multicast the **current contents** of its on-board memory when the RPI expires, (i.e. the module does not update its channels prior to the multicast).

Figure 2.2



IMPORTANT The RPI value is set during the initial module configuration using RSLogix 5000. This value can be adjusted when the controller is in Program mode.

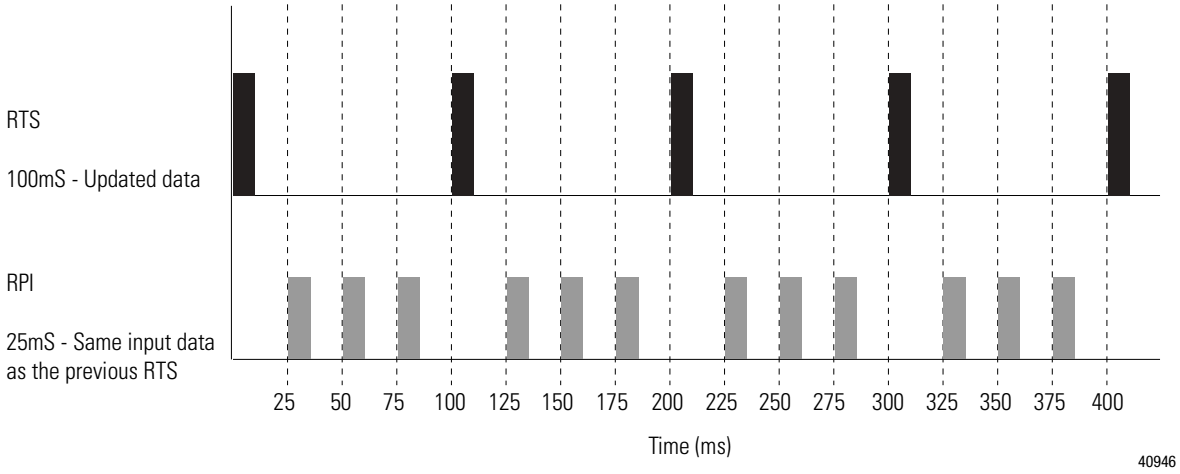
It is important to note that the module will reset the RPI timer each time an RTS is performed. This operation dictates how and when the owner-controller in the local chassis will receive updated channel data, depending on the values given to these parameters.

If the RTS value is less than or equal to the RPI, each multicast of data from the module will have updated channel information. In effect, the module is only multicasting at the RTS rate.

If the RTS value is greater than the RPI, the module multicasts at both the RTS rate and the RPI rate. Their respective values will dictate how often the owner-controller will receive data and how many multicasts from the module contain updated channel data.

In the example below, the RTS value is 100mS and the RPI value is 25mS. Only every fourth multicast from the module will contain updated channel data.

Figure 2.3



Triggering Event Tasks

When configured to do so, ControlLogix analog input modules can trigger an event task. The event task offers ControlLogix controller users a task that executes a section of logic immediately when an event (i.e. receipt of new data) occurs.

Your ControlLogix analog I/O module can trigger event tasks every RTS, after the module has sampled and multicast its data. Events tasks are useful for synchronizing process variable (PV) samples and proportional integral derivative (PID) calculations.

IMPORTANT ControlLogix analog I/O modules can trigger event tasks at every RTS but not at the RPI. For example, in Figure 2.3 above, an event task can only be triggered every 100ms.

Input Modules in a Remote Chassis

If an input module resides in a remote chassis, the role of the RPI and the module's RTS behavior change slightly with respect to getting data to the owner-controller, depending on what network type you are using to connect to the modules.

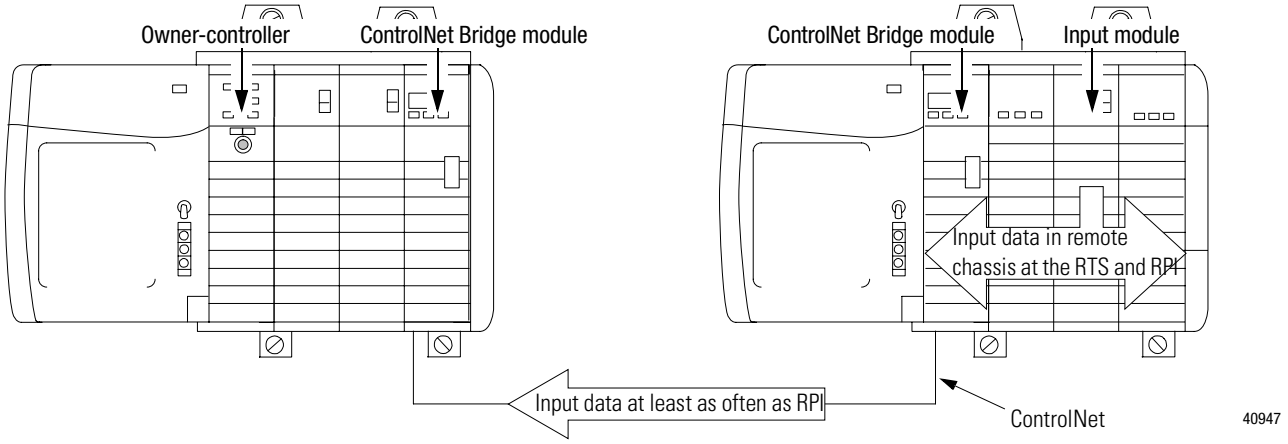
Remote Input Modules Connected Via ControlNet

When remote analog I/O modules are connected to the owner-controller via a scheduled ControlNet network, the RPI and RTS intervals still define when the module will multicast data **within its own chassis** (as described in the previous section). However, only the value of the RPI determines how often the owner-controller will receive it over the network.

When an RPI value is specified for an input module in a remote chassis connected by a scheduled ControlNet network, in addition to instructing the module to multicast data within its own chassis, the RPI also "reserves" a spot in the stream of data flowing across the ControlNet network.

The timing of this "reserved" spot may or may not coincide with the exact value of the RPI, but the control system guarantees that the owner-controller receives data **at least as often** as the specified RPI.

Figure 2.4 Input Module in Remote Chassis with RPI Reserving Spot in Flow of Data



The "reserved" spot on the network and the module's RTS are asynchronous to each other. This means there are Best and Worst Case scenarios as to when the owner-controller will receive updated channel data from the module in a networked chassis.

Best Case RTS Scenario

In the Best Case scenario, the module performs an RTS multicast with updated channel data just before the "reserved" network slot is made available. In this case, the remotely-located owner-controller receives the data almost immediately.

Worst Case RTS Scenario

In the Worst Case scenario, the module performs an RTS multicast just after the "reserved" network slot has passed. In this case, the owner-controller will not receive data until the next scheduled network slot.

TIP Because it is the RPI and NOT the RTS which dictates when the module's data will be sent over the network, we recommend the RPI value be set LESS THAN OR EQUAL TO the RTS to make sure that updated channel data is received by the owner-controller with each receipt of data.

Remote Input Modules Connected Via EtherNet/IP

When remote analog input modules are connected to the owner-controller via an EtherNet/IP network, data is transferred to the owner-controller in the following way:

- At the RTS or RPI (whichever is faster), the module multicasts data within its own chassis.
- The 1756-ENBT module in the remote chassis immediately sends the module's data over the network to the owner-controller as long as it has not sent data within a timeframe that is 1/4 the value of the analog input module's RPI.

  For example, if an analog input module uses an RPI = 100ms, the 1756-ENBT module will only send module data immediately on receiving it if another data packet was not sent within the last 25ms.

Output Module Operation

The RPI parameter governs exactly when an analog output module receives data from the owner-controller and when the output module echoes data. An owner-controller sends data to an analog output module **only at the period specified in the RPI**. Data is NOT sent to the module at the end of the controller's program scan.

When an analog output module receives **new data** from an owner-controller (i.e. every RPI), the module automatically multicasts or "echoes" a data value that corresponds to the analog signal present at the output terminals to the rest of the control system. This feature, called **Output Data Echo**, occurs whether the output module is local or remote.

For more information on data echo, see the feature description in each module-specific chapter.

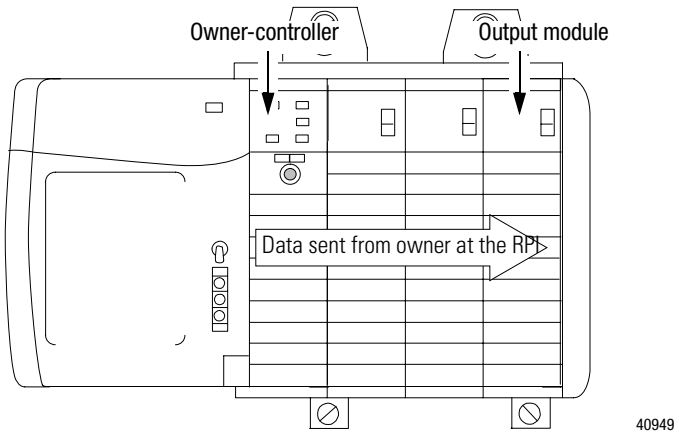
Depending on the value of the RPI, with respect to the length of the controller program scan, the output module can receive and "echo" data multiple times during one program scan.

When the RPI is less than the program scan length, the controller effectively allows the module's output channels to change values multiple times during a single program scan because the output module is not dependent on reaching the end of the program to send data.

Output Modules in a Local Chassis

When specifying an RPI value for an analog output module, you instruct the controller when to broadcast the output data to the module. If the module resides in the same chassis as the owner-controller, the module receives the data almost immediately after the controller sends it.

Figure 2.5



Output Modules in a Remote Chassis

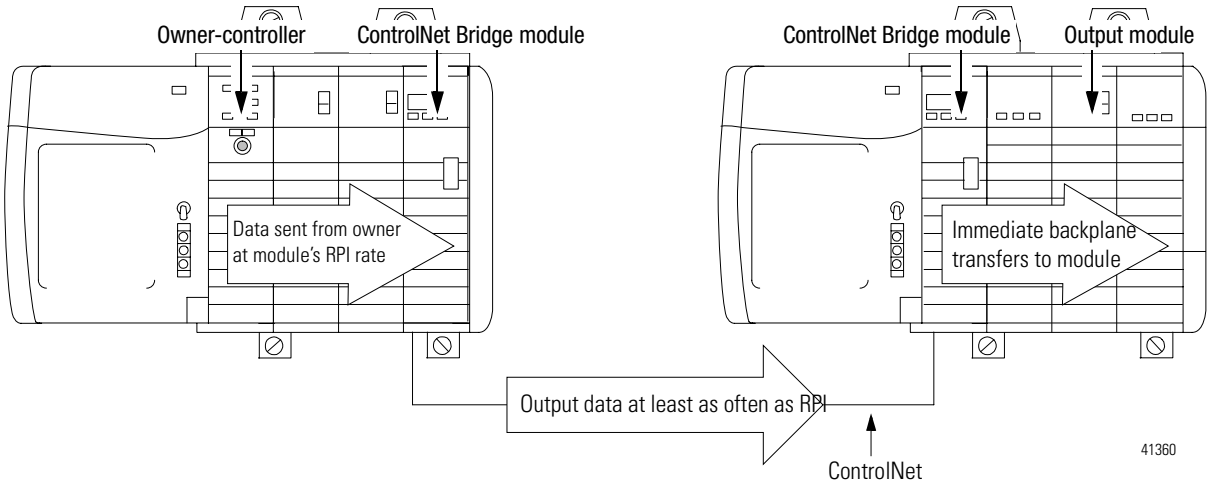
If an output module resides in a remote chassis, the role of the RPI changes slightly with respect to getting data from the owner-controller, depending on what network type you are using to connect to the modules.

Remote Output Modules Connected Via ControlNet

When remote analog output modules are connected to the owner-controller via a scheduled ControlNet network, in addition to instructing the controller to multicast the output data within its own chassis, the RPI also "reserves" a spot in the stream of data flowing across the ControlNet network.

The timing of this "reserved" spot may or may not coincide with the exact value of the RPI, but the control system will guarantee that the output module will receive data **at least as often** as the specified RPI.

Figure 2.6 Output Module in Remote Chassis with RPI Reserving a Spot in Flow of Data



The "reserved" spot on the network and when the controller sends the output data are asynchronous to each other. This means there are Best and Worst Case scenarios as to when the module will receive the output data from the controller in a networked chassis.

Best Case RPI Scenario

In the Best Case scenario, the controller sends the output data just BEFORE the “reserved” network slot is available. In this case, the remotely located output module receives the data almost immediately.

Worst Case RPI Scenario

In the Worst Case scenario, the controller sends the data just AFTER the “reserved” network slot has passed. In this case, the module does not receive the data until the next scheduled network slot.

IMPORTANT

These Best and Worst Case scenarios indicate the time required for output data to transfer from the controller to the module **once the controller has produced it**.

The scenarios do not take into account when the module will receive NEW data (updated by the user program) from the controller. That is a function of the length of the user program and its asynchronous relationship with the RPI.

Remote Output Modules Connected Via EtherNet/IP

When remote analog output modules are connected to the owner-controller via an EtherNet/IP network, the controller multicasts data in the following way:

- At the RPI, the owner-controller multicasts data within its own chassis.
- The 1756-ENBT module in the local chassis immediately sends the data over the network to the analog output module as long as it has not sent data within a timeframe that is 1/4 the value of the analog module’s RPI.

Listen-Only Mode

Any controller in the system can **listen** to the data from any I/O module (e.g. input data or "echoed" output data) even if the controller does not own the module. In other words, the controller does not have to own a module's configuration data to listen to it.

During the I/O configuration process, you can specify one of several 'Listen-Only' modes in the Communication Format field. For more information on Communications Format, see page 10-6.

Choosing a 'Listen-Only' mode option allows the controller and module to establish communications without the controller sending any configuration data. In this instance, another controller owns the module being listened to.

IMPORTANT

Controllers using the Listen-Only mode continue to receive data multicast from the I/O module as long as a connection between an owner-controller and I/O module is maintained.

If the connection between all owner-controllers and the module is broken, the module stops multicasting data and connections to all 'Listening controllers' are also broken.

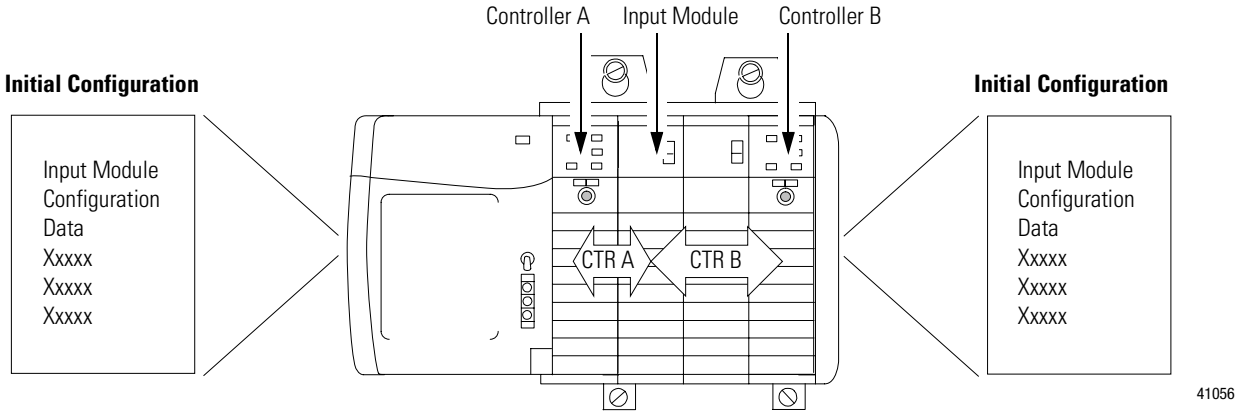
Multiple Owners of Input Modules

Because 'Listening controllers' lose their connections to modules when communications with the owner stop, the ControlLogix system will allow you to define more than one owner for input modules.

IMPORTANT Only input modules can have multiple owners. If multiple owners are connected to the same input module, they **must maintain identical configuration** for that module.

In the example below, Controller A and Controller B have both been configured to be the owner of the input module.

Figure 2.7 Multiple Owners with Identical Configuration Data



When multiple controllers are configured to own the same input module, the following events occur:

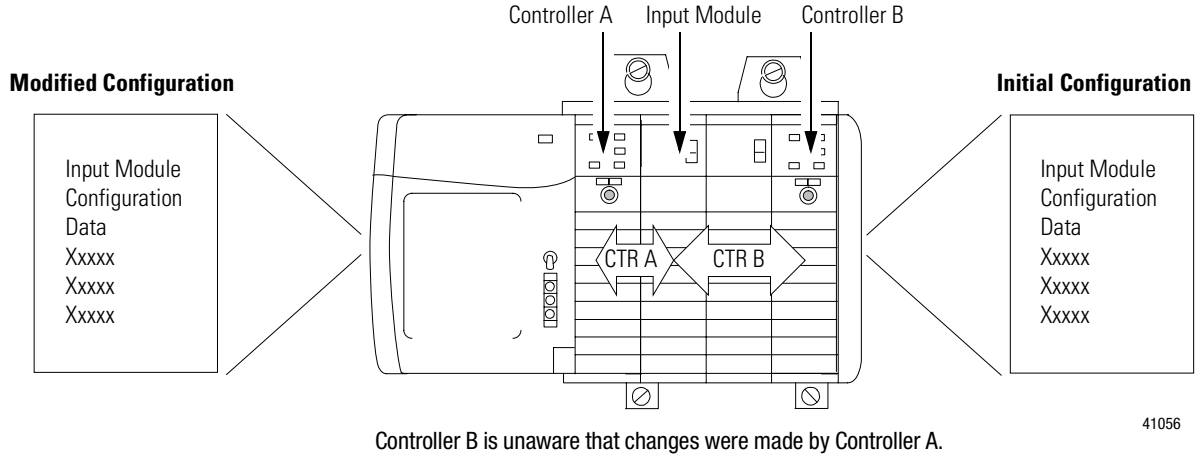
- When the controllers begin downloading configuration data, both try to establish a connection with the input module.
- Whichever controller's data arrives first establishes a connection.
- When the second controller's data arrives, the module compares it to its current configuration data (the data received and accepted from the first controller).
  - If the configuration data sent by the second controller matches the configuration data sent by the first controller the connection is also accepted.
  - If any parameter of the second configuration data is different from the first, the module rejects the connection; RSLogix 5000 alerts you to the rejected connection through an error message.

The advantage of multiple owners over a 'Listen-only' connection is that now either of the controllers can lose the connection to the module and the module will continue to operate and multicast data to the system because of the connection maintained by the other owner-controller.

Configuration Changes in an Input Module with Multiple Owners

You must be careful when changing an input module's configuration data in a multiple owner scenario. When the configuration data is changed in one of the owners, for example, Controller A, and sent to the module, that configuration data is accepted as the new configuration for the module. Controller B continues to listen, unaware that any changes have been made in the module's behavior.

Figure 2.8 Multiple Owners with Changed Configuration Data



Controller B is unaware that changes were made by Controller A.

IMPORTANT

A pop-up screen in RSLogix 5000 alerts you to the possibility of a multiple owner situation and allows you to inhibit the connection before changing the module's configuration. When changing configuration for a module with multiple owners, we recommend the connection be inhibited.

To prevent other owners from receiving potentially erroneous data, as described above, the following steps **must be followed** when changing a module's configuration in a multiple owner scenario while online:

1. For each owner-controller, inhibit the controller's connection to the module, either in the software on the Connection tab or the pop-up screen warning of the multiple owner condition.
2. Make the appropriate configuration data changes in the software. For detailed information on using RSLogix 5000 to change configuration, see Chapter 10.
3. Repeat steps 1 and 2 for all owner-controllers, making the **exact same changes** in all controllers.
4. Disable the Inhibit box in each owner's configuration.

Chapter Summary and What's Next

In this chapter, you learned about Analog I/O Operation Within the ControlLogix System.

Chapter 3 describes Using ControlLogix Analog I/O Module Features.

Notes:

Using ControlLogix Analog I/O Module Features

What This Chapter Contains

This chapter describes features that are common to all ControlLogix analog I/O modules.

For information about:	See page:
Determining Input Module Compatibility	3-1
Determining Output Module Compatibility	3-1
Features Common to All Analog I/O Modules	3-2
Understanding the Relationship Between Module Resolution, Scaling and Data Format	3-11

Determining Input Module Compatibility

ControlLogix analog input modules convert an analog signal of either volts, millivolts, milliamps or ohms that is connected to the module's screw terminals into a digital value.

The digital value which represents the magnitude of the analog signal is then transmitted on the backplane to either a controller or other control entities.

For more information on compatibility of other Rockwell Automation products to ControlLogix analog input modules, see the I/O Products Systems Overview, publication CIG-SO001.

Determining Output Module Compatibility

ControlLogix output modules convert a digital value that is delivered to the module via the backplane into an analog signal of -10.5 to +10.5 volts or 0 to 21 milliamps.

The digital value represents the magnitude of the desired analog signal. The module converts the digital value into an analog signal and provides this signal on the module's screw terminals.

For more information on compatibility of other Rockwell Automation products to ControlLogix analog output modules, see the I/O Products Systems Overview, publication CIG-SO001.

Features Common to All Analog I/O Modules

Table 3.1 lists the features that are common to all ControlLogix analog I/O modules. The features are described later in this section.

Table 3.1

Feature:	Page of description:
Removal and Insertion Under Power (RIUP)	3-2
Module Fault Reporting	3-3
Fully Software Configurable	3-3
Electronic Keying	3-4
Access to System Clock for Timestamping Functions	3-6
Rolling Timestamp	3-6
Producer/Consumer Model	3-6
Status Indicator Information	3-7
Full Class I Division 2 Compliance	3-7
UL, CSA, FM, CE, C-Tick, EEx, TUV Agency Certification	3-7
Field Calibration	3-8
Sensor Offset	3-8
Latching of Alarms	3-8

Removal and Insertion Under Power (RIUP)

All ControlLogix I/O modules may be inserted and removed from the chassis while power is applied. This feature allows greater availability of the overall control system because, while the module is being removed or inserted, there is no additional disruption to the rest of the controlled process.

Module Fault Reporting

ControlLogix analog I/O modules provide both hardware and software indication when a module fault has occurred. Each module has an LED fault indicator and RSLogix 5000 will graphically display this fault and include a fault message describing the nature of the fault. This feature allows you to determine how your module has been affected and what action should be taken to resume normal operation.

For more information on module fault reporting as it relates to specific modules, see the chapter describing that module, either chapter 4, 5, 6, 7 or 8.

Fully Software Configurable

The RSLogix 5000 software uses a custom, easily understood interface to write configuration. All module features are enabled or disabled through the I/O configuration portion of the software.

You can also use the software to interrogate any module in the system to retrieve:

- serial number
- revision information
- catalog number
- vendor identification
- error/fault information
- diagnostic counters.

By eliminating such tasks as setting hardware switches and jumpers, the software makes module configuration easier and more reliable.

Electronic Keying

Instead of plastic mechanical backplane keys, electronic keying allows the ControlLogix system to control what modules belong in the various slots of a configured system.

During module configuration, you must choose one of the following keying options for your I/O module:

- Exact Match
- Compatible Match
- Disable Keying

When the controller attempts to connect to and configure an I/O module (e.g. after program download), the module compares the following parameters before allowing the connection and configuration to be accepted:

- Vendor
- Product Type
- Catalog Number
- Major Revision - Change that affects the module's function or RSLogix 5000 interface
- Minor Revision - Change that does not affects the module's function or RSLogix 5000 interface (e.g. bug fixes)

The comparison is made between the keying information present in the I/O module and the keying information in the controller's program. This feature can prevent the inadvertent operation of a control system with the wrong module in the wrong slot. For example, if you select Exact Match and a module with revision 2.2 is placed in a location configured for a module with revision 2.4, the controller does not make a connection to the new module because of the mismatched revisions.

Table 3.2 describes the keying options available with your ControlLogix analog I/O module.

Table 3.2

Keying option:	Definiton:
Exact Match	All of the parameters listed above must match or the inserted module will reject a connection to the controller.
Compatible Match	The Compatible Match mode allows an I/O module to determine whether it can emulate the module defined in the configuration sent from the controller. With ControlLogix analog I/O modules, the module can emulate older revisions. The module will accept the configuration if the configuration's major.minor revision is less than or equal to the physical module's revision. For example, if the configuration contains a major.minor revision of 1.7, the module inserted into the slot must have a firmware revision of 1.7 or higher for a connection to be made. When a module is inserted with a major.minor revision that is less than the revision for which the slot is configured (i.e. the module has a revison of 1.6 and the slot is configured for a module with revision 1.8), no connection is made between the controller and the I/O module.
	TIP We recommend using Compatible Match whenever possible. Remember, though, with major revision changes, the module only works to the level of the configuration. At the time of this printing, the ControlLogix analog I/O modules all used a major revision of 1.(1) However, if a new major revision for a ControlLogix analog I/O module is released, consider this example. If a slot is configured for a module with major.minor revision of 1.7 and you insert a module with a major.minor revision of 2.3, the module works at the 1.7 level, with respect to module functions that are related to RSLogix 5000 such as interface changes. However, bug fixes that are affected by the module's firmware, would work at the 2.3 revision level. If possible, we suggest you make sure configuration is updated to match the revision levels of all I/O modules. Failure to do so may not prevent the application from working but may defeat the purpose of upgrading your modules' revision levels.
Disable Keying	The inserted module attempts to accept a connection to the controller regardless of its type.
	ATTENTION Be extremely cautious when using the disable keying option; if used incorrectly, this option can lead to personal injury or death, property damage or economic loss.
	If keying is disabled, a controller makes a connection with most modules of the same type as that used in the slot configuration. For example, if a slot is configured for a 1756-IF16 (16-point non-isolated analog current/voltage input module), and a 1756-IF8 (8-point non-isolated analog current/voltage input module) is inserted into the slot, the controller may establish a connection because keying is disabled. Even if keying is disabled, a controller will not establish a connection if the slot is configured for one module type (e.g. input module) and a module of another type (e.g. output module) is inserted in the slot.

(1) Minor revisions are incremented by single counts such that minor level 10 (i.e. major.minor revision level = 1.10) follows minor revision level 9 (i.e. 1.9).

Access to System Clock for Timestamping Functions

Controllers within the ControlLogix chassis maintain a system clock. This clock is also known as the Coordinated System Time (CST). You can configure your analog I/O modules to access this clock and timestamp input data or output echo data when the module multicasts to the system. You decide how to timestamp data when you choose a Communications Format. For more information on choosing a Communications Format, see page 10-6.

This feature allows for accurate calculations between events to help you identify the sequence of events in either fault conditions or in the course of normal I/O operations. The system clock can be used between multiple modules in the same chassis.

Rolling Timestamp

Each module maintains a rolling timestamp that is unrelated to the CST. The rolling timestamp is a continuously running 15 bit timer that counts in milliseconds.

For input modules, whenever a module scans its channels, it also records the value of the rolling timestamp at that time. The user program can then use the last two rolling timestamp values and calculate the interval between receipt of data or the time when new data has been received.

For output modules, the rolling timestamp value is only updated when new values are applied to the Digital to Analog Converter (DAC).

Producer/Consumer Model

By using the Producer/Consumer model, ControlLogix I/O modules can produce data without having been polled by a controller first. The modules produce the data and any owner or listen-only controller device can decide to consume it.

For example, an input module produces data and any number of processors can consume the data at the same time. This eliminates the need for one processor to send the data to another processor. For a more detailed explanation of this process, see Chapter 2, Analog I/O Operation Within the ControlLogix System.

Status Indicator Information

Each ControlLogix analog I/O module has status indicators on the front of the module that allows you to check the module health and operational status of a module.

Table 3.3 describes what status each status indicator represents:

Table 3.3

Status:	Description:
Calibration status	display indicates when your module is in the calibration mode
Module status	display indicates the module's communication status

For examples of LED indicators on ControlLogix analog I/O modules, see Chapter 12, Troubleshooting Your ControlLogix Analog I/O Module.

Full Class I Division 2 Compliance

All ControlLogix analog I/O modules maintain CSA Class I Division 2 system certification. This allows the ControlLogix system to be placed in an environment other than only a 100% hazard free.

IMPORTANT Modules should not be pulled under power, nor should a powered RTB be removed, when a hazardous environment is present.

UL, CSA, FM, CE, C-Tick, EEx, TUV Agency Certification

Any ControlLogix analog I/O modules that have obtained various agency certifications are marked as such. Ultimately, all analog modules will have these agency approvals and be marked accordingly.

Field Calibration

ControlLogix analog I/O modules allow you to calibrate on a channel-by-channel or module-wide basis. RSLogix 5000 provides a software interface to perform calibration.

To see how to calibrate your module, see Chapter 11, Calibrating the ControlLogix Analog I/O Modules.

Sensor Offset

You can add this offset directly to the input or output during calibration calculation. The purpose of this feature is to allow you to compensate for any sensor offset errors which may exist, such offset errors are common in thermocouple sensors.

To see how to set the sensor offset, see page 10-10.

Latching of Alarms

The latching feature allows analog I/O modules to latch an alarm in the set position once it has been triggered, even if the condition causing the alarm to occur disappears.

Data Format

During initial configuration of any ControlLogix analog I/O module, you must choose a Communications Format. The format chosen determines the data format of data exchanged between the owner-controller and the I/O module. For more information on choosing a Communications Format, see page 10-6.

Your analog module multicasts data in the formats listed in Table 3.4.

Table 3.4

Format type:	Description:
Integer	This mode uses a 16-bit signed format and allows faster sampling rates while using less memory in the controller but also limits the availability of features on your module. The faster sampling rates and lower memory usage vary according to module and application type. For more information on the specific sampling rates, see the Module Filter section in the module-specific chapters. Memory usage can be up to 50% less than in floating point.
Floating point	This mode uses a 32 bit IEEE floating point format.

Your choice of data format may restrict the features available with an I/O module. For example, if you use an integer data format with the 1756-OF6CI module, the Clamping feature is not available for use. For specific listings of what features are available and not available see the individual chapters for each catalog number.

TIP

We recommend that you use the floating point data format in most applications. Floating point is simpler to use and offer all module features. All ControlLogix analog I/O module default to floating point when initialled configured.

You should only use the integer data format if your application requires faster sampling rates than offered in in floating point or if you application memory is extremely limited.

For a more detailed explanation of Data Formats, as they relate to module resolution and scaling, see the next section.

Module Inhibiting

Module inhibiting allows you to indefinitely suspend a connection between an owner-controller and an analog I/O module. This process can occur in either of the following ways:

- You write configuration for an I/O module but inhibit the module to prevent it from communicating with the owner-controller. In this case, the owner does not establish a connection and configuration is not sent to the module until the connection is uninhibited.
- In your application, a controller already owns a module, has downloaded configuration to the module and is currently exchanging data over the connection between the devices. In this case, you can inhibit the module and the owner-controller behaves as if the connection to the module does not exist.

IMPORTANT Whenever you inhibit an output module, it enters the program mode and all outputs change to the state configured for the program mode. For example, if an output module is configured so that the state of the outputs go to zero (0) during program mode, whenever that module is inhibited, the outputs will go to zero (0).

The following examples are instances where you may need to use module inhibiting:

- Multiple controllers own the same analog input module. A change is required in the module's configuration; however, the change must be made to the program in all controllers. In this case, you can:
  a. Inhibit the module.
  b. Change configuration in all controllers.
  c. Unihibit the module.

- You want to FLASH upgrade an analog I/O module. We recommend you:
  a. Inihibit the module.
  b. Perform the upgrade.
  c. Uninhibit the module.

- You are using a program that includes a module that you do not physically possess yet, but you do not want the controller to continually look for a module that does not exist yet. In this case, you can inhibit the module in your program until it physically resides in the proper slot.

Understanding the Relationship Between Module Resolution, Scaling and Data Format

The following three concepts are closely related and must be explained in conjunction with each other:

- Module Resolution
- Scaling
- Data Format as Related to Resolution and Scaling

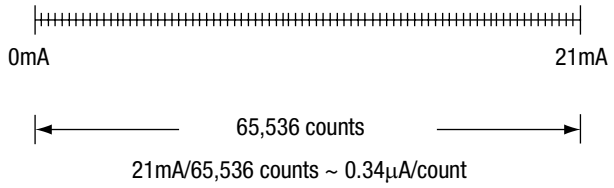
Module Resolution

Resolution is the smallest amount of change that the module can detect. Analog input modules are capable of 16 bit resolution. Output modules are capable of 13-16 bit resolution, depending on the module type.

The 16 bits represent 65,536 counts. This total is fixed but the value of each count is determined by the operational range you choose for your module.

For example, if you are using the 1756-IF6I module, your module's available current range equals 21mA. Divide your range by the number of counts to figure out the value of each count. In this case, one count is approximately 0.34μA.

Figure 3.1 Module Resolution



IMPORTANT A module's resolution is fixed. It will not change regardless of what data format you choose or how you decide to scale your module in floating point mode.

Resolution is based on the module hardware and the range selected. If you use a sensor with limited range, you do not change the module resolution.

Table 3.5 lists the resolution for each module's range.

Table 3.5 Current Values Represented in Engineering Units

Module:	Range:	Number of significant bits:	Resolution:
1756-IF16 and 1756-IF8	+/- 10.25V	16 bits	320μV/count
	0V - 10.25V		160μV/count
	0V - 5.125V		80μV/count
	0mA - 20.5mA		0.32μA/count
1756-IF6CIS	0mA - 21mA	16 bits	0.34μA/count
1756-IF6I	+/- 10.5V	16 bits	343μV/count
	0V - 10.5V		171μV/count
	0V - 5.25V		86μV/count
	0mA - 21mA		0.34μA/count
1756-IR6I	1Ω - 487Ω	16 bits	7.7mΩ/count
	2Ω - 1000Ω		15mΩ/count
	4Ω - 2000Ω		30mΩ/count
	8Ω - 4020Ω		60mΩ/count
1756-IT6I and 1756-IT6I2	-12mV - 30mV	16 bits	0.7μV/count
	-12mV - 78mV		1.4μV/count
1756-OF4 and 1756-OF8	+/- 10.4V	16 bits	320μV/count
	0mA - 21mA	15 bits	0.65μA/count
1756-OF6VI	+/- 10.5V	14 bits	1.3mV
1756-OF6CI	0mA - 21mA	13 bits	2.7μA

IMPORTANT Because these modules must allow for possible calibration inaccuracies, resolution values represent the available Analog to Digital or Digital to Analog counts over the specified range.

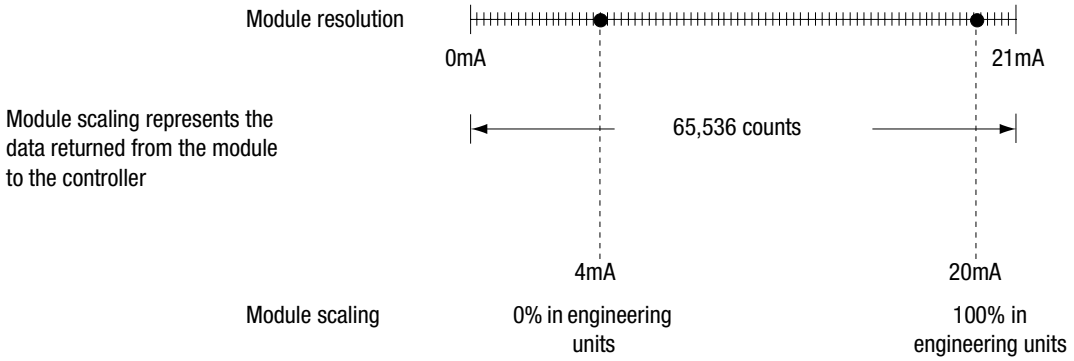
Scaling

With scaling, you change a quantity from one notation to another. For ControlLogix analog I/O modules, scaling is **only available with the floating point data format**.

When you scale a channel, you must choose two points along the module's operating range and apply low and high values to those points. For example, if you are using the 1756-IF6I module in current mode, the module maintains a 0mA to 21mA range capability. But your application may use a 4mA to 20mA transmitter. You can scale the module to represent 4mA as the low signal and 20mA as the high signal.

Scaling allows you to configure the module to return data to the controller so that 4mA returns a value of 0% in engineering units and 20mA returns a value of 100% in engineering units.

Figure 3.2 Module Resolution Compared to Module Scaling



IMPORTANT In choosing two points for the low and high value of your application, you do not limit the range of the module. The module's range and its resolution remain constant regardless of how you scale it for your application.

The module may operate with values beyond the 4mA to 20mA range. If an input signal beyond the low and high signals is present at the module (e.g. 3mA), that data will be represented in terms of the engineering units set during scaling. Table 3.5 shows example values that may appear based on the example mentioned above.

Table 3.6 Current Values Represented in Engineering Units

Current:	Engineering units value:
3mA	-6.25%
4mA	0%
12mA	50%
20mA	100%
21mA	106.25%

Data Format as Related to Resolution and Scaling

You can choose one of the following data formats for your application:

- Integer mode
- Floating point mode

Integer mode

This mode provides the most basic representation of analog data. When a module multicasts data in the integer mode, the low and high signals of the input range are fixed.

IMPORTANT Scaling is not available in integer mode. The low signal of your application range equals -32,768 counts while the high signal equals 32,767 counts.

In integer mode, input modules generate digital signal values that correspond to a range from -32,768 to 32,767 counts.

Table 3.7 lists the conversions of a generated digital signal to the number of counts.

Table 3.7 Input Signal to User Count Conversion

Input module:	Available range:	Low signal and user counts:	High signal and user counts:
1756-IF16/IF8	+/- 10V	-10.25V -32768 counts	10.25V 32767 counts
	0V - 10V	0V -32768 counts	10.25V 32767 counts
	0V - 5V	0V -32768 counts	5.125V 32767 counts
	0mA - 20mA	0mA -32768 counts	20.58mA 32767 counts
1756-IF6CIS	0mA - 20mA	0mA -32768 counts	21.09376mA 32767 counts
1756-IF6I	+/- 10V	-10.54688V -32768 counts	10.54688V 32767 counts
	0V - 10V	0V -32768 counts	10.54688V 32767 counts
	0V - 5V	0V -32768 counts	5.27344V 32767 counts
	0mA - 20mA	0mA -32768 counts	21.09376mA 32767 counts
1756-IR6I	1Ω – 487Ω	0.859068653Ω -32768 counts	507.862Ω 32767 counts
	2Ω – 1000Ω	2Ω -32768 counts	1016.502Ω 32767 counts
	4Ω – 2000Ω	4Ω -32768 counts	2033.780Ω 32767 counts
	8Ω – 4020Ω	8Ω -32768 counts	4068.392Ω 32767 counts
1756-IT6I and 1756-IT6I2	-12mV - 30mV	-15.80323mV -32768 counts	31.396mV 32767 counts
	-12mV - 78mV	-15.15836mV -32768 counts	79.241mV 32767 counts

Output modules allow you to generate an analog signal at the screw terminals that correspond to a range from -32,768 to 32,767 counts.

Table 3.8 lists the conversions a generated digital signal to the number of counts.

Table 3.8 Output Signal to User Count Conversion

Output module:	Available range:	Low signal and user counts:	High signal and user counts:
1756-OF4/OF8	0mA - 20mA	0mA -32768 counts	21.2916mA 32767 counts
	+/- 10V	-10.4336V -32768 counts	10.4336V 32767 counts
1756-OF6CI	0mA - 20mA	0mA -32768 counts	21.074mA 32767 counts
1756-OF6VI	+/- 10V	-10.517V -32768 counts	10.517V 32767 counts

Floating point mode

This data type mode allows you to change the data representation of the selected module. Although the full range of the module does not change, you can **scale** your module to represent I/O data in terms specific for your application.

For example, if you are using the 1756-IF6I module in floating point mode and choose an input range of 0mA to 20mA, the module can use signals within the range of 0mA to 21mA but you can scale the module to represent data between 4mA to 20mA as the low and high signals in engineering units as shown in Figure 3.1 on page 3-11.

For an example of how to define data representation in engineering units through RSLogix 5000, see page 10-10.

Difference Between Integer and Floating Point

The key difference between choosing integer mode or floating point mode is that integer is fixed between -32,768 and 32,767 counts and floating point mode provides scaling to represent I/O data in specific engineering units for your application. Module resolution remains constant between the formats at 0.34μA/count.

For example, Table 3.9 shows the difference in the data returned from the 1756-IF6I module to the controller between data formats. In this case, the module uses the 0mA-20mA input range with 0mA scaled to 0% and 20mA scaled to 100%, as shown in Figure 3.1 on page 3-11.

Table 3.9 Difference Between Data Formats in Applications Using the 1756-IF6I Module and An Input Range of 0mA to 20mA

Signal value:	Fixed number of counts in integer mode:	Data representation in floating point mode (Engineering units):
0mA	-32768 counts	-25%
4mA	-20341 counts	0%
12mA	4514 counts	50%
20mA	29369 counts	100%
21.09376mA	32767 counts	106.25%

Chapter Summary and What's Next

In this chapter you learned about using features common to all ControlLogix analog I/O modules

Move to Chapter 4 to learn about non-isolated analog input modules.

Notes:

Non-Isolated Analog Voltage/Current Input Modules (1756-IF16, -IF8)

What This Chapter Contains

This chapter describes features specific to ControlLogix non-isolated analog voltage/current input modules.

For information about:	See page:
Choosing a Wiring Method	4-2
Choosing a Data Format	4-4
Features Specific to Non-Isolated Analog Input Modules	4-5
Using Module Block and Input Circuit Diagrams	4-12
Wiring the 1756-IF16 Module	4-15
Wiring the 1756-IF8 Module	4-19
1756-IF16 Module Fault and Status Reporting	4-23
1756-IF8 Module Fault and Status Reporting	4-30

In addition to the features described in this chapter, the non-isolated analog voltage/current input modules support all features described in Chapter 3. Table 4.1 lists additional features that your non-isolated analog voltage/current input modules support.

Table 4.1 Additional Features Supported by the Non-Isolated Analog Input Modules

Feature:	Page of description:
Removal and Insertion Under Power (RIUP)	3-2
Module Fault Reporting	3-3
Fully Software Configurable	3-3
Electronic Keying	3-4
Access to System Clock for Timestamping Functions	3-6
Rolling Timestamp	3-6
Producer/Consumer Model	3-6
Status Indicator Information	3-7
Full Class I Division 2 Compliance	3-7
UL, CSA, FM, CE, C-Tick, EEx, TUV Agency Certification	3-7
Field Calibration	3-8
Sensor Offset	3-8
Latching of Alarms	3-8

Choosing a Wiring Method

The 1756-IF16 and 1756-IF8 modules support the following three wiring methods:

- Single-Ended Wiring Method
- Differential Wiring Method
- High Speed Mode Differential Wiring Method

After determining which wiring method you will use on your module, you must inform the system of that choice when you choose a Communications Format. For more information on choosing a Communications Format, see page 10-6.

For examples of each wiring format on the 1756-IF16 module, see the examples beginning on page 4-15. For examples of each wiring format on the 1756-IF8 module, see the examples beginning on page 4-19.

Single-Ended Wiring Method

Single-ended wiring compares one side of the signal input to signal ground. This difference is used by the module in generating digital data for the controller.

When using the single-ended wiring method, all input devices are tied to a common ground. In addition to the common ground, the use of single-ended wiring maximizes the number of usable channels on the module (8 channels for 1756-IF8 module & 16 channels for the 1756-IF16).

Differential Wiring Method

The differential wiring method is recommended for applications in which it is advantageous or required to have separate signal pairs or a common ground is not available. Differential wiring is recommended for environments where improved noise immunity is needed.

IMPORTANT This wiring method allows use of only half a module's channels. For example, you can only use 8 channels on the 1756-IF16 module and 4 channels on the 1756-IF8 module.

High Speed Mode Differential Wiring Method

You can configure the 1756-IF16 and 1756-IF8 modules for a high speed mode that will give you the fastest data updates possible. When using the high speed mode, remember the following conditions:

- This mode uses the differential wiring method
- This mode only allows use of 1 out of every 4 channels on the module

Update times for applications using the high speed mode can be found in Table 4.5 on page 4-6.

Choosing a Data Format

Data format determines the format of the data returned from the module to the owner-controller and the features that are available to your application. You choose a data format when you choose a Communications Format. For more information on Communications Format, see page 10-6.

You can choose one of the two following data formats:

- Integer mode
- Floating point mode

Table 4.2 shows which features are available in each format.

Table 4.2 Features Available in Each Data Format

Data format:	Features available:	Features not available:
Integer mode	Multiple input ranges	Process alarms
	Module filter	Digital filtering
	Real time sampling	Rate alarms
		Scaling
Floating point mode	All features	See below

IMPORTANT When using the **1756-IF16** module in **single-ended** mode (i.e. 16 channel mode) with floating point data format, **process alarms and rate alarms** are **not available**.

This condition exists only when the 1756-IF16 is wired for single-ended mode. The 1756-IF8 is not affected.

Features Specific to Non-Isolated Analog Input Modules

Table 4.3 lists features that are specific to the 1756-IF16 and 1756-IF8 modules. The features are described later in this section.

Table 4.3

Feature:	Page of description:
Multiple Input Ranges	4-5
Module Filter	4-6
Real Time Sampling	4-7
Underrange/Overrange Detection	4-7
Digital Filter	4-8
Process Alarms	4-9
Rate Alarm	4-10
Wire Off Detection	4-10

Multiple Input Ranges

You can select from a series of operational ranges for **each channel** on your module. The range designates the minimum and maximum signals that are detectable by the module.

Table 4.4 Possible Input Ranges

Module:	Possible ranges:
1756-IF16 and 1756-IF8	-10 to 10V
	0 to 5V
	0 to 10V
	0 to 20mA

For an example of how to choose an input range for your module, see page 10-10.

Module Filter

The module filter is a built-in feature of the Analog-to-Digital convertor which attenuates the input signal beginning at the specified frequency. This feature is applied on a module-wide basis.

The module attenuates the selected frequency by approximately -3dB or 0.707 of the applied amplitude. This selected frequency is also called the bandwidth of the module.

An input signal with frequencies above the selected frequency will be attenuated more while frequencies below the selection will receive no attenuation.

In addition to frequency rejection, a by-product of the filter selection is the minimum sample rate (RTS) that is available. For example, in floating point mode, the 1000Hz selection will not attenuate any frequencies less than 1000Hz but will allow sampling of all 16 channels within 18ms. But the 10Hz selection attenuates all frequencies above 10Hz and only allow sampling all 16 channels within 488ms.

IMPORTANT 60Hz is the default setting for the module filter. This setting provides approximately 3dB of filtering of a 60Hz input.

Use Table 4.5 to choose a module filter setting.

Table 4.5 Notch Filter Selections with Associated Performance Data

Module Filter Setting (-3dB)[1] [2]	Wiring Mode	10Hz	50Hz/60Hz (Default)	100Hz	250Hz	1000Hz
Minimum Sample Time (RTS)	Single-Ended	488ms	88ms	56ms	28ms	16ms
Integer Mode	Differential	244ms	44ms	28ms	14ms	8ms
	High Speed Differential	122ms	22ms	14ms	7ms	5ms
Minimum Sample Time (RTS)	Single-Ended	488ms	88ms	56ms	28ms	18ms
Floating Point Mode	Differential	244ms	44ms	28ms	14ms	11ms
	High Speed Differential	122ms	22ms	14ms	7ms	6ms
Effective Resolution		16 bits	16 bits	16 bits	14 bits	12 bits

(1) For optimal 50/60Hz noise rejection (>80dB), choose the 10Hz filter.

(2) Worst case settling time to 100% of a step change is double the RTS sample times

To see how to choose a Module Filter, see page 10-10.

Real Time Sampling

This parameter instructs the module how often to scan its input channels and obtain all available data. After the channels are scanned, the module multicasts that data. This feature is applied on a module-wide basis.

During module configuration, you specify a Real Time Sampling (RTS) period and a Requested Packet Interval (RPI) period. Both of these features instruct the module to multicast data, but only the RTS feature instructs the module to scan its channels before multicasting.

For more information on Real Time Sampling, see page 2-4. For an example of how to set the RTS rate, see page 10-10.

Underrange/Overrange Detection

This feature detects when the non-isolated input module is operating beyond limits set by the input range. For example, If you are using the 1756-IF16 module in the 0V-10V input range and the module voltage increases to 11V, the Overrange detection detects this condition.

Use the following table to see the input ranges of non-isolated input modules and the lowest/highest signal available in each range before the module detects an underrange/overrange condition:

Table 4.6 Low and High Signal Limits on Non-Isolated Input Modules

Input module:	Available range:	Lowest signal in range:	Highest signal in range:
1756-IF16 and 1756-IF8	+/- 10V	-10.25V	10.25V
	0V-10V	0V	10.25V
	0V-5V	0V	5.125V
	0mA-20mA	0mA	20.58mA

Digital Filter

The digital filter smooths input data noise transients for all channels on the module. This feature is applied on a **per channel** basis.

The digital filter value specifies the time constant for a digital first order lag filter on the input. It is specified in units of milliseconds. A value of 0 disables the filter.

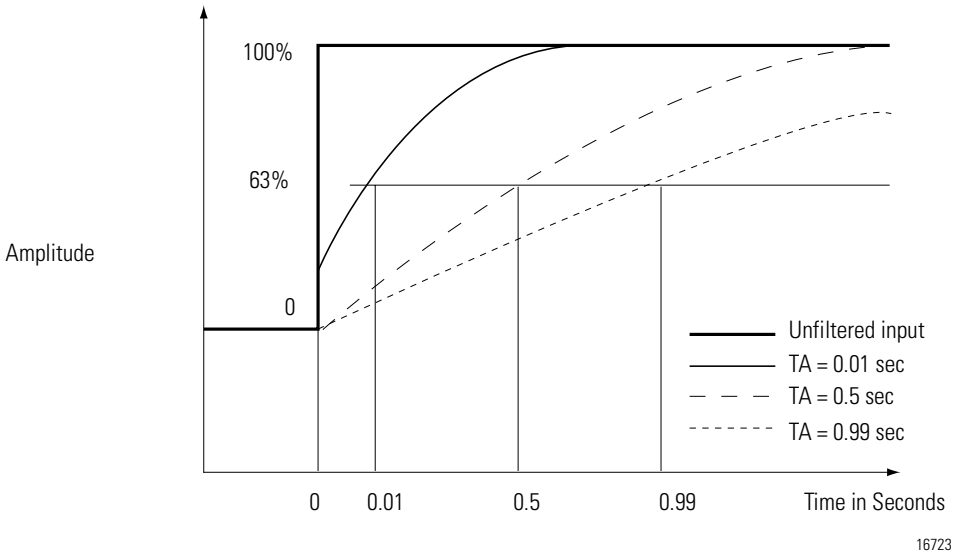
The digital filter equation is a classic first order lag equation.

$$Yn = Yn\text{-}1 + \frac{[\Delta t]}{\Delta t + TA} (X_n - Y_n\text{-}1)$$

Yn = present output, filtered peak voltage (PV)
Yn-1 = previous output, filtered PV
Δt = module channel update time (seconds)
TA = digital filter time constant (seconds)
Xn = present input, unfiltered PV

Using a step input change to illustrate the filter response, as shown in Figure 4.1, you can see that when the digital filter time constant elapses, 63.2% of the total response is reached. Each additional time constant achieves 63.2% of the remaining response.

Figure 4.1



To see how to set the Digital Filter, see page 10-10.

Process Alarms

Process alarms alert you when the module has exceeded configured high or low limits for **each channel**. You can latch process alarms. These are set at four user configurable alarm trigger points:

- High high
- High
- Low
- Low low

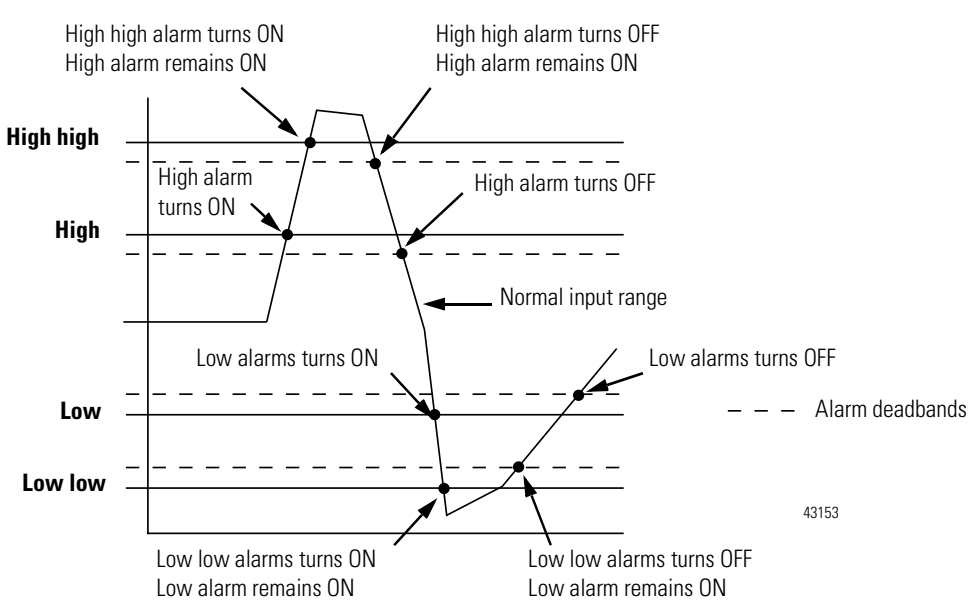
IMPORTANT Process alarms are not available in integer mode or in applications using 1756-IF16 module in the single-ended, floating point mode. The values for each limit are entered in scaled engineering units.

Alarm Deadband

You may configure an **Alarm Deadband** to work with the process alarms. The deadband allows the process alarm status bit to remain set, despite the alarm condition disappearing, as long as the input data remains within the deadband of the process alarm.

Figure 4.2 shows input data that sets each of the four alarms at some point during module operation. In this example, Latching is disabled; therefore, each alarms turns OFF when the condition that caused it to set ceases to exist.

Figure 4.2



To see how to set Process Alarms, see page 10-10.

Rate Alarm

The rate alarm triggers if the rate of change between input samples for **each channel** exceeds the specified trigger point for that channel.

IMPORTANT Rate alarms are not available in integer mode or in applications using 1756-IF16 module in the single-ended, floating point mode. The values for each limit are entered in scaled engineering units.

For example, if you set the 1756-IF16 (with normal scaling in Volts) to a rate alarm of 1.0 V/S, the rate alarm will only trigger if the difference between measured input samples changes at a rate > 1.0 V/S.

If the module's RTS is 100 ms (i.e. sampling new input data every 100ms) and at time 0, the module measures 5.0 volts and at time 100ms measures 5.08 V, the rate of change is (5.08V - 5.0V) / (100mS) = 0.8 V/S. The rate alarm would not set as the change is less than the trigger point of 1.0V/s.

If the next sample taken is 4.9V, the rate of change is (4.9V-5.08V)/(100mS)=-1.8V/S. The absolute value of this result is > 1.0V/S, so the rate alarm will set. Absolute value is applied because rate alarm checks for the magnitude of the rate of change being beyond the trigger point, whether a positive or negative excursion.

To see how to set the Rate Alarm, see page 10-10.

Wire Off Detection

The 1756-IF16 and 1756-IF8 modules will alert you when a **signal wire only** has been disconnected from one of its channels or the RTB has been removed from the module. When a wire off condition occurs for this module, two events occur:

- Input data for that channel changes to a specific scaled value
- A fault bit is set in the owner-controller which may indicate the presence of a wire off condition

Because the 1756-IF16 and 1756-IF8 modules can be applied in voltage or current applications, differences exist as to how a wire off condition is detected in each application.

Table 4.7 lists the differences that occur when a wire off condition occurs in various applications.

Table 4.7

When the Wire Off condition occurs in this application:	The following events occur:
Single-Ended Voltage Applications	• Input data for **odd numbered channels** changes to the scaled value associated with the **underrange** signal value of the selected operational range in floating point mode (minimum possible scaled value) or -32,767 counts in integer mode • The ChxUnderrange (x=channel number) tag is set to 1 • Input data for **even numbered channels** changes to the scaled value associated with the **overrange** signal value of the selected operational range in floating point mode (maximum possible scaled value) or 32,767 counts in integer mode • The ChxOverrange (x=channel number) tag[1] is set to 1
Single-Ended Current	• Input data for that channel changes to the scaled value associated with the **underrange** signal value of the selected operational range in floating point mode (minimum possible scaled value) or -32,768 counts in integer mode • The ChxUnderrange (x=channel number) tag is set to 1
Differential Voltage	• Input data for that channel changes to the scaled value associated with the **overrange** signal value of the selected operational range in floating point mode (maximum possible scaled value) or 32,768 counts in integer mode • The ChxOverrange (x=channel number) tag is set to 1
Differential Current Applications	• Input data for that channel changes to the scaled value associated with the **underrange** signal value of the selected operational range in floating point mode (minimum possible scaled value) or -32,768 counts in integer mode • The ChxUnderrange (x=channel number) tag is set to 1 In current applications, if wire off detection occurs for one of the following reasons: • because the RTB has been disconnected from the module • both the signal wire and the jumper wire have been disconnected the module reacts with the same conditions as described in differential voltage applications.

(1) For more information about tags in the tag editor, see Appendix B.

Using Module Block and Input Circuit Diagrams

This section shows the 1756-IF16 and 1756-IF8 modules' block diagrams and input circuit diagrams.

Module Block Diagrams

Figure 4.3 1756-IF16 Module Block Diagram

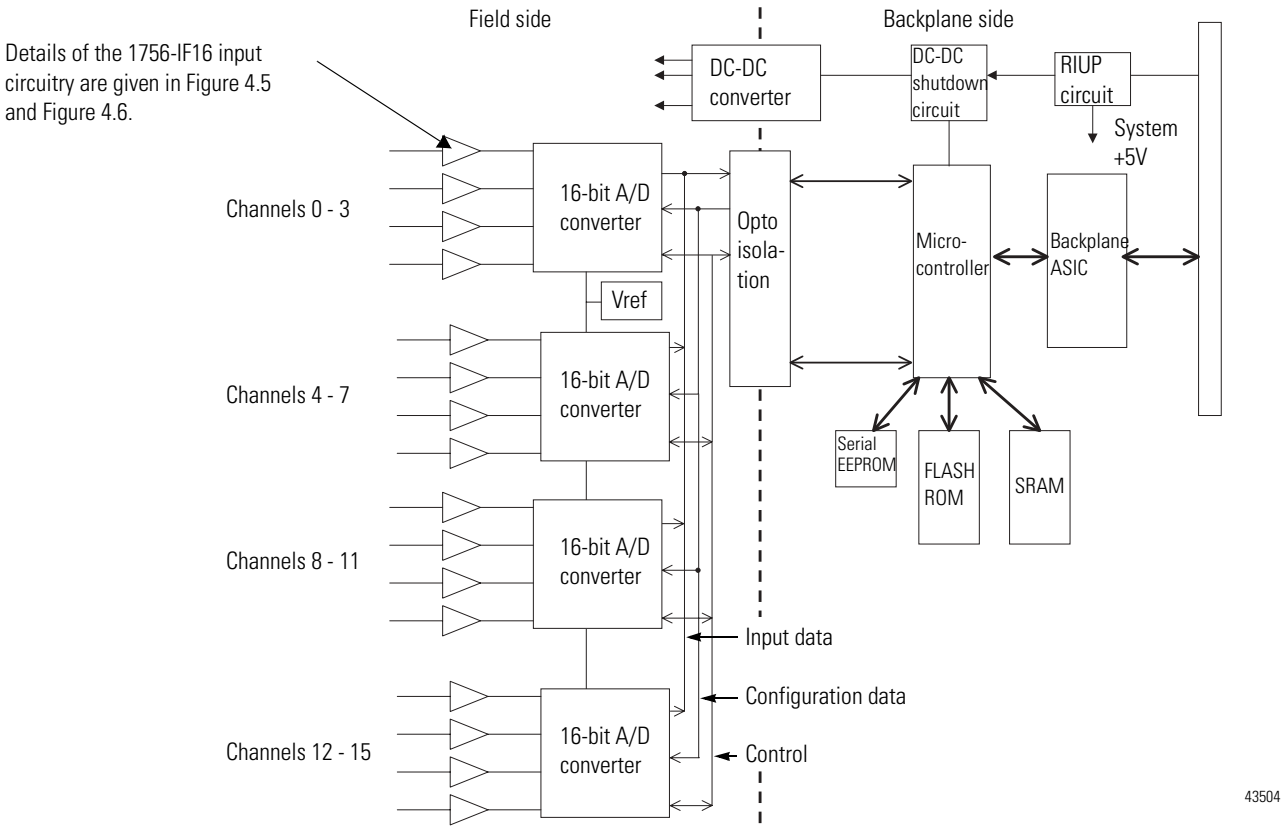
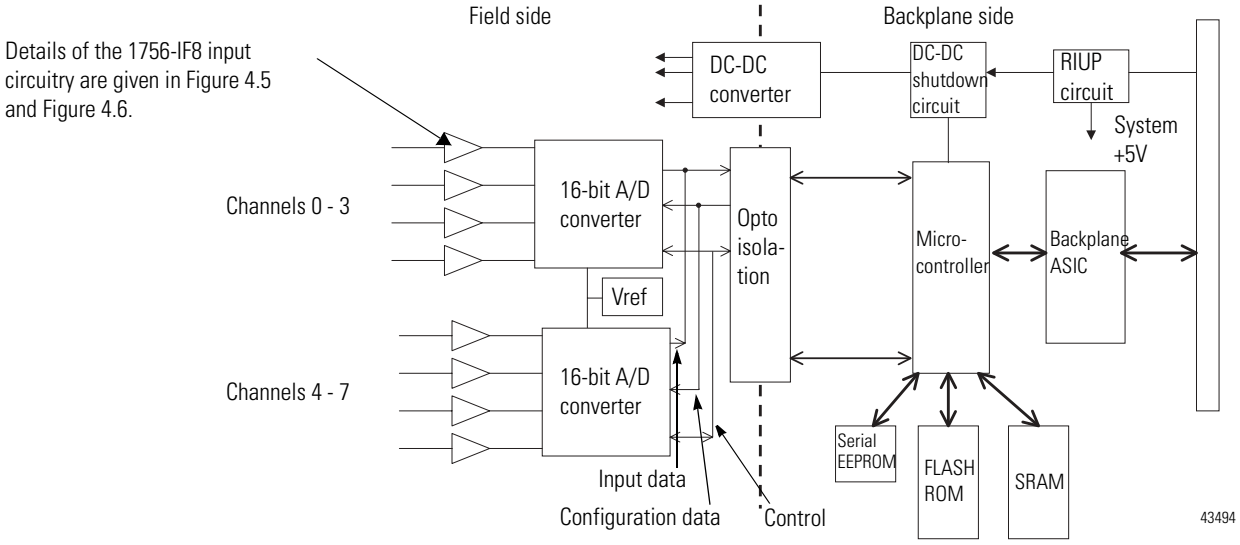


Figure 4.4 1756-IF8 Module Block Diagram

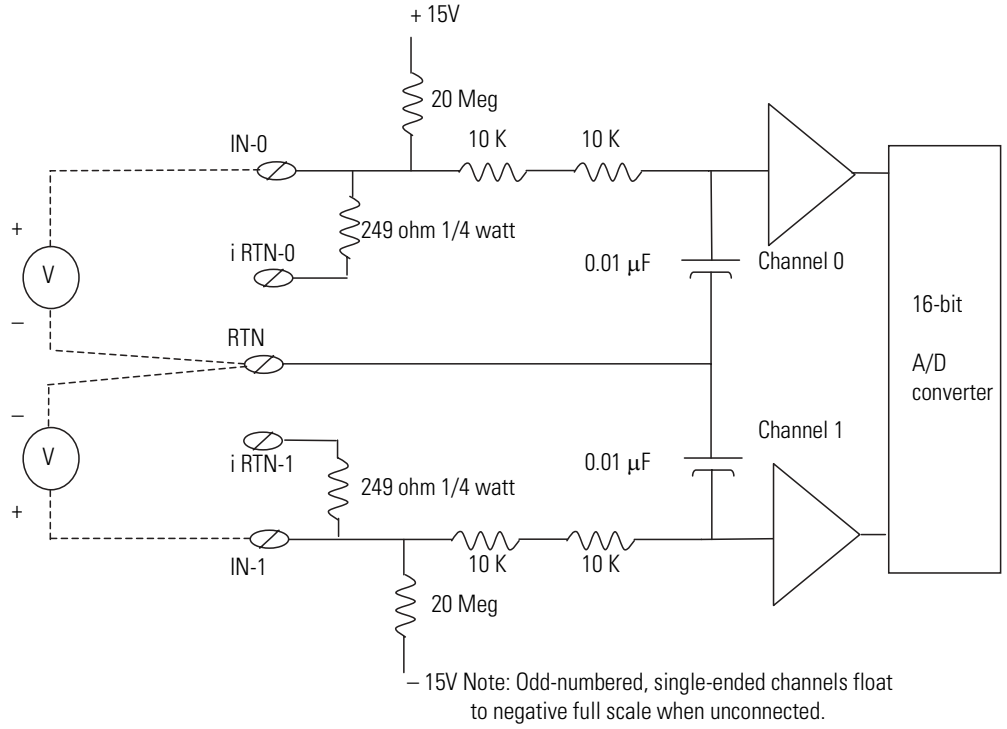


Field Side Circuit Diagrams

The field side circuit diagrams are the same for both the 1756-IF16 and 1756-IF8 modules.

Figure 4.5 1756-IF16 and 1756-IF8 Voltage Input Circuit

Single-Ended Voltage Inputs



Differential Voltage Inputs

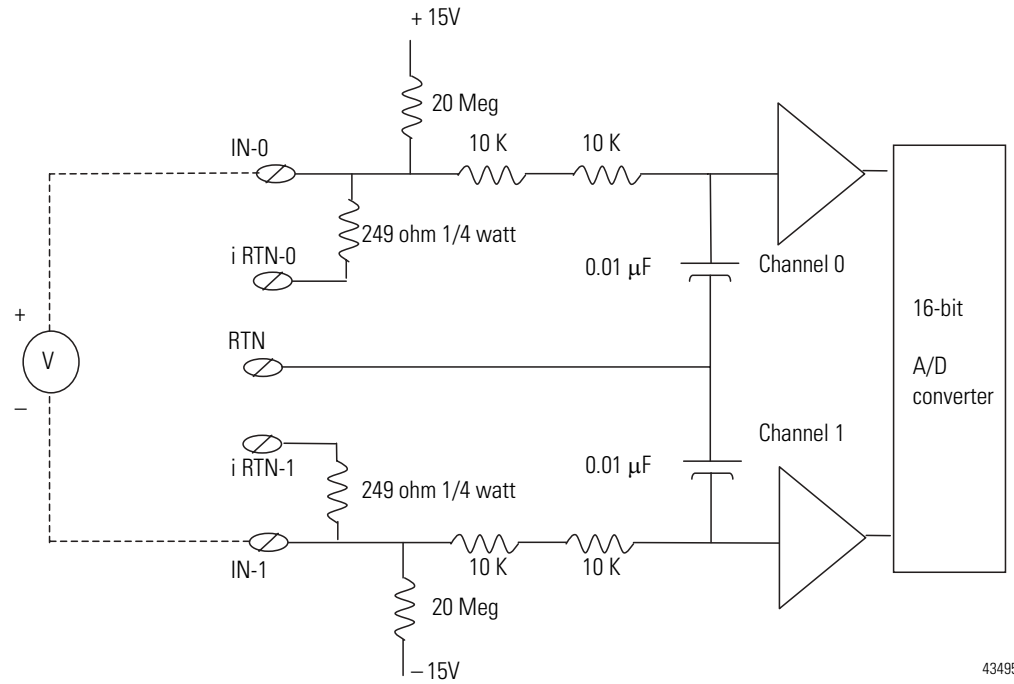
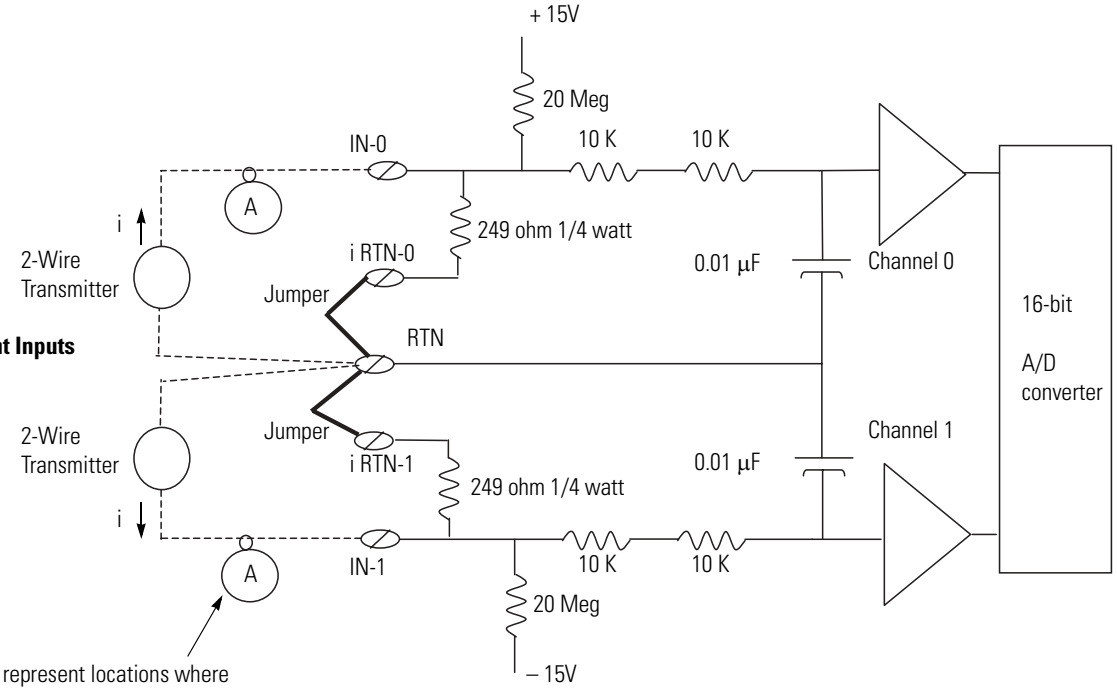


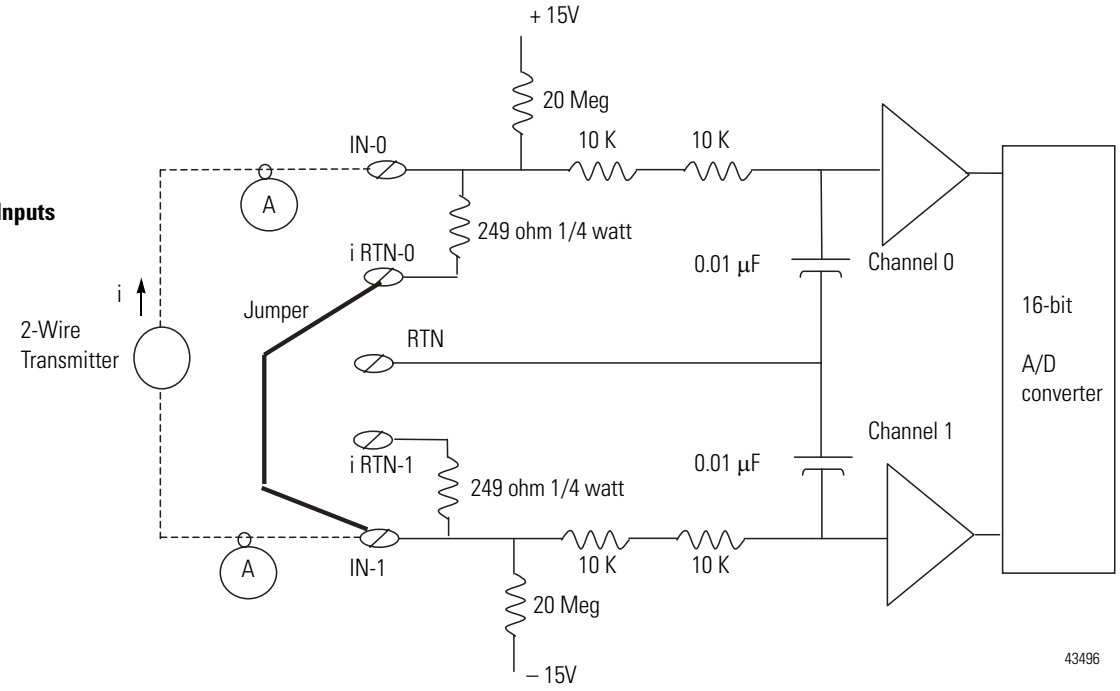
Figure 4.6 1756-IF16 and 1756-IF8 Current Input Circuit

Single-Ended Current Inputs



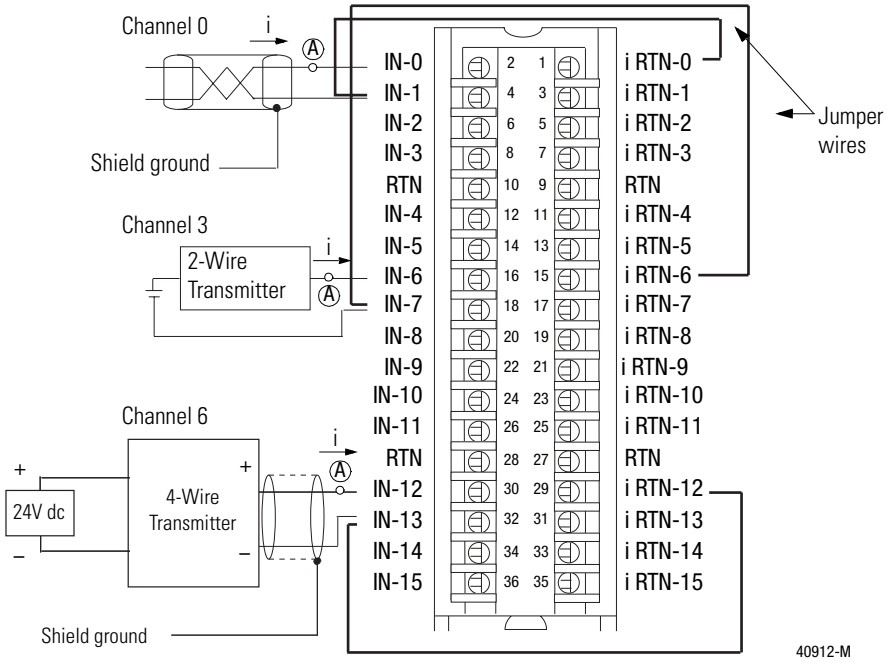
The A locations represent locations where you can place additional loop devices (e.g. strip chart recorders) in the current loop.

Differential Current Inputs



Wiring the 1756-IF16 Module

Figure 4.7 1756-IF16 Differential Current Wiring Example



NOTES:

1. Use the Table D.8 when wiring your module in differential mode

Table D.8

This channel:	Uses these terminals:	This channel:	Uses these terminals:
Channel 0	IN-0 (+), IN-1 (-) & i RTN-0	Channel 4	IN-8 (+), IN-9 (-) & i RTN-8
Channel 1	IN-2 (+), IN-3 (-) & i RTN-2	Channel 5	IN-10 (+), IN-11 (-) & i RTN-10
Channel 2	IN-4 (+), IN-5 (-) & i RTN-4	Channel 6	IN-12 (+), IN-13 (-) & i RTN-12
Channel 3	IN-6 (+), IN-7 (-) & i RTN-6	Channel 7	IN-14 (+), IN-15 (-) & i RTN-14

2. All terminals marked RTN are connected internally.

3. A 249Ω current loop resistor is located between IN-x and i RTN-x terminals.

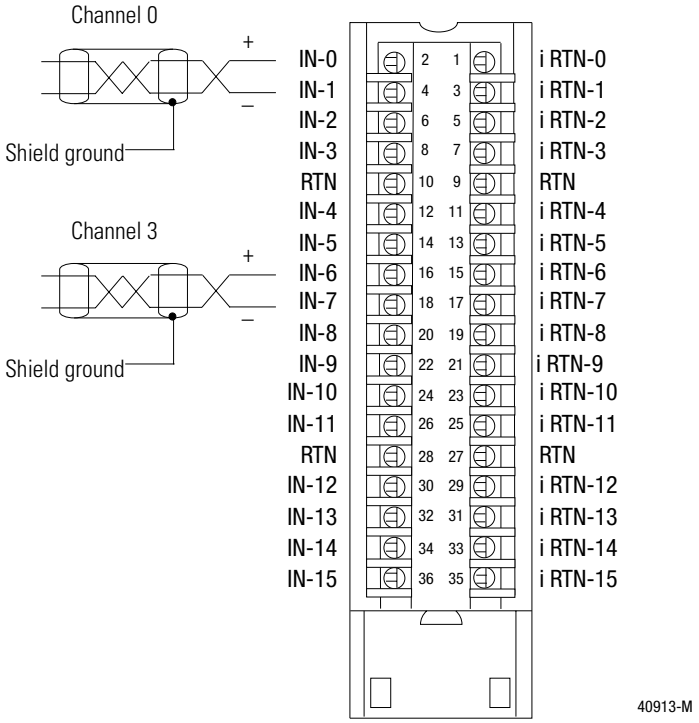
4. If multiple (+) or multiple (-) terminals are tied together, connect that tie point to a RTN terminal to maintain the module's accuracy.

5. Place additional loop devices (e.g. strip chart recorders, etc.) at the A location in the current loop.

6. Do not connect more than two wires to any single terminal.

IMPORTANT: When operating in 4 channel, **high speed mode**, only use channels 0, 2, 4 and 6.

Figure 4.8 1756-IF16 Differential Voltage Wiring Example



NOTES:

1. Use the Table D.9 when wiring your module in differential mode

Table D.9

This channel:	Uses these terminals:	This channel:	Uses these terminals:
Channel 0	IN-0 (+) & IN-1 (-)	Channel 4	IN-8 (+) & IN-9 (-)
Channel 1	IN-2 (+) & IN-3 (-)	Channel 5	IN-10 (+) & IN-11 (-)
Channel 2	IN-4 (+) & IN-5 (-)	Channel 6	IN-12 (+) & IN-13 (-)
Channel 3	IN-6 (+) & IN-7 (-)	Channel 7	IN-14 (+) & IN-15 (-)

2. All terminals marked RTN are connected internally.

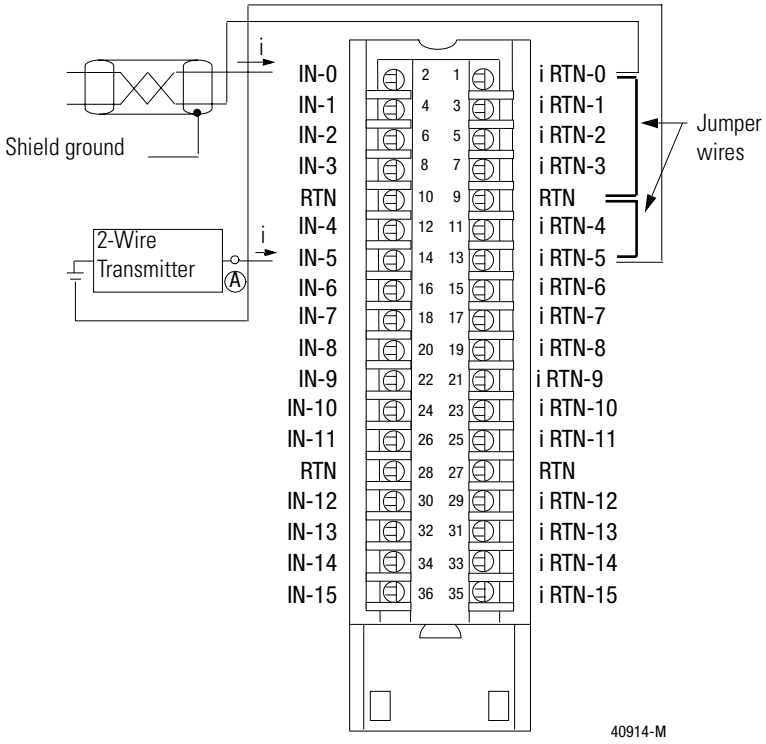
3. If multiple (+) or multiple (-) terminals are tied together, connect that tie point to a RTN terminal to maintain the module's accuracy.

4. Terminals marked RTN or iRTN are not used for differential voltage wiring.

5. Do not connect more than two wires to any single terminal.

IMPORTANT: When operating in 4 channel, **high speed mode**, only use channels 0, 2, 4 and 6.

Figure 4.9 1756-IF16 Single-Ended Current Wiring Example



NOTES:

1. All terminals marked RTN are connected internally.

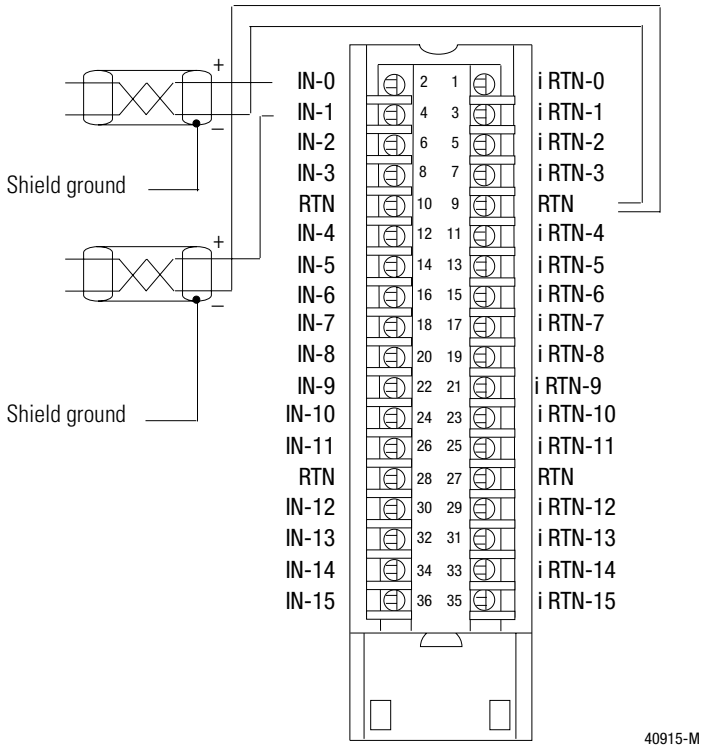
2. For current applications, all terminals marked iRTN must be wired to terminals marked RTN.

3. A 249Ω current loop resistor is located between IN-x and i RTN-x terminals.

4. Place additional loop devices (e.g. strip chart recorders, etc.) at the A location in the current loop.

5. Do not connect more than two wires to any single terminal.

Figure 4.10 1756-IF16 Single-Ended Voltage Wiring Example

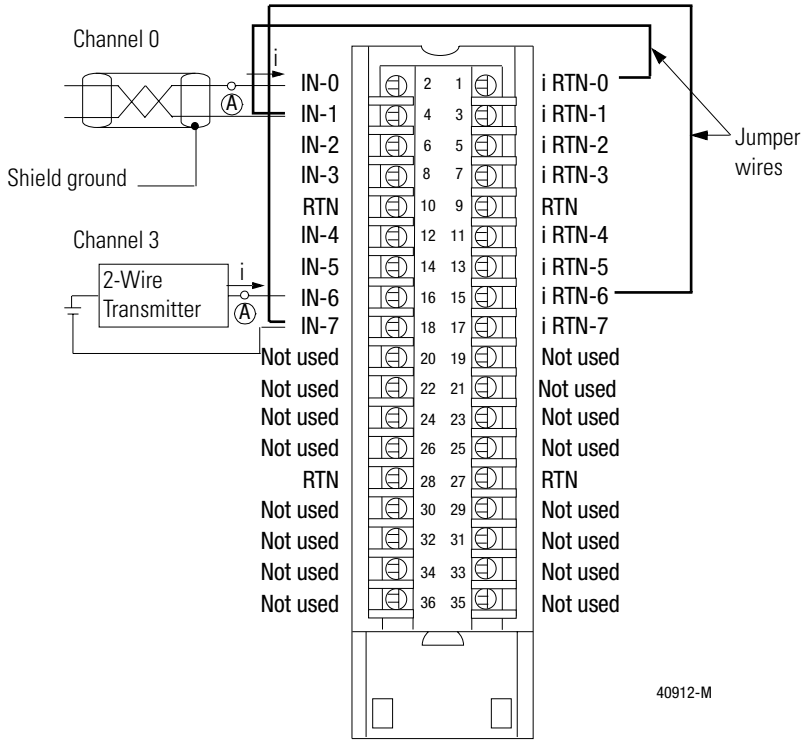


NOTES:

1. All terminals marked RTN are connected internally.
2. Terminals marked iRTN are not used for single-ended voltage wiring.
3. Do not connect more than two wires to any single terminal.

Wiring the 1756-IF8 Module

Figure 4.11 1756-IF8 Differential Current Wiring Example - 4 Channels



NOTES:

1. Use the Table 4.10 when wiring your module in differential mode

Table 4.10

This channel:	Uses these terminals:
Channel 0	IN-0 (+), IN-1 (-) & i RTN-0
Channel 1	IN-2 (+), IN-3 (-) & i RTN-2
Channel 2	IN-4 (+), IN-5 (-) & i RTN-4
Channel 3	IN-6 (+), IN-7 (-) & i RTN-6

2. All terminals marked RTN are connected internally.

3. A 249Ω current loop resistor is located between IN-x and i RTN-x terminals.

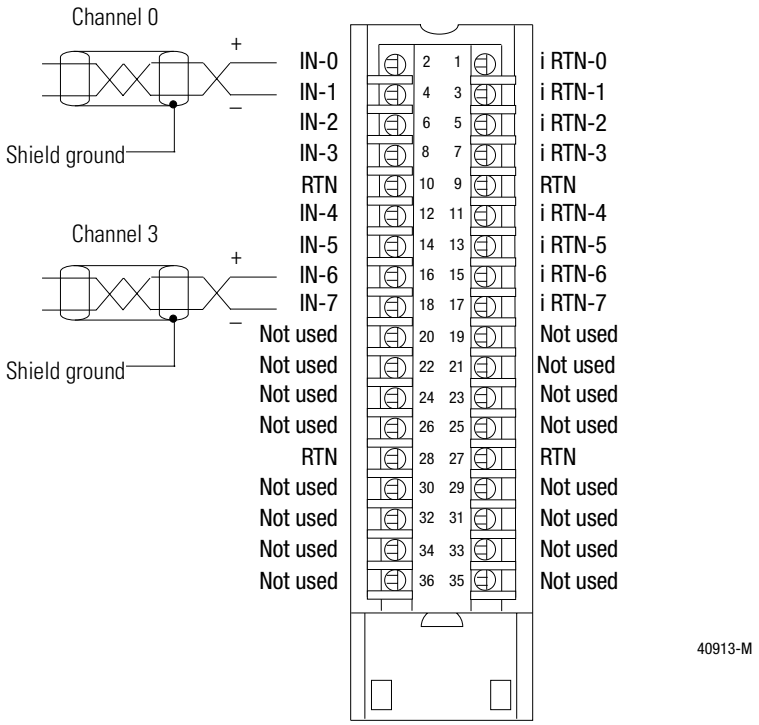
4. If multiple (+) or multiple (-) terminals are tied together, connect that tie point to a RTN terminal to maintain the module's accuracy.

5. Place additional loop devices (e.g. strip chart recorders, etc.) at the A location in the current loop.

6. Do not connect more than two wires to any single terminal.

IMPORTANT: When operating in 2 channel, **high speed mode**, only use channels 0 and 2.

Figure 4.12 1756-IF8 Differential Voltage Wiring Example - 4 Channels



NOTES:

1. Use the Table 4.11 when wiring your module in differential mode

Table 4.11

This channel:	Uses these terminals:
Channel 0	IN-0 (+) & IN-1 (-)
Channel 1	IN-2 (+) & IN-3 (-)
Channel 2	IN-4 (+) & IN-5 (-)
Channel 3	IN-6 (+) & IN-7 (-)

2. All terminals marked RTN are connected internally.

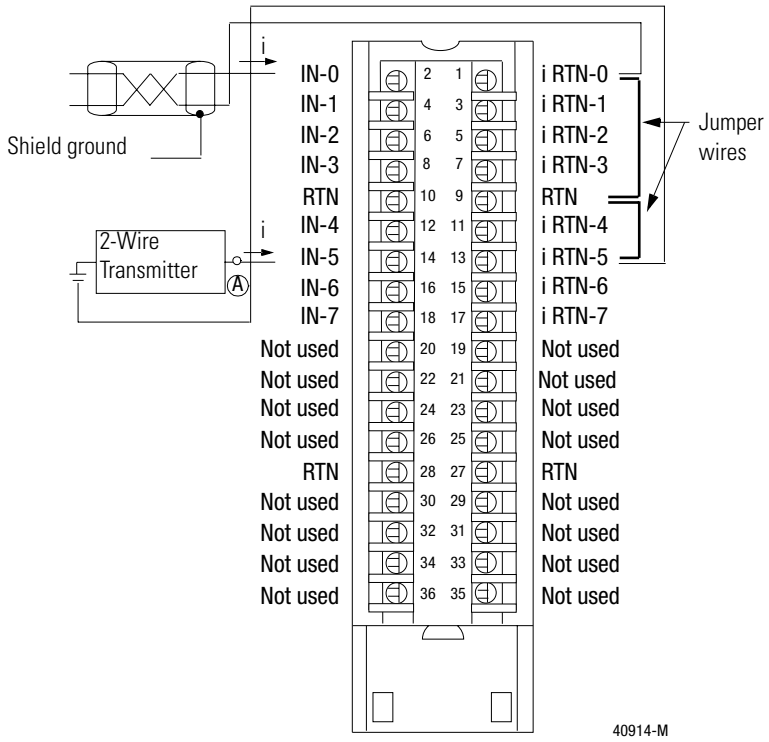
3. If multiple (+) or multiple (-) terminals are tied together, connect that tie point to a RTN terminal to maintain the module's accuracy.

4. Terminals marked RTN or iRTN are not used for differential voltage wiring.

5. Do not connect more than two wires to any single terminal.

IMPORTANT: When operating in 2 channel, **high speed mode**, only use channels 0 and 2.

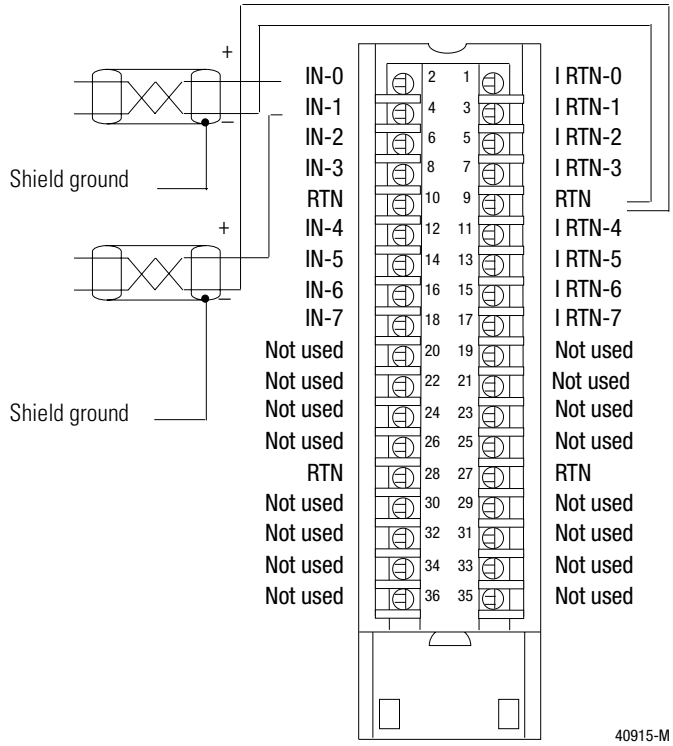
Figure 4.13 1756-IF8 Single-Ended Current Wiring Example



NOTES:

1. All terminals marked RTN are connected internally.
2. For current applications, all terminals marked iRTN must be wired to terminals marked RTN.
3. A 249Ω current loop resistor is located between IN-x and i RTN-x terminals.
4. Place additional loop devices (e.g. strip chart recorders, etc.) at the A location in the current loop.
5. Do not connect more than two wires to any single terminal.

Figure 4.14 1756-IF8 Single-Ended Voltage Wiring Example



NOTES:

1. All terminals marked RTN are connected internally.
2. Terminals marked iRTN are not used for single-ended voltage wiring.
3. Do not connect more than two wires to any single terminal.

1756-IF16 Module Fault and Status Reporting

The 1756-IF16 module multicasts status/fault data to the owner/listening controller with its channel data. The fault data is arranged in such a manner as to allow the user to choose the level of granularity he desires for examining fault conditions.

Three levels of tags work together to provide an increasing degree of detail as to the specific cause of faults on the module.

Table 4.12 lists tags that can be examined in ladder logic to indicate when a fault has occurred:

Table 4.12

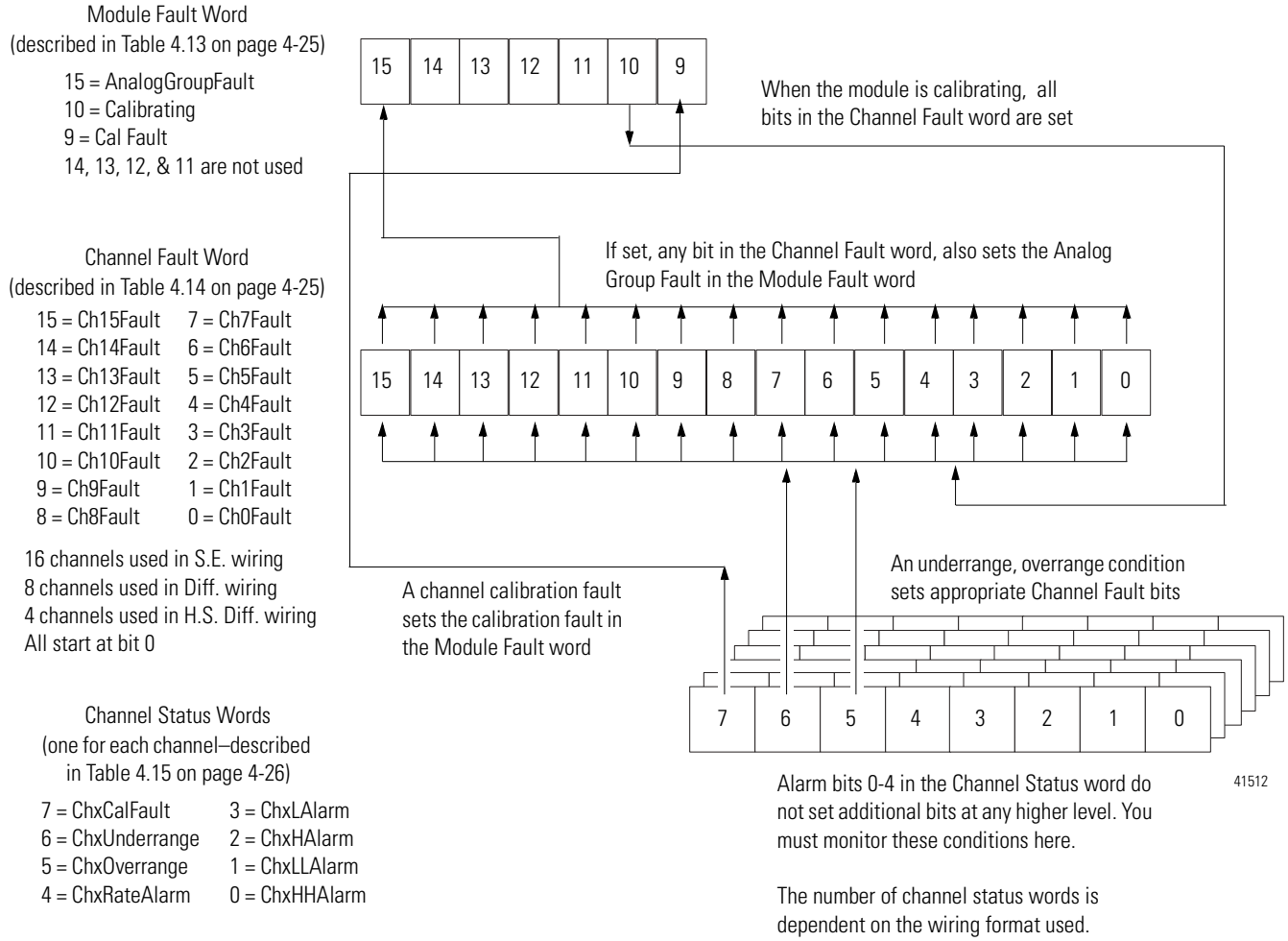
Tag:	Description:
Module Fault Word	This word provides fault summary reporting. Its tag name is ModuleFaults.
Channel Fault Word	This word provides underrange, overrange and communications fault reporting. Its tag name is ChannelFaults. When examining the Channel Fault Word for faults, remember the following: • 16 channels are used in single-ended wiring • 8 channels are used in differential wiring • 4 channels are used in high speed differential wiring • All bytes start with bit 0
Channel Status Words	These words, one per channel, provide individual channel underrange and overrange fault reporting for process alarms, rate alarms and calibration faults. Its tag name is ChxStatus.

IMPORTANT Differences exist between floating point and integer modes as they relate to module fault reporting. These differences are explained in the following two sections.

1756-IF16 Fault Reporting in Floating Point Mode

Figure 4.15 an overview of the fault reporting process for the 1756-IF16 module in floating point mode.

Figure 4.15



1756-IF16 Module Fault Word Bits – Floating Point Mode

Bits in this word provide the highest level of fault detection. A nonzero condition in this word reveals that a fault exists on the module. You can examine further down to isolate the fault.

Table 4.13 lists tags that can be examined in ladder logic to indicate when a fault has occurred:

Table 4.13

Tag:	Description:
Analog Group Fault	This bit is set when any bits in the Channel Fault word are set. Its tag name is AnalogGroupFault.
Calibrating	This bit is set when any channel is being calibrated. When this bit is set, all bits in the Channel Fault word are set. Its tag name is Calibrating.
Calibration Fault	This bit is set when any of the individual Channel Calibration Fault bits are set. Its tag name is CalibrationFault.

1756-IF16 Channel Fault Word Bits – Floating Point Mode

During normal module operation, bits in the Channel Fault word are set if any of the respective channels has an Under or Overrange condition. Checking this word for a nonzero value is a quick way to check for Under or Overrange conditions on the module.

Table 4.14 lists the conditions that set **all** Channel Fault word bits:

Table 4.14

This condition sets all Channel Fault word bits:	And causes the module to display the following in the Channel Fault word bits:
A channel is being calibrated	• "FFFF" for single-ended operating mode • "00FF" for differential operating mode • "000F" for high speed differential operating mode
A communications fault occurred between the module and its owner-controller	"FFFF" for all bits, regardless of the application

Your logic can monitor the Channel Fault Word bit for a particular input to determine the state of that point.

1756-IF16 Channel Status Word Bits – Floating Point Mode

Any of the Channel Status words, one for each channel, display a nonzero condition if that particular channel has faulted for the conditions listed below. Some of these bits set bits in other Fault words. When the Underrange or Overrange bits (bits 6 & 5) in any of the words are set, the appropriate bit is set in the Channel Fault word.

When the Calibration Fault bit (bit 7) is set in any of the words, the Calibration Fault bit (bit 9) is set in the Module Fault word. Table 4.15 lists the conditions that set each of the word bits.

Table 4.15

Tag (Status word):	Bit:	Event that sets this tag:
ChxCalFault	Bit 7	This bit is set if an error occurs during calibration for that channel, causing a bad calibration. This bit also sets bit 9 in the Module Fault word.
Underrange	Bit 6	This bit is set when the input signal at the channel is less than or equal to the minimum detectable signal. For more information on the minimum detectable signal for each module, see Table 4.6 on page 4-7. This bit also sets the appropriate bit in the Channel Fault word.
Overrange	Bit 5	This bit is set when the input signal at the channel is greater than or equal to the maximum detectable signal. For more information on the maximum detectable signal for each module, see Table 4.6 on page 4-7. This bit also sets the appropriate bit in the Channel Fault word.
ChxRateAlarm	Bit 4(1)	This bit is set when the input channel's rate of change exceeds the configured Rate Alarm parameter. It remains set until the rate of change drops below the configured rate. If latched, the alarm will remain set until it is unlatched.
ChxLAlarm	Blt 3(1)	This bit is set when the input signal moves beneath the configured Low Alarm limit. It remains set until the signal moves above the configured trigger point. If latched, the alarm will remain set until it is unlatched. If a deadband is specified, the alarm will also remain set as long as the signal remains within the configured deadband.
ChxHAlarm	Bit 2(1)	This bit is set when the input signal moves above the configured High Alarm limit. It remains set until the signal moves below the configured trigger point. If latched, the alarm will remain set until it is unlatched. If a deadband is specified, the alarm will also remain set as long as the signal remains within the configured deadband.
ChxLLAlarm	Bit 1(1)	This bit is set when the input signal moves beneath the configured Low-Low Alarm limit. It remains set until the signal moves above the configured trigger point. If latched, the alarm will remain set until it is unlatched. If a deadband is specified, the alarm will also remain latched as long as the signal remains within the configured deadband.
ChxHHAlarm	Bit 0(1)	This bit is set when the input signal moves above the configured High-High Alarm limit. It remains set until the signal moves below the configured trigger point. If latched, the alarm will remain set until it is unlatched. If a deadband is specified, the alarm will also remain latched as long as the signal remains within the configured deadband.

(1) Bits 0-4 are **not available** in floating point single-ended mode.

1756-IF16 Fault Reporting in Integer Mode

The following graphic provides an overview of the fault reporting process for the 1756-IF16 module in integer mode.

Figure 4.16

Module Fault Word
(described in Table 4.16 on page 4-28)

15 = AnalogGroupFault
10 = Calibrating
9 = Cal Fault
14, 13, 12, & 11 are not used

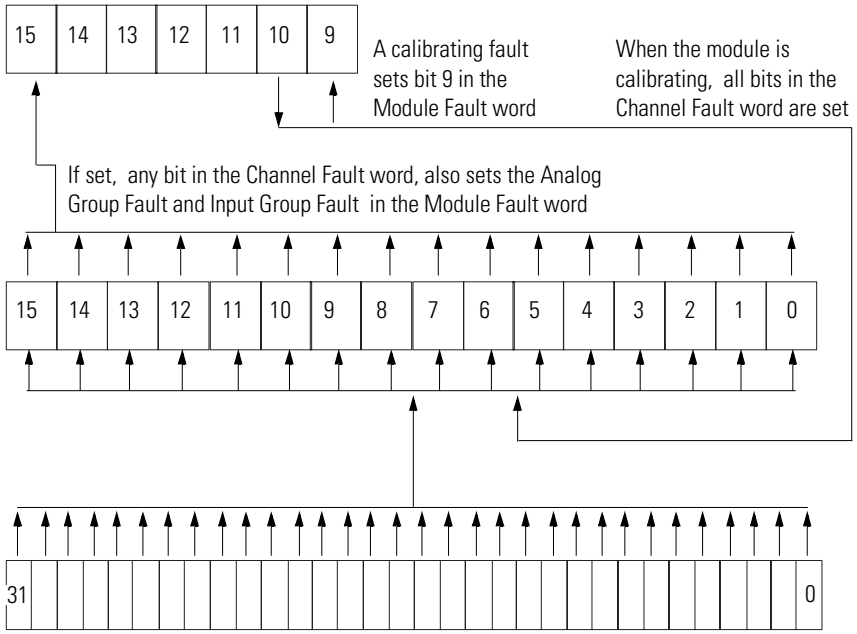
Channel Fault Word
(described in Table 4.17 on page 4-28)

15 = Ch15Fault 7 = Ch7Fault
14 = Ch14Fault 6 = Ch6Fault
13 = Ch13Fault 5 = Ch5Fault
12 = Ch12Fault 4 = Ch4Fault
11 = Ch11Fault 3 = Ch3Fault
10 = Ch10Fault 2 = Ch2Fault
9 = Ch9Fault 1 = Ch1Fault
8 = Ch8Fault 0 = Ch0Fault
16 channels used in S.E. wiring
8 channels used in Diff. wiring
4 channels used in H.S. Diff. wiring
All start at bit 0

Channel Status Words
(described in Table 4.18 on page 4-29)

31 = Ch0Underrange 23 = Ch4Underrange 15 = Ch8Underrange 7 = Ch12Underrange
30 = Ch0Overrange 22 = Ch4Overrange 14 = Ch8Overrange 6 = Ch12Overrange
29 = Ch1Underrange 21 = Ch5Underrange 13 = Ch9Underrange 5 = Ch13Underrange
28 = Ch1Overrange 20 = Ch5Overrange 12 = Ch9Overrange 4 = Ch13Overrange
27 = Ch2Underrange 19 = Ch6Underrange 11 = Ch10Underrange 3 = Ch14Underrange
26 = Ch2Overrange 18 = Ch6Overrange 10 = Ch10verrange 2 = Ch14Overrange
25 = Ch3Underrange 17 = Ch7Underrange 9 = C11Underrange 1 = Ch15Underrange
24 = Ch3Overrange 16 = Ch7Overrange 8 = Ch11Overrange 0 = Ch15Overrange

16 channels used in S.E. wiring
8 channels used in Diff. wiring
4 channels used in H.S. Diff. wiring
All start at bit 31



1756-IF16 Module Fault Word Bits – Integer Mode

In integer mode, Module Fault word bits (bits 15-8) operate exactly as described in floating point mode. Table 4.16 lists tags that can be examined in ladder logic to indicate when a fault has occurred:

Table 4.16

Tag:	Description:
Analog Group Fault	This bit is set when any bits in the Channel Fault word are set. Its tag name is AnalogGroupFault.
Calibrating	This bit is set when any channel is being calibrated. When this bit is set, all bits in the Channel Fault word are set. Its tag name is Calibrating.
Calibration Fault	This bit is set when any of the individual Channel Calibration Fault bits are set. Its tag name is CalibrationFault.

1756-IF16 Channel Fault Word Bits – Integer Mode

In integer mode, Channel Fault word bits operate exactly as described in floating point mode. Table 4.17 lists the conditions that set **all** Channel Fault word bits:

Table 4.17

This condition sets all Channel Fault word bits:	And causes the module to display the following in the Channel Fault word bits:
A channel is being calibrated	• "FFFF" for single-ended operating mode • "00FF" for differential operating mode • "000F" for high speed differential operating mode
A communications fault occurred between the module and its owner-controller	"FFFF" for all bits, regardless of the application

Your logic can monitor the Channel Fault Word bit for a particular input to determine the state of that point.

1756-IF16 Channel Status Word Bits – Integer Mode

The Channel Status word has the following differences when the 1756-IF16 module is used in integer mode:

- Only Underrange and Overrange conditions are reported by the module.
- Alarming and Calibration Fault activities are not available, although the Calibration Fault bit in the Module Fault word activates if a channel is not properly calibrated.
- There is one 32 bit Channel Status word for all 16 channels.

When the Calibration Fault bit (bit 7) is set in any of the words, the Calibration Fault bit (bit 9) is set in the Module Fault word. Table 4.18 lists the conditions that set each of the words.

Table 4.18

Tag (Status word):	Bit:	Event that sets this tag:
ChxUnderrange	Odd-numbered bits from bit 31 to bit 1 (e.g. bit 31 represents channel 0). For a full listing of the channels these bits represent, see Figure 4.16 on page 4-27.	The underrange bit is set when the input signal at the channel is less than or equal to the minimum detectable signal. For more information on the minimum detectable signal for each module, see Table 4.6 on page 4-7. This bit also sets the appropriate bit in the Channel Fault word.
ChxOverrange	Even-numbered bits from bit 30 to bit 0 (e.g. bit 30 represents channel 0). For a full listing of the channels these bits represent, see Figure 4.16 on page 4-27.	The overrange bit is set when the input signal at the channel is greater than or equal to the maximum detectable signal. For more information on the maximum detectable signal for each module, see Table 4.6 on page 4-7. This bit also sets the appropriate bit in the Channel Fault word.

1756-IF8 Module Fault and Status Reporting

The 1756-IF8 module multicasts status/fault data to the owner/listening controller with its channel data. The fault data is arranged in such a manner as to allow the user to choose the level of granularity he desires for examining fault conditions.

Three levels of tags work together to provide an increasing degree of detail as to the specific cause of faults on the module.

Table 4.19 lists tags that can be examined in ladder logic to indicate when a fault has occurred:

Table 4.19

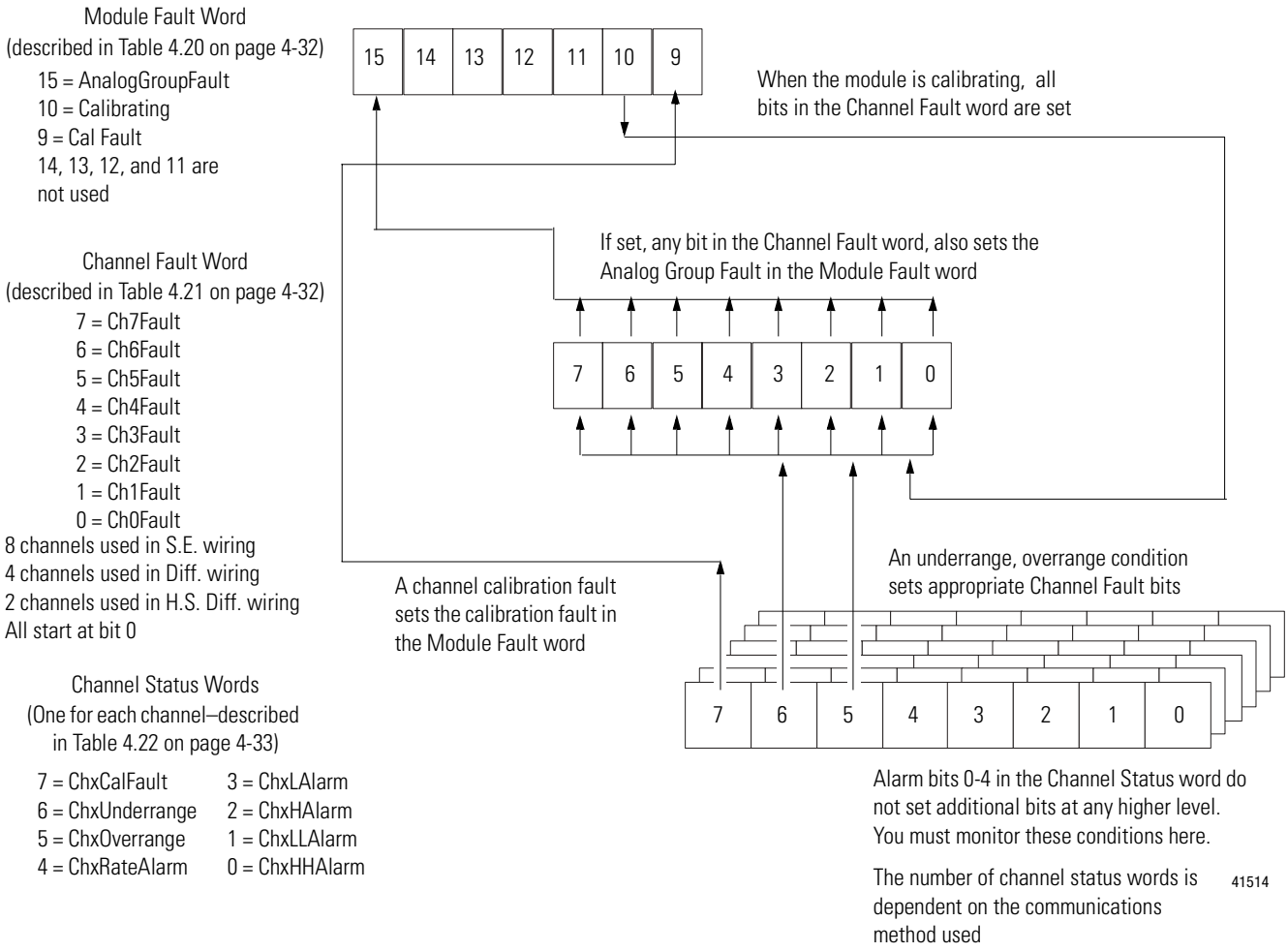
Tag:	Description:
Module Fault Word	This word provides fault summary reporting. Its tag name is ModuleFaults.
Channel Fault Word	This word provides underrange, overrange and communications fault reporting. Its tag name is ChannelFaults. When examining the Channel Fault Word for faults, remember the following: • 8 channels are used in single-ended wiring • 4 channels are used in differential wiring • 2 channels are used in high speed differential wiring • All bytes start with bit 0
Channel Status Words	These words, one per channel, provide individual channel underrange and overrange fault reporting for process alarms, rate alarms and calibration faults. Its tag name is ChxStatus.

IMPORTANT Differences exist between floating point and integer modes as they relate to module fault reporting. These differences are explained in the following two sections.

1756-IF8 Fault Reporting in Floating Point Mode

Figure 4.17 offers an overview of the fault reporting process for the 1756-IF8 module in floating point mode.

Figure 4.17



1756-IF8 Module Fault Word Bits – Floating Point Mode

Bits in this word provide the highest level of fault detection. A nonzero condition in this word reveals that a fault exists on the module. You can examine further down to isolate the fault.

Table 4.20 lists tags that can be examined in ladder logic to indicate when a fault has occurred:

Table 4.20

Tag:	Description:
Analog Group Fault	This bit is set when any bits in the Channel Fault word are set. Its tag name is AnalogGroupFault.
Calibrating	This bit is set when any channel is being calibrated. When this bit is set, all bits in the Channel Fault word are set. Its tag name is Calibrating.
Calibration Fault	This bit is set when any of the individual Channel Calibration Fault bits are set. Its tag name is CalibrationFault.

1756-IF8 Channel Fault Word Bits – Floating Point Mode

During normal module operation, bits in the Channel Fault word are set if any of the respective channels has an Under or Overrange condition. Checking this word for a nonzero value is a quick way to check for Under or Overrange conditions on the module.

Table 4.21 lists the conditions that set **all** Channel Fault word bits:

Table 4.21

This condition sets all Channel Fault word bits:	And causes the module to display the following in the Channel Fault word bits:
A channel is being calibrated	• "00FF" for single-ended wiring applications • "000F" for differential wiring applications • "0003" for high speed differential wiring applications
A communications fault occurred between the module and its owner-controller	"FFFF" for all bits, regardless of the application

Your logic can monitor the Channel Fault Word bit for a particular input to determine the state of that point.

1756-IF8 Channel Status Word Bits – Floating Point Mode

Any of the Channel Status words, one for each channel, will display a nonzero condition if that particular channel has faulted for the conditions listed below. Some of these bits set bits in other Fault words. When the Underrange and Overrange bits (bits 6 & 5) in any of the words are set, the appropriate bit is set in the Channel Fault word.

When the Calibration Fault bit (bit 7) is set in any of the words, the Calibration Fault bit (bit 9) is set in the Module Fault word. Table 4.22 lists the conditions that set each of the word bits.

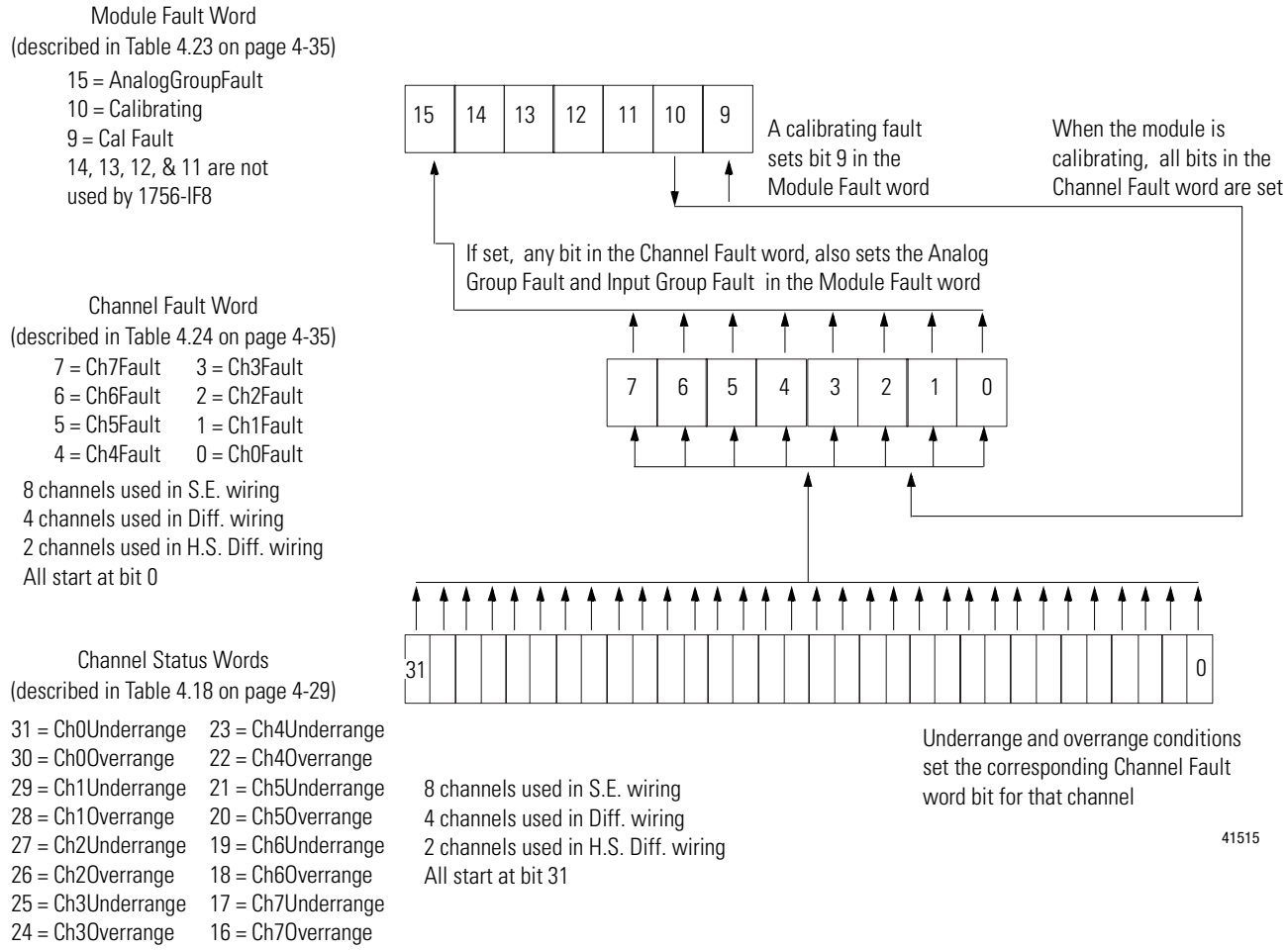
Table 4.22

Tag (Status word):	Bit:	Event that sets this tag:
ChxCalFault	Bit 7	This bit is set if an error occurs during calibration for that channel, causing a bad calibration. This bit also sets bit 9 in the Module Fault word.
Underrange	Bit 6	This bit is set when the input signal at the channel is less than or equal to the minimum detectable signal. For more information on the minimum detectable signal for each module, see Table 4.6 on page 4-7. This bit also sets the appropriate bit in the Channel Fault word.
Overrange	Bit 5	This bit is set when the input signal at the channel is greater than or equal to the maximum detectable signal. For more information on the maximum detectable signal for each module, see Table 4.6 on page 4-7. This bit also sets the appropriate bit in the Channel Fault word.
ChxRateAlarm	Bit 4	This bit is set when the input channel's rate of change exceeds the configured Rate Alarm parameter. It remains set until the rate of change drops below the configured rate. If latched, the alarm will remain set until it is unlatched.
ChxLAlarm	Blt 3	This bit is set when the input signal moves beneath the configured Low Alarm limit. It remains set until the signal moves above the configured trigger point. If latched, the alarm will remain set until it is unlatched. If a deadband is specified, the alarm will also remain set as long as the signal remains within the configured deadband.
ChxHAlarm	Bit 2	This bit is set when the input signal moves above the configured High Alarm limit. It remains set until the signal moves below the configured trigger point. If latched, the alarm will remain set until it is unlatched. If a deadband is specified, the alarm will also remain set as long as the signal remains within the configured deadband.
ChxLLAlarm	Bit 1	This bit is set when the input signal moves beneath the configured Low-Low Alarm limit. It remains set until the signal moves above the configured trigger point. If latched, the alarm will remain set until it is unlatched. If a deadband is specified, the alarm will also remain latched as long as the signal remains within the configured deadband.
ChxHHAlarm	Bit 0	This bit is set when the input signal moves above the configured High-High Alarm limit. It remains set until the signal moves below the configured trigger point. If latched, the alarm will remain set until it is unlatched. If a deadband is specified, the alarm will also remain latched as long as the signal remains within the configured deadband.

1756-IF8 Fault Reporting in Integer Mode

Figure 4.18 offers an overview of the fault reporting process for the 1756-IF8 module in integer mode.

Figure 4.18



1756-IF8 Module Fault Word Bits – Integer Mode

In integer mode, Module Fault word bits (bits 15-8) operate exactly as described in floating point mode. Table 4.23 lists tags that can be examined in ladder logic to indicate when a fault has occurred:

Table 4.23

Tag:	Description:
Analog Group Fault	This bit is set when any bits in the Channel Fault word are set. Its tag name is AnalogGroupFault.
Calibrating	This bit is set when any channel is being calibrated. When this bit is set, all bits in the Channel Fault word are set. Its tag name is Calibrating.
Calibration Fault	This bit is set when any of the individual Channel Calibration Fault bits are set. Its tag name is CalibrationFault.

1756-IF8 Channel Fault Word Bits – Integer Mode

In integer mode, Channel Fault word bits operate exactly as described in floating point mode. Table 4.24 lists the conditions that set **all** Channel Fault word bits:

Table 4.24

This condition sets all Channel Fault word bits:	And causes the module to display the following in the Channel Fault word bits:
A channel is being calibrated	• "00FF" for single-ended wiring applications • "000F" for differential wiring applications • "0003" for high speed differential wiring applications
A communications fault occurred between the module and its owner-controller	"FFFF" for all bits, regardless of the application

1756-IF8 Channel Status Word Bits – Integer Mode

The Channel Status word has the following differences when the 1756-IF16 module is used in integer mode:

- Only Underrange and Overrange conditions are reported by the module.
- Alarming and Calibration Fault activities are not available, although the Calibration Fault bit in the Module Fault word activates if a channel is not properly calibrated.
- There is one 32 bit Channel Status word for all 8 channels.

When the Calibration Fault bit (bit 7) is set in any of the words, the Calibration Fault bit (bit 9) is set in the Module Fault word. Table 4.25 lists the conditions that set each of the words.

Table 4.25

Tag (Status word):	Bit:	Event that sets this tag:
ChxUnderrange	Odd-numbered bits from bit 31 to bit 1 (e.g. bit 31 represents channel 17). For a full listing of the channels these bits represent, see Figure 4.18 on page 4-34.	The underrange bit is set when the input signal at the channel is less than or equal to the minimum detectable signal. For more information on the minimum detectable signal for each module, see Table 4.6 on page 4-7. This bit also sets the appropriate bit in the Channel Fault word.
ChxOverrange	Even-numbered bits from bit 30 to bit 16 (e.g. bit 30 represents channel 0). For a full listing of the channels these bits represent, see Figure 4.18 on page 4-34.	The overrange bit is set when the input signal at the channel is greater than or equal to the maximum detectable signal. For more information on the maximum detectable signal for each module, see Table 4.6 on page 4-7. This bit also sets the appropriate bit in the Channel Fault word.

Chapter Summary and What's Next

In this chapter you read about the Non-Isolated Analog Voltage/Current Input Modules (1756-IF16, -IF8).

Chapter 5 describes features specific to the Sourcing Current Loop Input Module (1756-IF6CIS) and Isolated Analog Voltage/Current Input Module (1756-IF6I).

Sourcing Current Loop Input Module (1756-IF6CIS) and Isolated Analog Voltage/Current Input Module (1756-IF6I)

What This Chapter Contains

This chapter describes features specific to ControlLogix isolated analog voltage/current input module and the ControlLogix sourcing current loop input module.

For information about:	See page:
Using the Isolated Power Source on the 1756-IF6CIS	5-2
Choosing a Data Format	5-4
Features Specific to the 1756-IF6I and 1756-IF6CIS Modules	5-4
Using Module Block and Input Circuit Diagrams	5-12
Wiring the 1756-IF6CIS Module	5-14
Wiring the 1756-IF6I Module	5-17
1756-IF6CIS or 1756-IF6I Module Fault and Status Reporting	5-19

IMPORTANT

The 1756-IF6CIS and 1756-IF6I modules primarily operate the same with a few exceptions, including:

- The 1756-IF6CIS only operates in current mode
- The 1756-IF6CIS offers an isolated power source for each channel that supplies power to external transmitters

The differences on the 1756-IF6CIS module are described on page 5-2.

With a few noted exceptions included in the descriptions, the rest of the features described in this chapter apply to both modules.

Using the Isolated Power Source on the 1756-IF6CIS

The 1756-IF6CIS module offers an internal power source on each channel. The source is current limited to 28mA and allows the module to power a two-wire transmitter directly without the need for an external power supply. The transmitter can then vary the current to the analog input in proportion to the process variable being measured. The inclusion of an internal an on-board current source, saves you the expense of extra power supplies and greatly simplifies the interface wiring to field devices.

In addition to supplying loop power to 2-wire transmitters, the module can also acomodate current loops powered by an external supply and loops using 4-wire transmitters.

Power Calculations with the 1756-IF6CIS Module

The 1756-IF6CIS module uses the system power supply (1756-Px7x) as the source for loop power. Because of the demands placed on that supply (e.g. the 1756-IF6CIS module consumes 7.9W of backplane power), special care must be taken when calculating the power requirements for modules in the same chassis as a 1756-IF6CIS module.

For example, when used with the 1756-L55M13 controller, you can place only 8 1756-IF6CIS modules in the chassis before exceeding the wattage capacity of the power supply.

Including Other Devices in the Wiring Loop

The voltage source on each channel can drive loop impedance of up to 1000 ohms. This allows you to include other devices, such as chart recorders and meters, in the current loop.

For more information on wiring the 1756-IF6CIS module, see page 5-14.

The 1756-IF6CIS and 1756-IF6I modules also support features described in Chapter 3. Table 5.1 lists those additional features.

Table 5.1 Additional Features Supported by the 1756-IF6CIS and 1756-IF6I Modules

Feature:	Page of description:
Removal and Insertion Under Power (RIUP)	3-2
Module Fault Reporting	3-3
Fully Software Configurable	3-3
Electronic Keying	3-4
Access to System Clock for Timestamping Functions	3-6
Rolling Timestamp	3-6
Producer/Consumer Model	3-6
Status Indicator Information	3-7
Full Class I Division 2 Compliance	3-7
UL, CSA, FM, CE, C-Tick, EEx, TUV Agency Certification	3-7
Field Calibration	3-8
Sensor Offset	3-8
Latching of Alarms	3-8

Choosing a Data Format

Data format determines the format of the data returned from the module to the owner-controller and the features that are available to your application. You choose a data format when you choose a Communications Format. For more information on Communications Format, see page 10-6.

You can choose one of the two following data formats:

- Integer mode
- Floating point mode

Table 5.2 shows which features are available in each format.

Table 5.2 Features Available in Each Data Format

Data format:	Features available:	Features not available:
Integer mode	Multiple input ranges Notch filter Real time sampling	Digital filtering Process alarms Rate alarms Scaling
Floating point mode	All features	N/A

Features Specific to the 1756-IF6I and 1756-IF6CIS Modules

Table 5.3 lists features that are specific to the 1756-IF6CIS and 1756-IF6I modules. The features are described later in this section.

Table 5.3

Feature:	Page of description:
Multiple Input Ranges(1)	5-5
Notch Filter	5-6
Real Time Sampling	5-7
Underrange/Overrange Detection	5-7
Digital Filter	5-8
Process Alarms	5-9
Rate Alarm	5-10
Wire Off Detection	5-11

(1) Only the 1756-IF6I offers multiple input ranges. The 1756-IF6CIS module only operates in the 0 to 20mA range.

Multiple Input Ranges

You can only use the 1756-IF6CIS module in current applications. Unlike other analog input modules, this module does not allow you to choose an input range. All channels use the 0 to 20mA input range.

For the 1756-IF6I module, however, you can select from a series of operational ranges for **each channel** on your module. The range designates the minimum and maximum signals that are detectable by the module. The 1756-IF6I module offers multiple input ranges in both current and voltage applications.

Table 5.4 lists the possible input ranges available for use with the 1756-IF6CIS and 1756-IF6I modules.

Table 5.4 Possible Input Ranges

Module:	Available input ranges:
1756-IF6CIS	0 to 20mA
1756-IF6I	-10 to 10V 0 to 5V 0 to 10V 0 to 20mA

For an example of how to choose an input range for your module, see page 10-10.

Notch Filter

An Analog-to-Digital Convertor (ADC) filter removes line noise in your application for **each channel**.

Choose a notch filter that most closely matches the anticipated noise frequency in your application. Remember that each filter time affects the response time of your module. Also, the highest frequency notch filter settings also limit the effective resolution of the channel.

IMPORTANT 60Hz is the default setting for the notch filter.

Table 5.5 lists the available notch filter setting.

Table 5.5 Module Filter Settings

Notch setting:	10Hz	50Hz	60Hz (Default)	100Hz	250Hz	1000Hz
Minimum Sample Time (RTS) – Integer mode(1)	102mS	22mS	19mS	12mS	10mS	10mS
Minimum Sample Time (RTS) – Floating point mode(2)	102mS	25mS	25mS	25mS	25mS	25mS
0-100% Step Response Time(2)	400mS + RTS	80mS + RTS	68mS + RTS	40mS + RTS	16mS + RTS	4mS + RTS
-3dB Frequency	3Hz	13Hz	15Hz	26Hz	66Hz	262Hz
Effective Resolution	16 bits	16 bits	16 bits	16 bits	15 bits	10 bits

(1) Integer mode must be used for RTS values lower than 25mS. The minimum RTS value for the module will be dependent on the channel with the lowest notch filter setting.

(2) Worst case settling time to 100% of a step change would include 0-100% step response time plus one RTS sample time.

To see how to choose a Notch Filter, see page 10-11.

Real Time Sampling

This parameter instructs the module to scan its input channels and obtain all available data. After the channels are scanned, the module multicasts that data.

During module configuration, you specify a Real Time Sampling (RTS) period and a Requested Packet Interval (RPI) period. These features both instruct the module to multicast data, but only the RTS feature instructs the module to scan its channels before multicasting.

For more information on Real Time Sampling, see page 2-4. For an example of how to set the RTS rate, see page 10-10.

Underrange/Overrange Detection

This feature detects when the isolated input module is operating beyond limits set by the input range. For example, If you are using the 1756-IF6I module in the 0V-10V input range and the module voltage increases to 11V, the Overrange detection detects this condition.

Table 5.6 lists the input ranges of the 1756-IF6CIS and 1756-IF6I modules and the lowest/highest signal available in each range before the module detects an underrange/overrange condition:

Table 5.6 Low and High Signal Limits on the Isolated Input Module

Input module:	Available range:	Lowest signal in range:	Highest signal in range:
1756-IF6CIS	0mA-20mA	0mA	21.09376mA
1756-IF6I	+/- 10V	-10.54688V	10.54688V
	0V-10V	0V	10.54688V
	0V-5V	0V	5.27344V
	0mA-20mA	0mA	21.09376mA

Digital Filter

IMPORTANT The digital filter is only available in applications using floating point mode.

The digital filter smooths input data noise transients on **each input channel**. This value specifies the time constant for a digital first order lag filter on the input. It is specified in units of milliseconds. A value of 0 disables the filter.

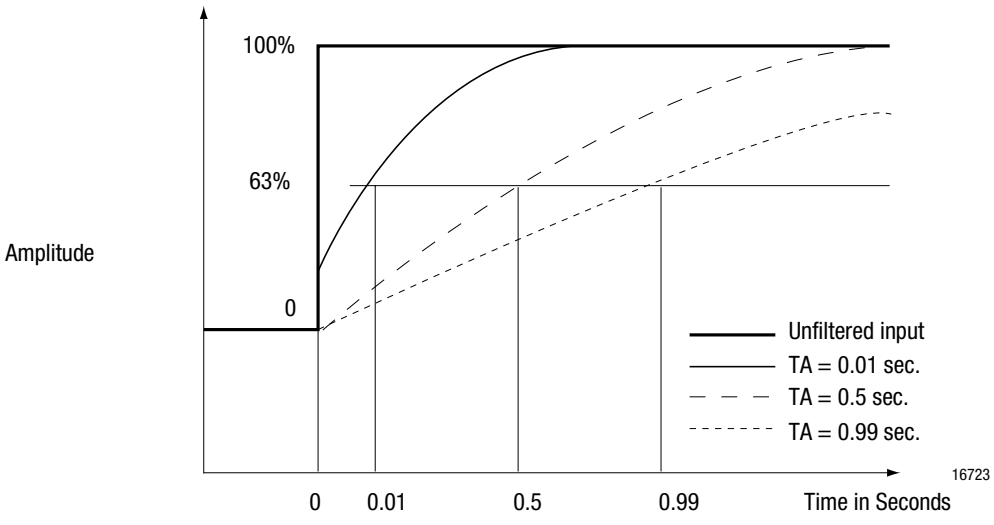
The digital filter equation is a classic first order lag equation.

$$Yn = Yn\text{-}1 + \frac{[\Delta t]}{\Delta t + TA} (X_n - Y_n\text{-}1)$$

Yn = present output, filtered peak voltage (PV)
Yn-1 = previous output, filtered PV
Δt = module channel update time (seconds)
TA = digital filter time constant (seconds)
Xn = present input, unfiltered PV

Using a step input change to illustrate the filter response, you can see that when the digital filter time constant elapses, 63.2% of the total response is reached. Each additional time constant achieves 63.2% of the remaining response. For more information, see Figure 5.1.

Figure 5.1



To see how to set the Digital Filter, see page 10-10.

Process Alarms

Process alarms alert you when the module has exceeded configured high or low limits for **each channel**. You can latch process alarms. These are set at four user configurable alarm trigger points:

- High high
- High
- Low
- Low low

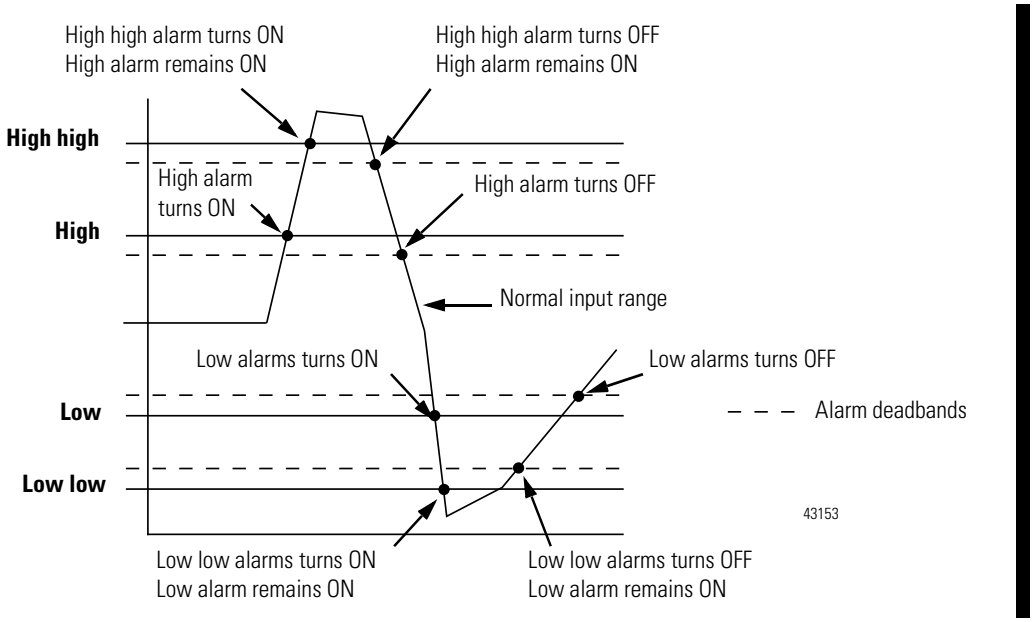
IMPORTANT Process alarms are only available in applications using floating point mode. The values for each limit are entered in scaled engineering units.

Alarm Deadband

You may configure an **Alarm Deadband** to work with these alarms. The deadband allows the process alarm status bit to remain set, despite the alarm condition disappearing, as long as the input data remains within the deadband of the process alarm.

Figure 5.2 shows input data that sets each of the four alarms at some point during module operation. In this example, Latching is disabled; therefore, each alarms turns OFF when the condition that caused it to set ceases to exist.

Figure 5.2



To see how to set Process Alarms, see page 10-10.

Rate Alarm

The rate alarm triggers if the rate of change between input samples for **each channel** exceeds the specified trigger point for that channel.

IMPORTANT The rate alarm is only available in applications using floating point mode.

EXAMPLE

1756-IF6CIS

For example, if you set an 1756-IF6I (with normal scaling in mA) to a rate alarm of 1.0 mA/S, the rate alarm only triggers if the difference between measured input samples changes at a rate > 1.0 mA/S.

If the module's RTS is 100 ms (i.e. sampling new input data every 100ms) and at time 0, the module measures 5.0mA and at time 100ms measures 5.08mA, the rate of change is (5.08mA - 5.0mA) / (100mS) = 0.8mA/S. The rate alarm would not set as the change is less than the trigger point of 1.0mA/s.

If the next sample taken is 4.9mA, the rate of change is (4.9mA-5.08V)/(100mS)=-1.8mA/S. The absolute value of this result is > 1.0mA/S, so the rate alarm will set. Absolute value is used because rate alarm checks for the magnitude of the rate of change being beyond the trigger point, whether a positive or negative excursion.

1756-IF6I

For example, if you set an 1756-IF6I (with normal scaling in Volts) to a rate alarm of 1.0 V/S, the rate alarm only triggers if the difference between measured input samples changes at a rate > 1.0 V/S.

If the module's RTS is 100 ms (i.e. sampling new input data every 100ms) and at time 0, the module measures 5.0 volts and at time 100ms measures 5.08 V, the rate of change is (5.08V - 5.0V) / (100mS) = 0.8 V/S. The rate alarm would not set as the change is less than the trigger point of 1.0V/s.

If the next sample taken is 4.9V, the rate of change is (4.9V-5.08V)/(100mS)=-1.8V/S. The absolute value of this result is > 1.0V/S, so the rate alarm will set. Absolute value is used because rate alarm checks for the magnitude of the rate of change being beyond the trigger point, whether a positive or negative excursion.

To see how to set the Rate Alarm, see page 10-10.

Wire Off Detection

The 1756-IF6CIS and 1756-IF6I modules will alert you when a wire has been disconnected from one of its channels or the RTB has been removed from the module. When a wire off condition occurs for this module, two events occur:

- Input data for that channel changes to a specific scaled value
- A fault bit is set in the owner-controller which may indicate the presence of a wire off condition

Because the 1756-IF6I module can be used in voltage or current applications, differences exist as to how a wire off condition is detected in each application. The 1756-IF6CIS module can only be used in current mode. Table 5.7 lists the differences that occur when a wire off condition occurs in various applications.

Table 5.7

When the Wire Off condition occurs in this application:	The following events occur:
Voltage Applications 1756-IF6I only	• Input data for that channel changes to the scaled value associated with the **overrange** signal value of the selected operational range in floating point mode (maximum possible scaled value) or 32,767 counts in integer mode • The ChxOverrange (x=channel number) tag is set to 1
Current Applications	When the condition occurs because a wire is disconnected: • Input data for that channel changes to the scaled value associated with the **underrange** signal value of the selected operational range in floating point mode (minimum possible scaled value) or -32,768 counts in integer mode • The ChxUnderrange (x=channel number) tag is set to 1 When the condition occurs because the RTB has been disconnected from the module (**1756-IF6I module only** [i.e. the following events only occur when an RTB is disconnected from the 1756-IF6I module]): • Input data for that channel changes to the scaled value associated with the **overrange** signal value of the selected operational range in floating point mode (maximum possible scaled value) or 32,767 counts in integer mode • The ChxOverrange (x=channel number) tag is set to 1

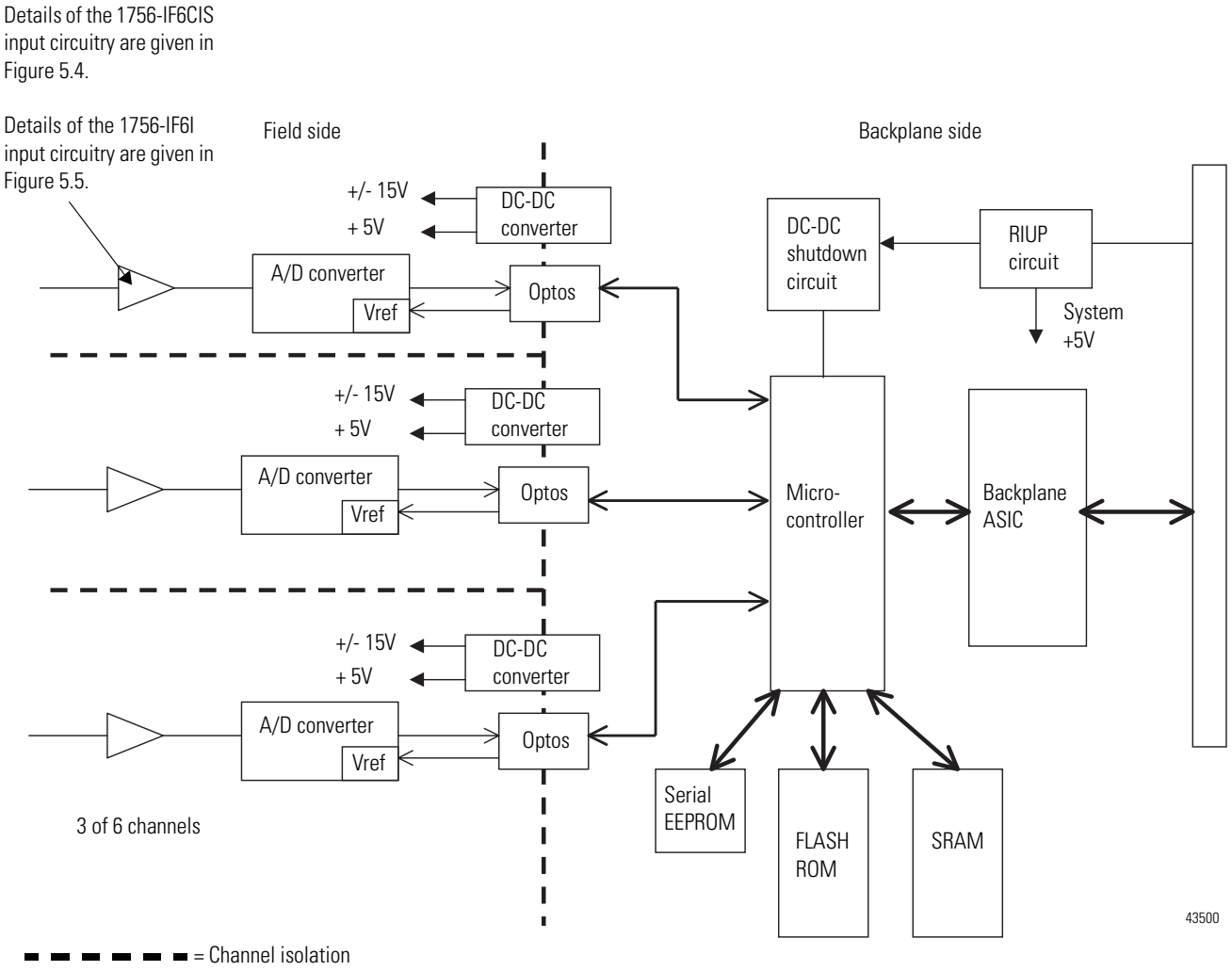
For more information about tags in the tag editor, see Appendix B.

Using Module Block and Input Circuit Diagrams

This section shows the 1756-IF6CIS and 1756-IF6I modules' block diagrams and input circuit diagrams.

Module Block Diagrams

Figure 5.3 1756-IF6CIS and 1756-IF6I Module Block Diagram



Field Side Circuit Diagrams

Figure 5.4 1756-IF6CIS Input Circuit

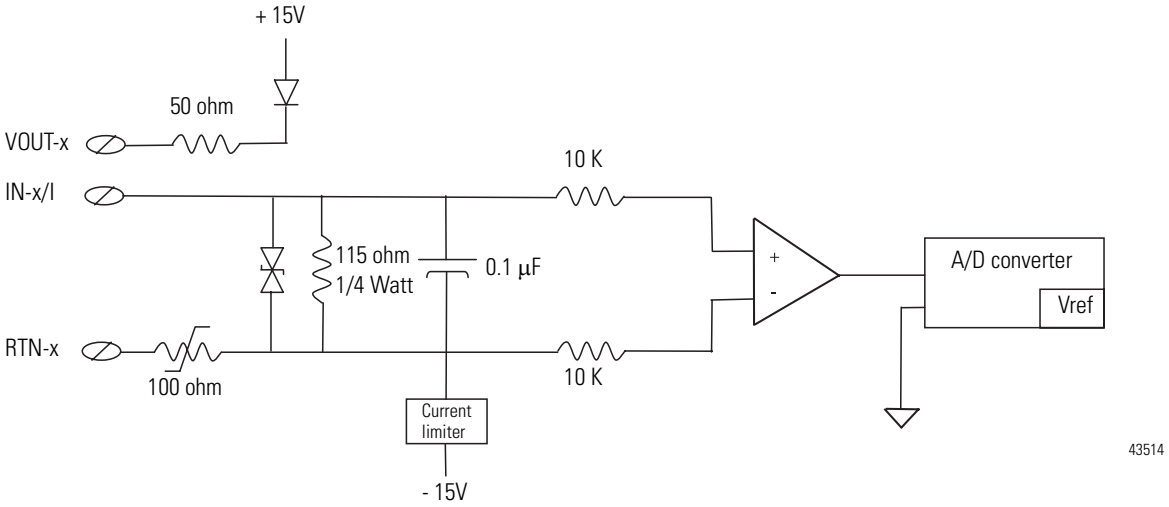
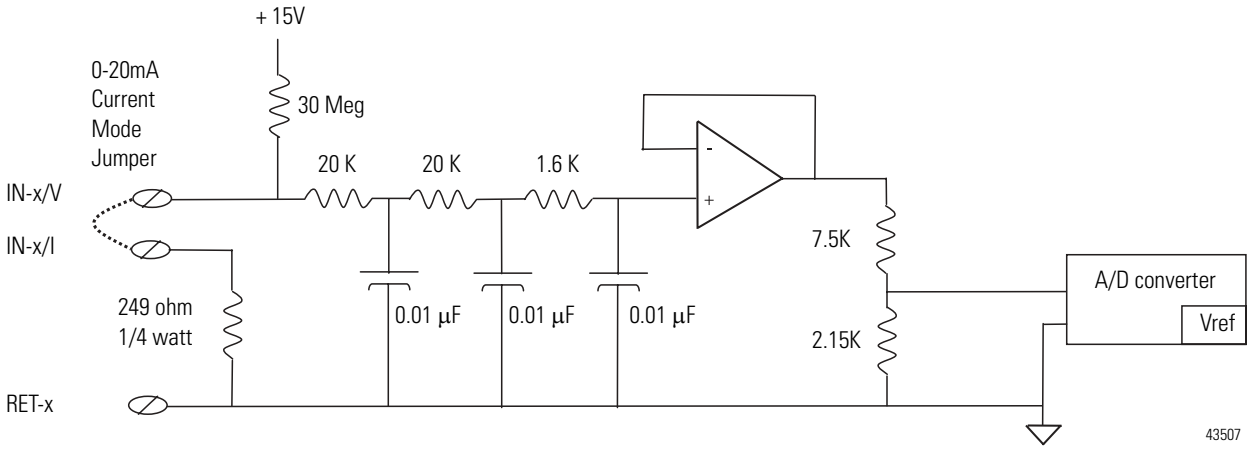
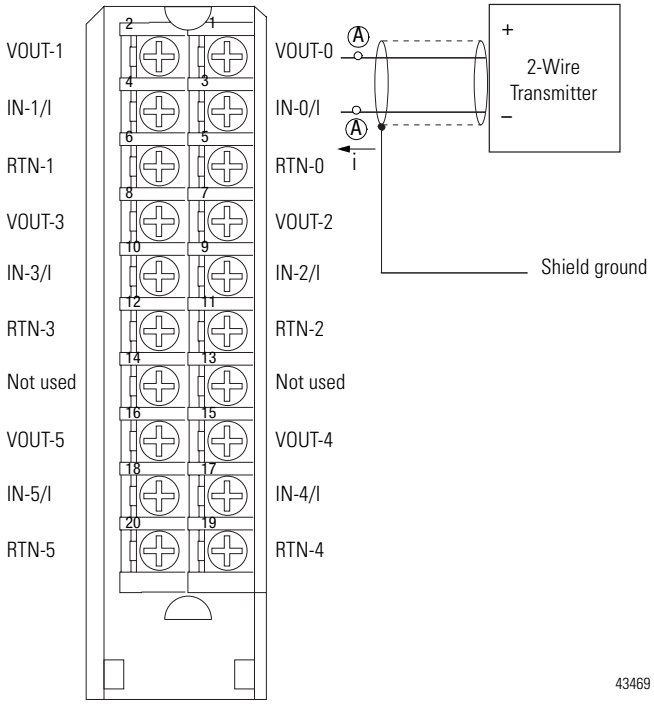


Figure 5.5 1756-IF6I Input Circuit



Wiring the 1756-IF6CIS Module

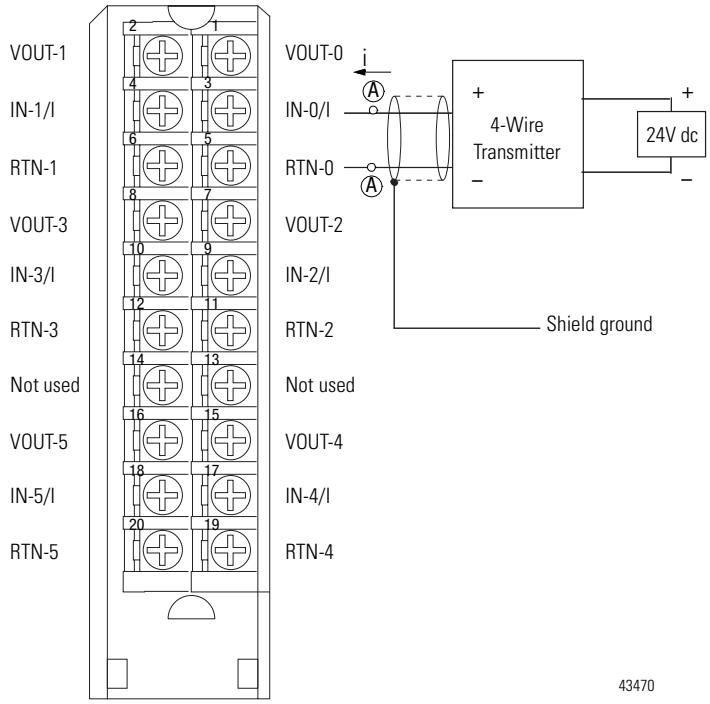
Figure 5.6 1756-IF6CIS – 2-wire transmitter connected to the module and the module providing 24V dc loop power



NOTE:

1. Do not connect more than 2 wires to any single terminal.
2. Place additional loop devices (e.g. strip chart recorders) at either A location in the current loop.

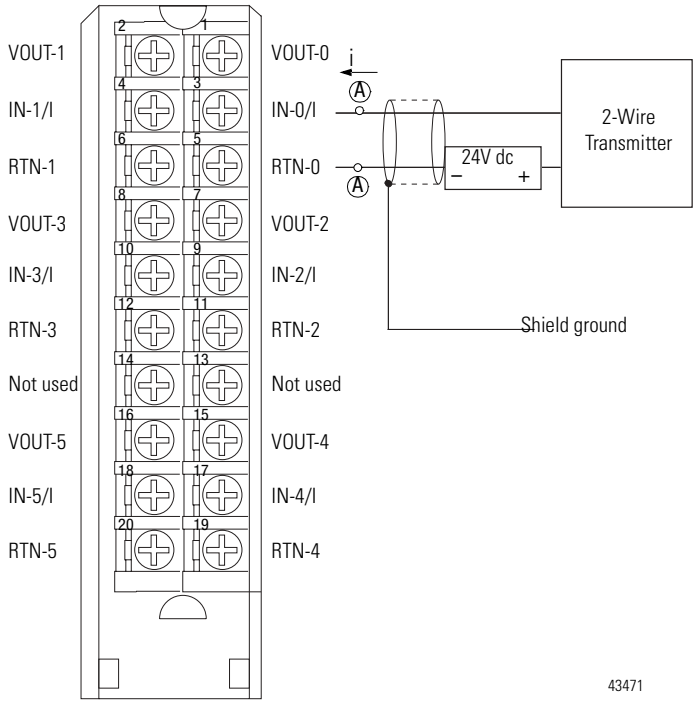
Figure 5.7 1756-IF6CIS – 4-wire transmitter connected to the module and an external, user-provided power supply providing 24V dc loop power



NOTES:

1. If separate power sources are used, do not exceed the specified isolation voltage.
2. Do not connect more than 2 wires to any single terminal.
3. Place additional loop devices (e.g. strip chart recorders) at either A location in the current loop.

Figure 5.8 1756-IF6CIS – 2-wire transmitter connected to the module and an external, user-provided power supply providing 24V dc loop power

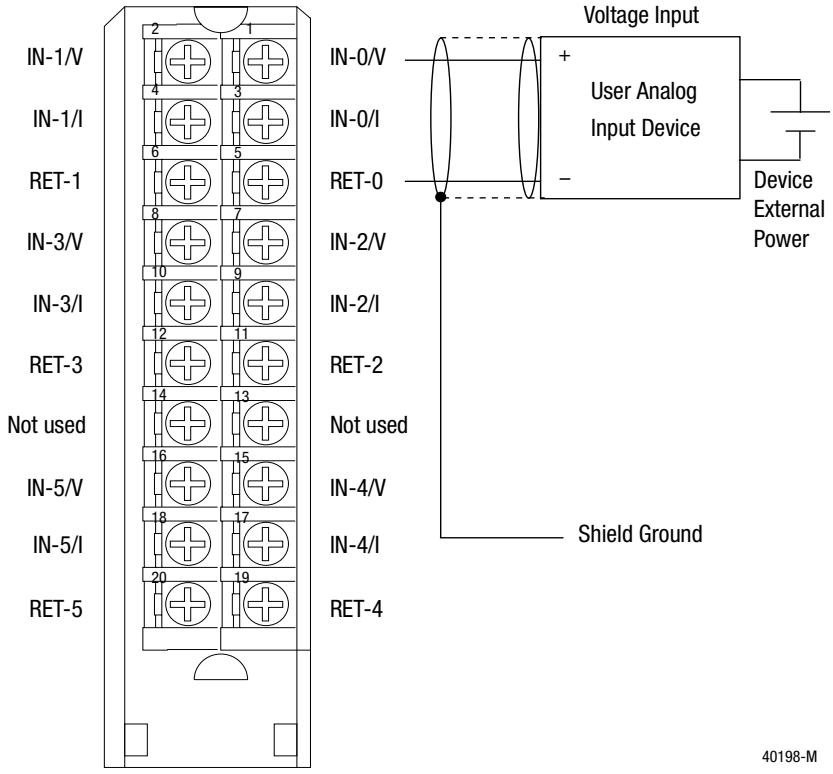


NOTES:

1. If separate power sources are used, do not exceed the specified isolation voltage.
2. Do not connect more than 2 wires to any single terminal.
3. Place additional loop devices (e.g. strip chart recorders) at either A location in the current loop.

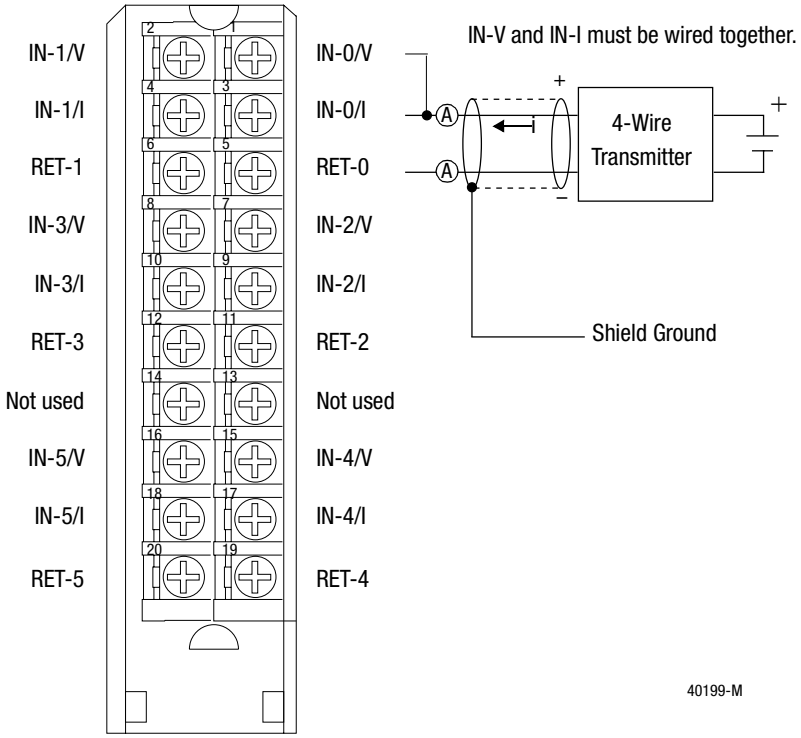
Wiring the 1756-IF6I Module

Figure 5.9 1756-IF6I Voltage wiring example



NOTES: Do not connect more than 2 wires to any single terminal.

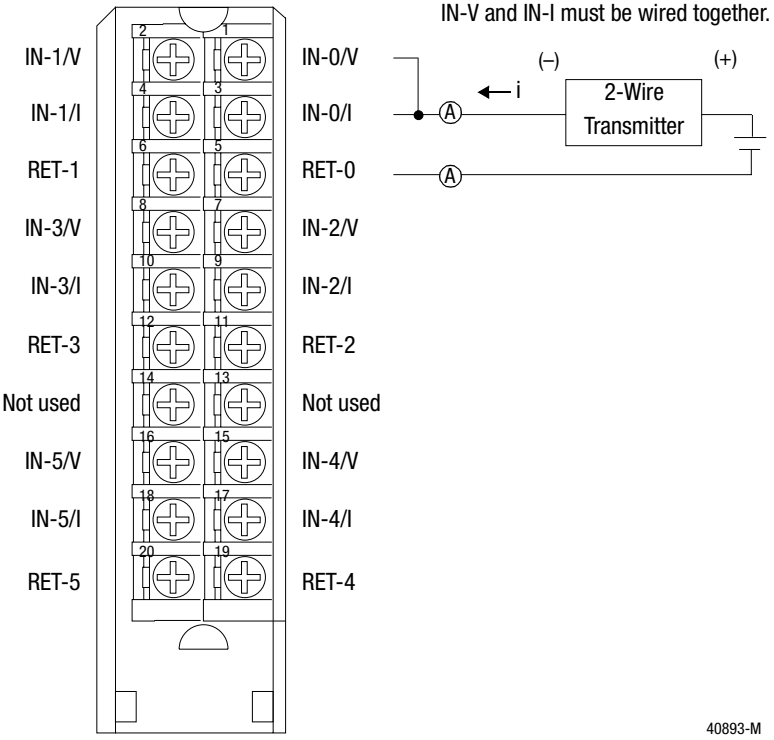
Figure 5.10 1756-IF6I Current wiring example with a 4-wire transmitter



NOTE: Place additional loop devices (e.g. strip chart recorders, etc.) at either A location.

NOTES: Do not connect more than 2 wires to any single terminal.

Figure 5.11 1756-IF6I Current wiring example with a 2-wire transmitter



NOTE: Place additional loop devices (e.g. strip chart recorders, etc.) at either A location.

NOTES: Do not connect more than 2 wires to any single terminal.

1756-IF6CIS or 1756-IF6I Module Fault and Status Reporting

The 1756-IF6CIS and 1756-IF6I modules multicast status/fault data to the owner/listening controllers with its channel data. The fault data is arranged in such a manner as to allow the user to choose the level of granularity he desires for examining fault conditions.

Three levels of tags work together to provide increasing degree of detail as to the specific cause of faults on the module.

Table 5.8 lists tags that can be examined in ladder logic to indicate when a fault has occurred:

Table 5.8

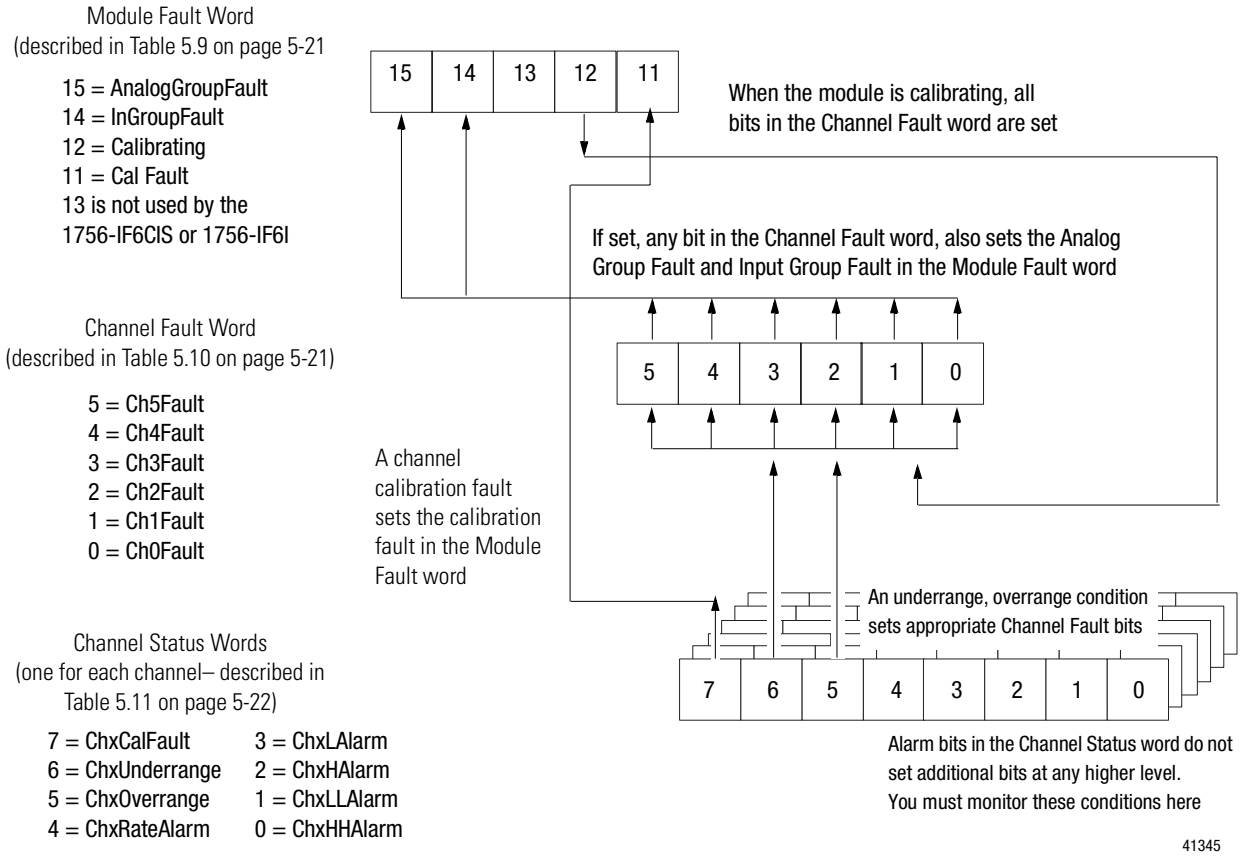
Tag:	Description:
Module Fault Word	This word provides fault summary reporting. Its tag name is ModuleFaults.
Channel Fault Word	This word provides underrange, overrange and communications fault reporting. Its tag name is ChannelFaults.
Channel Status Words	This word provides individual channel underrange and overrange fault reporting for process alarms, rate alarms and calibration faults. Its tag name is ChxStatus.

IMPORTANT Differences exist between floating point and integer modes as they relate to module fault reporting. These differences are explained in the following two sections.

Fault Reporting in Floating Point Mode

Figure 5.12 provides an overview of the fault reporting process in floating point mode.

Figure 5.12



Module Fault Word Bits – Floating Point Mode

Bits in this word provide the highest level of fault detection. A nonzero condition in this word reveals that a fault exists on the module. You can examine further down to isolate the fault.

Table 5.9 lists tags that can be examined in ladder logic to indicate when a fault has occurred:

Table 5.9

Tag:	Description:
Analog Group Fault	This bit is set when any bits in the Channel Fault word are set. Its tag name is AnalogGroupFault.
Input Group Fault	This bit is set when any bits in the Channel Fault word are set. Its tag name is InputGroup.
Calibrating	This bit is set when any channel is being calibrated. When this bit is set, all bits in the Channel Fault word are set. Its tag name is Calibrating.
Calibration Fault	This bit is set when any of the individual Channel Calibration Fault bits are set. Its tag name is CalibrationFault.

Channel Fault Word Bits – Floating Point Mode

During normal module operation, bits in the Channel Fault word are set if any of the respective channels has an Under or Overrange condition. Checking this word for a nonzero value is a quick way to check for Under or Overrange conditions on the module.

Table 5.10 lists the conditions that set **all** Channel Fault word bits:

Table 5.10

This condition sets all Channel Fault word bits:	And causes the module to display the following in the Channel Fault word bits:
A channel is being calibrated	"003F" for all bits
A communications fault occurred between the module and its owner-controller	"FFFF" for all bits

Your logic can monitor the Channel Fault Word bit for a particular input to determine the state of that point.

Channel Status Word Bits – Floating Point Mode

Any of the 6 Channel Status words, one for each channel, will display a nonzero condition if that particular channel has faulted for the conditions listed below. Some of these bits set bits in other Fault words. When the Underrange and Overrange bits (bits 6 & 5) in any of the words are set, the appropriate bit is set in the Channel Fault word.

When the Calibration Fault bit (bit 7) is set in any of the words, the Calibration Fault bit (bit 11) is set in the Module Fault word. Table 5.11 lists the conditions that set each of the word bits.

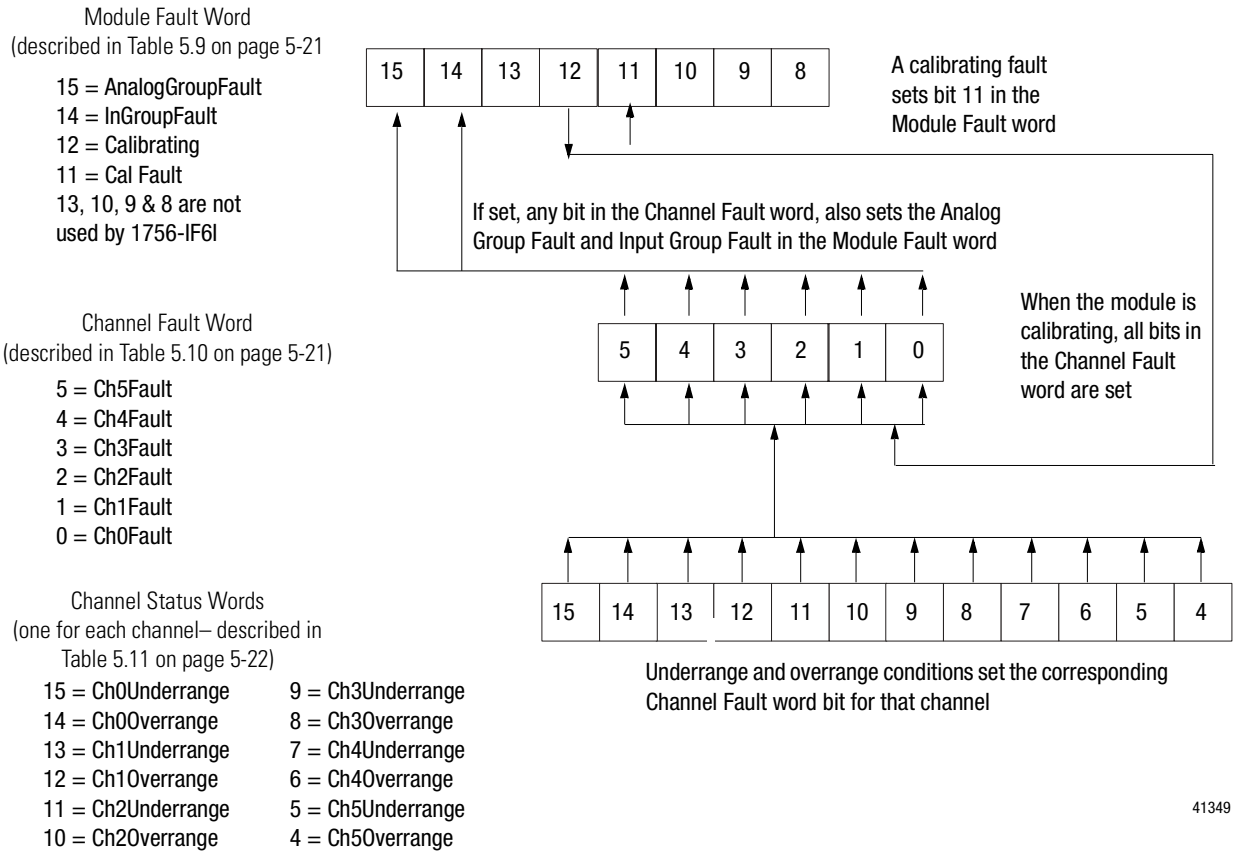
Table 5.11

Tag (Status word):	Bit:	Event that sets this tag:
ChxCalFault	Bit 7	This bit is set if an error occurs during calibration for that channel, causing a bad calibration. This bit also sets bit 9 in the Module Fault word.
Underrange	Bit 6	This bit is set when the input signal at the channel is less than or equal to the minimum detectable signal. For more information on the minimum detectable signal for each module, see Table 5.6 on page 5-7. This bit also sets the appropriate bit in the Channel Fault word.
Overrange	Bit 5	This bit is set when the input signal at the channel is greater than or equal to the maximum detectable signal. For more information on the maximum detectable signal for each module, see Table 5.6 on page 5-7. This bit also sets the appropriate bit in the Channel Fault word.
ChxRateAlarm	Bit 4	This bit is set when the input channel's rate of change exceeds the configured Rate Alarm parameter. It remains set until the rate of change drops below the configured rate. If latched, the alarm remains set until it is unlatched.
ChxLAlarm	Blt 3	This bit is set when the input signal moves beneath the configured Low Alarm limit. It remains set until the signal moves above the configured trigger point. If latched, the alarm will remain set until it is unlatched. If a deadband is specified, the alarm will also remain set as long as the signal remains within the configured deadband.
ChxHAlarm	Bit 2	This bit is set when the input signal moves above the configured High Alarm limit. It remains set until the signal moves below the configured trigger point. If latched, the alarm remains set until it is unlatched. If a deadband is specified, the alarm also remains set as long as the signal remains within the configured deadband.
ChxLLAlarm	Bit 1	This bit is set when the input signal moves beneath the configured Low-Low Alarm limit. It remains set until the signal moves above the configured trigger point. If latched, the alarm remains set until it is unlatched. If a deadband is specified, the alarm also remains latched as long as the signal remains within the configured deadband.
ChxHHAlarm	Bit 0	This bit is set when the input signal moves above the configured High-High Alarm limit. It remains set until the signal moves below the configured trigger point. If latched, the alarm remains set until it is unlatched. If a deadband is specified, the alarm also remains latched as long as the signal remains within the configured deadband.

Fault Reporting in Integer Mode

Figure 5.13 offers an overview of the fault reporting process in integer mode.

Figure 5.13



Module Fault Word Bits – Integer Mode

In integer mode, Module Fault word bits (bits 15-8) operate exactly as described in floating point mode. Table 5.12 lists tags that can be examined in ladder logic to indicate when a fault has occurred:

Table 5.12

Tag:	Description:
Analog Group Fault	This bit is set when any bits in the Channel Fault word are set. Its tag name is AnalogGroupFault.
Input Group Fault	This bit is set when any bits in the Channel Fault word are set. Its tag name is InputGroup.
Calibrating	This bit is set when any channel is being calibrated. When this bit is set, all bits in the Channel Fault word are set. Its tag name is Calibrating.
Calibration Fault	This bit is set when any of the individual Channel Calibration Fault bits are set. Its tag name is CalibrationFault.

Channel Fault Word Bits – Integer Mode

In integer mode, Channel Fault word bits operate exactly as described in floating point mode. Table 5.13 lists the conditions that set **all** Channel Fault word bits:

Table 5.13

This condition sets all Channel Fault word bits:	And causes the module to display the following in the Channel Fault word bits:
A channel is being calibrated	"003F" for all bits
A communications fault occurred between the module and its owner-controller	"FFFF" for all bits

Your logic can monitor the Channel Fault Word bit for a particular input to determine the state of that point.

Channel Status Word Bits – Integer Mode

The Channel Status word has the following differences when used in integer mode:

- Only Underrange and Overrange conditions are reported by the module.
- Alarming and Calibration Fault activities are not available, although the Calibration Fault bit in the Module Fault word will activate if a channel is not properly calibrated.
- There is only 1 Channel Status word for all 6 channels.

When the Calibration Fault bit (bit 7) is set in any of the words, the Calibration Fault bit (bit 9) is set in the Module Fault word. Table 5.14 lists the conditions that set each of the words.

Table 5.14

Tag (Status word):	Bit:	Event that sets this tag:
ChxUnderrange	Odd-numbered bits from bit 15 to bit 5 (e.g. bit 15 represents channel 0). For a full listing of the channels these bits represent, see Figure 5.13 on page 5-23.	The underrange bit is set when the input signal at the channel is less than or equal to the minimum detectable signal. For more information on the minimum detectable signal for each module, see Table 5.6 on page 5-7. This bit also sets the appropriate bit in the Channel Fault word.
ChxOverrange	Even-numbered bits from bit 14 to bit 4 (e.g. bit 14 represents channel 0). For a full listing of the channels these bits represent, see Figure 5.13 on page 5-23.	The overrange bit is set when the input signal at the channel is greater than or equal to the maximum detectable signal. For more information on the maximum detectable signal for each module, see Table 5.6 on page 5-7. This bit also sets the appropriate bit in the Channel Fault word.

Chapter Summary and What's Next

In this chapter you learned about features specific to the Sourcing Current Loop Input Module (1756-IF6CIS) and Isolated Analog Voltage/Current Input Module (1756-IF6I).

Chapter 6 describes features specific to the Temperature Measuring Analog Modules (1756-IR6I, 1756-IT6I & 1756-IT6I2).

Temperature Measuring Analog Modules (1756-IR6I, 1756-IT6I & 1756-IT6I2)

What This Chapter Contains

This chapter describes features specific to temperature measuring ControlLogix analog modules.

For information about:	See page:
Choosing a Data Format	6-2
Features Specific to Temperature Measuring Modules	6-3
Differences Between the 1756-IT6I and 1756-IT6I2 Modules	6-12
Using Module Block and Input Circuit Diagrams	6-17
Wiring the 1756-IR6I Module	6-19
Wiring the 1756-IT6I Module	6-20
Wiring the 1756-IT6I2 Module	6-21
1756-IR6I, 1756-IT6I and 1756-IT6I2 Fault and Status Reporting	6-22

The temperature-measuring modules also support features described in Chapter 3. Table 6.1 lists those additional features.

Table 6.1 Additional Features Supported by the Temperature Measuring Modules

Feature:	Page of description:
Removal and Insertion Under Power (RIUP)	3-2
Module Fault Reporting	3-3
Fully Software Configurable	3-3
Electronic Keying	3-4
Access to System Clock for Timestamping Functions	3-6
Rolling Timestamp	3-6
Producer/Consumer Model	3-6
Status Indicator Information	3-7
Full Class I Division 2 Compliance	3-7
UL, CSA, FM, CE, C-Tick, EEx, TUV Agency Certification	3-7
Field Calibration	3-8
Sensor Offset	3-8
Latching of Alarms	3-8

Choosing a Data Format

Data format determines the features that are available to your application. You choose a data format when you choose a Communications Format. For more information on Communications Format, see page 10-6.

You can choose one of the two following data formats:

- Integer mode
- Floating point mode

Table 6.2 shows what features are available in each format.

Table 6.2 Features Available in Each Data Format

Data format:	Features available:	Features not available:
Integer mode	Multiple input ranges	Temperature linearization
	Notch filter	Process alarms
	Real time sampling	Digital filtering
	Cold Junction Temperature – (1756-IT6I and 1756-IT6I2 only)	Rate alarms
Floating point mode	All features	N/A

IMPORTANT Integer mode does not support temperature conversion on temperature measuring modules. If you choose integer mode, the 1756-IR6I is strictly an ohms (Ω) module and the 1756-IT6I and 1756-IT6I2 are strictly millivolts (mV) modules.

Features Specific to Temperature Measuring Modules

Table 6.3 lists features that are specific to the temperature-measuring modules. The features are described later in this section.

Table 6.3

Feature:	Page of description:
Multiple Input Ranges	6-3
Notch Filter	6-4
Real Time Sampling	6-5
Underrange/Overrange Detection	6-5
Digital Filter	6-6
Process Alarms	6-7
Rate Alarm	6-8
10 Ohm Offset	6-8
Wire Off Detection	6-9
Sensor Type	6-10
Temperature Units	6-12
Cold Junction Compensation	6-13

Multiple Input Ranges

You can select from a series of operational ranges for **each channel** on your module. The range designates the minimum and maximum signals that are detectable by the module.

Table 6.4 Possible Input Ranges

Module:	Possible ranges:
1756-IR6I	1 to 487Ω 2 to 1000Ω 4 to 2000Ω 8 to 4080Ω
1756-IT6I and 1756-IT6I2	-12 to +78mV -12 to +30mV

For an example of how to choose an input range for your module, see page 10-10.

Notch Filter

An Analog-to-Digital Convertor (ADC) filter removes line noise in your application for **each channel**.

Choose a notch filter that most closely matches the anticipated noise frequency in your application. Remember that each filter time affects the response time of your module. Also, the highest frequency notch filter settings also limit the effective resolution of the channel.

IMPORTANT 60Hz is the default setting for the notch filter.

Table 6.5 lists the available notch filter setting.

Table 6.5 Notch Filter Settings

Notch setting:	10Hz	50Hz	60Hz (Default)	100Hz	250Hz	1000Hz
Minimum Sample Time (RTS – Integer mode)(1)	102mS	22mS	19mS	12mS	10mS	10mS
Minimum Sample Time (RTS – Floating point mode)(2)	102mS	25mS	25mS	25mS	25mS	25mS
0-100% Step Response Time(3)	400mS + RTS	80mS + RTS	68mS + RTS	40mS + RTS	16mS + RTS	4mS + RTS
-3dB Frequency	3Hz	13Hz	15Hz	26Hz	66Hz	262Hz
Effective Resolution	16 bits	16 bits	16 bits	16 bits	15 bits	10 bits

(1) Integer mode must be used for RTS values lower than 25mS. The minimum RTS value for the module will be dependent on the channel with the lowest notch filter setting.

(2) In mV mode, 50mS minimum, if linearizing.

(3) Worst case settling time to 100% of a step change would include 0-100% step response time plus one RTS sample time.

To see how to choose a Notch Filter, see page 10-10.

Real Time Sampling

This parameter instructs the module to scan its input channels and obtain all available data. After the channels are scanned, the module multicasts that data.

During module configuration, you specify a Real Time Sampling (RTS) period and a Requested Packet Interval (RPI) period. These features both instruct the module to multicast data, but only the RTS feature instructs the module to scan its channels before multicasting.

For more information on Real Time Sampling, see page 2-4. For an example of how to set the RTS rate, see page 10-10.

Underrange/Overrange Detection

This feature detects when a temperature measuring input module is operating beyond limits set by the input range. For example, If you are using the 1756-IR6I module in the 2Ω-1000Ω input range and the module resistance increases to 1050Ω, the Overrange detection detects this condition.

Table 6.6 lists the input ranges of non-isolated input modules and the lowest/highest signal available in each range before the module detects an underrange/overrange condition:

Table 6.6 Low and High Signal Limits on Temperature Measuring Input Modules

Input module:	Available range:	Lowest signal in range:	Highest signal in range:
1756-IR6I	1Ω – 487Ω	0.859068653Ω	507.862Ω
	2Ω – 1000Ω	2Ω	1016.502Ω
	4Ω – 2000Ω	4Ω	2033.780Ω
	8Ω – 4020Ω	8Ω	4068.392Ω
1756-IT6I and 1756-IT6I2	-12mV to +30mV	-15.80323mV	31.396mV
	-12mV to +78mV	-15.15836mV	79.241mV

Digital Filter

IMPORTANT The digital filter is only available in applications using floating point mode.

The digital filter smooths input data noise transients on **each input channel**. This value specifies the time constant for a digital first order lag filter on the input. It is specified in units of milliseconds. A value of 0 disables the filter.

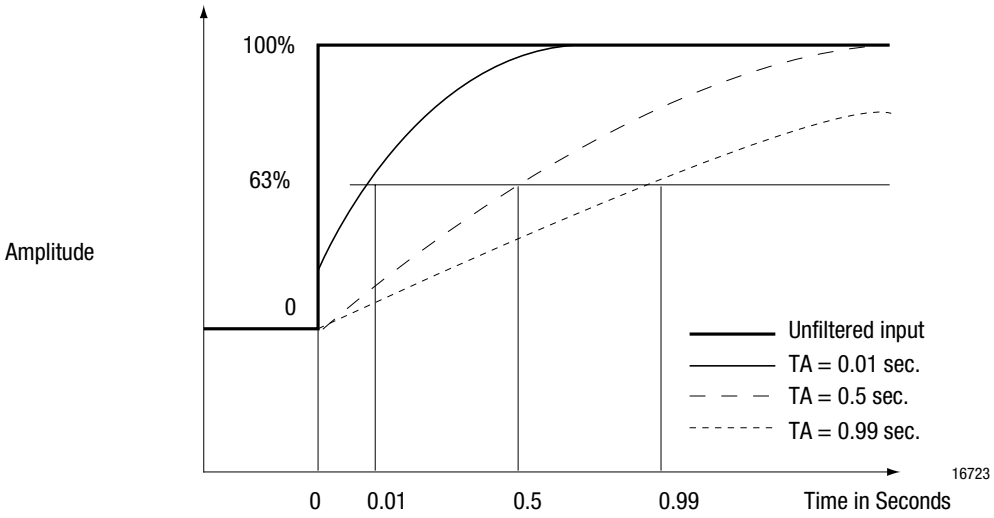
The digital filter equation is a classic first order lag equation.

$$Yn = Yn\text{-}1 + \frac{[\Delta t]}{\Delta t + TA} (X_n - Y_n\text{-}1)$$

Yn = present output, filtered peak voltage (PV)
Yn-1 = previous output, filtered PV
Δt = module channel update time (seconds)
TA = digital filter time constant (seconds)
Xn = present input, unfiltered PV

Using a step input change to illustrate the filter response, you can see that when the digital filter time constant elapses, 63.2% of the total response is reached. Each additional time constant achieves 63.2% of the remaining response. For more information, see Figure 6.1.

Figure 6.1



To see how to set the Digital Filter, see page 10-10.

Process Alarms

Process alarms alert you when the module has exceeded configured high or low limits for **each channel**. You can latch process alarms. These are set at four user configurable alarm trigger points:

- High high
- High
- Low
- Low low

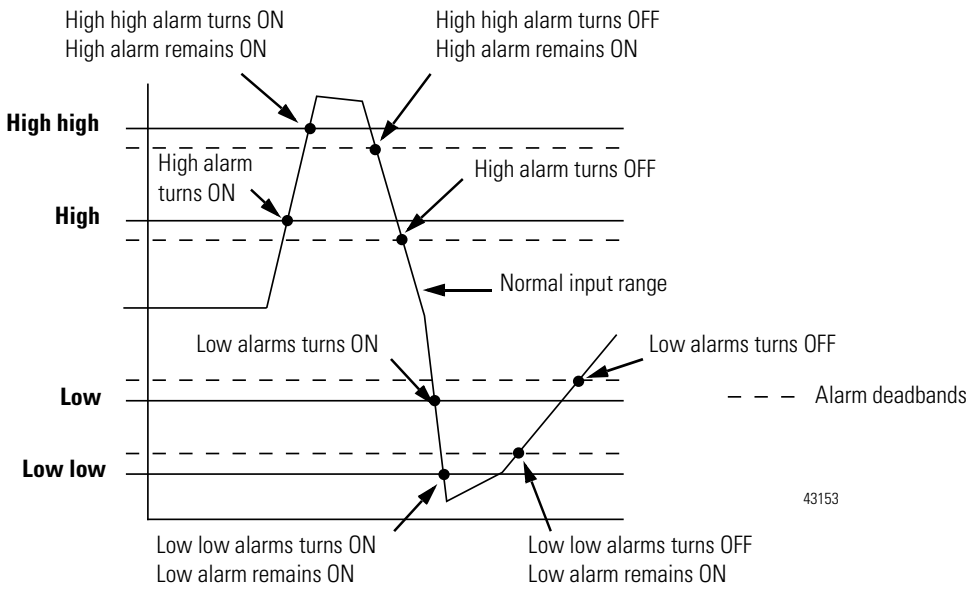
IMPORTANT Process alarms are only available in applications using floating point mode. The values for each limit are entered in scaled engineering units.

Alarm Deadband

You may configure an **Alarm Deadband** to work with these alarms. The deadband allows the process alarm status bit to remain set, despite the alarm condition disappearing, as long as the input data remains within the deadband of the process alarm.

Figure 6.2 shows input data that sets each of the four alarms at some point during module operation. In this example, Latching is disabled; therefore, each alarms turns OFF when the condition that caused it to set ceases to exist.

Figure 6.2



To see how to set Process Alarms, see page 10-10.

Rate Alarm

IMPORTANT Prior to RSLogix 5000, version 12 and module firmware revision 1.10, the rate alarm does not function correctly when linearizing (i.e. non-ohms or non-millivolt input range) temperature inputs on the 1756-IR6I, 1756-IT6I and 1756-IT6I2 modules.

To correctly use the rate alarm for a non-ohm input on the 1756-IR6I module and a non-millivolt input on the 1756-IT6I and 1756-IT6I2 modules, make sure you use RSLogix 5000, version 12 and module firmware 1.10 for these modules.

The rate alarm triggers if the rate of change between input samples for **each channel** exceeds the specified trigger point for that channel. This feature is **only available in applications using floating point**.

EXAMPLE If you set a 1756-IT6I2 module (with normal scaling in celsius) to a rate alarm of 100.1°C/S, the rate alarm only trigger if the difference between measured input samples changes at a rate > 100.1°C/S.

If the module's RTS is 100 ms (i.e. sampling new input data every 100ms) and at time 0, the module measures 355°C and at time 100ms measures 363°C, the rate of change is (363°C - 355°C) / (100mS) = 80°C/S. The rate alarm would not set as the change is less than the trigger point of 100.1°C/s.

If the next sample taken is 350.3°C, the rate of change is (350.3°C-363°C)/(100mS)=-127°C/S. The absolute value of this result is > 100.1°C/S, so the rate alarm will set. Absolute value is used because rate alarm checks for the magnitude of the rate of change being beyond the trigger point, whether a positive or negative excursion.

To see how to set the Rate Alarm, see page 10-10.

10 Ohm Offset

With this feature, you can compensate for a small offset error in a 10 ohm copper RTD. Values can range from -0.99 to +0.99 ohms in units of 0.01 ohms. For example, if the resistance of a copper RTD used with a channel is 9.74 ohms at 25°C, you would enter -0.26 in this field. To see how to set the 10 Ohm Offset, see page 10-14.

Wire Off Detection

The ControlLogix temperature measuring modules alert you when a wire has been disconnected from one of their channels. When a wire off condition occurs, two events occur:

- Input data for that channel changes to a specific scaled value
- A fault bit is set in the owner-controller which may indicate the presence of a wire off condition

Because these modules can each be used in various applications, differences exist when a wire off condition is detected in each application. Table 6.7 lists the differences that occur when a wire off condition occurs in various applications.

Table 6.7

In this application:	the following causes a wire off condition:	And if the wire off condition is detected, the following occurs:
1756-IR6I Module in Temperature Applications	Either of the following: 1. When any combination of wires are disconnected from the module, except the loss of the wire from terminal A only (see Figure 6.8 on page 6-19 and Figure 6.9 on page 6-19). 2. When only the wire connected to terminal A (see Figure 6.8 on page 6-19 and Figure 6.9 on page 6-19) is lost	If possibility #1 (in the previous column) is the cause: • input data for the channel changes to the lowest scaled temperature value associated with the selected RTD type • the ChxUnderrange (x=channel number) tag is set to 1 If possibility #2 (in the previous column) is the cause: • input data for the channel changes to the highest scaled temperature value associated with the selected RTD type • the ChxOverrrange (x=channel number) tag is set to 1
1756-IR6I Module in Ohms Applications	Either of the following: 1. When any combination of wires are disconnected from the module, except the loss of a wire from terminal A by itself (see Figure 6.8 on page 6-19 and Figure 6.9 on page 6-19) 2. When only the wire connected to terminal A (see Figure 6.8 on page 6-19 and Figure 6.9 on page 6-19) is lost	If possibility #1 (in the previous column) is the cause: • input data for the channel changes to the lowest scaled ohm value associated with the selected ohms range • the ChxUnderrange (x=channel number) tag is set to 1 If possibility #2 (in the previous column) is the cause: • input data for the channel changes to the highest scaled ohm value associated with the selected ohms range • the ChxOverrange (x=channel number) tag is set to 1
1756-IT6I or 1756-IT6I2 Module in Temperature Applications	A wire is disconnected from the module.	• input data for the channel changes to the highest scaled temperature value associated with the selected thermocouple type • the ChxOverrange (x=channel number) tag is set to 1
1756-IT6I Module or 1756-IT6I2 in Millivolt Applications		• input data for the channel changes to the scaled value associated with the **overrange** signal value of the selected operational range in floating point mode (maximum possible scaled value) or 32,767 counts in integer mode • the ChxOverrange (x=channel number) tag is set to 1

For more information about tags in the tag editor, see Appendix B.

Sensor Type

Three analog modules, the RTD (1756-IR6I) and Thermocouple (1756-IT6I and 1756-IT6I2), allow you to configure a **sensor type for each channel** that linearizes the analog signal into a temperature value. The RTD module linearizes ohms into temperature and the Thermocouple modules linearize millivolts into temperature.

IMPORTANT Sensor types are only available in applications using floating point mode.

Also, these modules can only linearize signals to temperature values in the floating point mode.

Table 6.8 lists the sensors that are available for your application:

Table 6.8 Available Sensors for Temperature Measuring Modules

Module:	Available sensors or thermocouples:
1756-IR6I	10Ω - Copper 427 type 100Ω - Platinum 385, Platinum 3916, and Nickel 618 types 120Ω - Nickel 618 and Nickel 672 types 200Ω - Platinum 385, Platinum 3916, and Nickel 618 types 500Ω - Platinum 385, Platinum 3916, and Nickel 618 types 1000Ω - Platinum 385 and Platinum 3916 types
1756-IT6I	B, E, J, K, R, S, T, N, C
1756-IT6I2	B, E, J, K, R, S, T, N, C, D, TXK/XK (L)

When you select any of the sensor or thermocouple types listed Table 6.8 during configuration, RSLogix 5000 uses the default values in the scaling box:

Table 6.9 Default Signal and Engineering Values in RSLogix 5000

1756-IR6I		1756-IT6I and 1756-IT6I2	
Low signal = 1	Low engineering = 1	Low signal = -12	Low engineering = -12
High signal = 487	High engineering = 487	High signal = +78	High engineering = +78

IMPORTANT The module sends back temperature values over the entire sensor range as long as the Low signal value equals the Low engineering value and the High signal value equals the High engineering value. The actual numbers used in the signal and engineering fields are irrelevant as long as they are equal.

Table 6.10 displays the temperature range for each 1756-IR6I sensor type.

Table 6.10 Temperature Limits for 1756-IR6I Sensor Types

1756-IR6I Sensor:	Copper 427	Nickel 618	Nickel 672	Platinum 385	Platinum 3916
Low temperature	-200.0°C -328.0°F	-60.0°C -76.0°F	-80.0°C -112.0°F	-200.0°C -328.0°F	-200.0°C -328.0°F
High temperature	260.0°C 500.0°F	250.0°C 482.0°F	320.0°C 608.0°F	870.0°C 1598.0°F	630.0°C 1166.0°F

To see how to choose an RTD sensor type, see page 10-14.

Table 6.11 displays the temperature range for each 1756-IT6I and 1756-IT6I2 sensor type.

Table 6.11 Temperature Limits for 1756-IT6I and 1756-IT6I2 Sensor Types

Thermocouple:	B	C	E	J	K	N	R	S	T	D[1]	TXK/XK (L)[1]
Low temperature	300.0°C 572.0°F	0.0°C 32.0°F	-270.0°C -454.0°F	-210.0°C -346.0°F	-270.0°C -454.0°F	-270.0°C -454.0°F	-50.0°C -58.0°F	-50.0°C -58.0°F	-270.0°C -454.0°F	0°C 32.0°F	-200°C -328°F
High temperature	1820.0°C 3308.0°F	2315.0°C 4199.0°F	1000.0°C 1832.0°F	1200.0°C 2192.0°F	1372.0°C 2502.0°F	1300.0°C 2372.0°F	1768.1°C 3215.0°F	1768.1°C 3215.0°F	400.0°C 752.0°F	2320°C 4208°F	800°C 1472°F

(1) Sensor types D and L are only available on the 1756-IT6I2 module.

IMPORTANT Table 6.11 lists temperature limits for sensors using the -12 to 78mV range only. When the -12 to 30mV range is used, temperature limits are truncated to the temperature value that corresponds to 30mV.

To see how to choose an thermocouple sensor type, see page 10-15.

Temperature Units

The 1756-IR6I, 1756-IT6I and 1756-IT6I2 modules provide the choice of working in Celsius or Fahrenheit. This choice affects all channels per module.

To see how to choose Temperature Units, see page 10-15.

Differences Between the 1756-IT6I and 1756-IT6I2 Modules

In addition to offering access to two more thermocouple types (i.e. types D and TXK/XK [L]), the 1756-IT6I2 module offers:

- greater cold junction compensation accuracy

  While the 1756-IT6I module can report cold junction temperature differences between channels as high as 3°C from the actual temperature, the 1756-IT6I2 module, because it has two Cold Junction Sensors (CJSs), reduces the potential cold junction error from actual temperature to 0.3°C.

  Table 6.12 lists cold junction error from actual temperature, depending on the type of cold junction compensation used.

Table 6.12

If you use this module:	with this type of cold junction compensation:	The cold junction error from actual temperature is:
1756-IT6I2	2 cold junction sensors on an RTB	+/-0.3°C
1756-IT6I2	IFM	+/-0.3°C
1756-IT6I	1 cold junction sensor on an RTB	+/-3.2°C maximum(1)
1756-IT6I	IFM	+/-0.3°C

(1) The cold junction error varies for each channel but 3.2°C is the maximum error any channel will show.

  For more information on Cold Junction Compensation, see page 6-13.

- improved module accuracy. For more information on the Improved Module Accuracy available with the 1756-IT6I2 module, see page 6-16.

Cold Junction Compensation

When using the Thermocouple (1756-IT6I and 1756-IT6I2) modules, you must account for additional voltage that may alter the input signal. The junction of thermocouple field wires with the screw terminations of an RTB or IFM generates a small voltage. This thermoelectric effect alters the input signal.

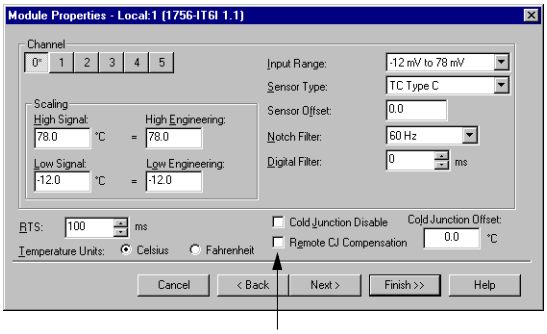
To accurately compensate the input signal from your module, you must use a CJS to account for the increased voltage. Because there are differences if you choose to connect sensors via an RTB or IFM, you must configure the module (via RSLogix 5000) to work with the type of CJS used in your application.

Connecting a Cold Junction Sensor Via a Removable Terminal Block

When you connect a CJS to your thermocouple module via an RTB, the following occurs, depending on module type:

- The 1756-IT6I module uses one (1) CJS in the middle of the module and estimates temperature deviation elsewhere on the connector.
- The 1756-IT6I2 module uses two (2) CJSs at the top and bottom of the module and calculates temperature at each channel's input terminals; this usage of multiple sensors results in increased accuracy.

If you connect a CJS via an IFM, configure the module as shown in the screen below.



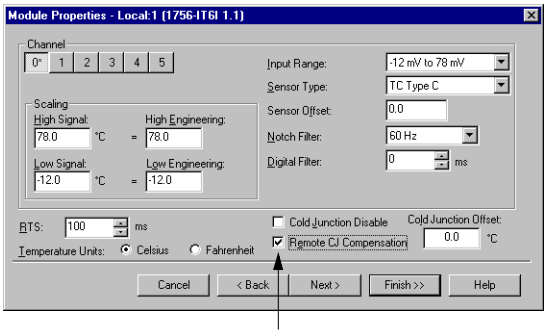
If you are using a CJS on an RTB, leave all fields unchecked,

To see how to connect a CJS to either thermocouple module, see page 6-14.

Connecting a Cold Junction Sensor Via an Interface Module

The IFMs use an isothermal bar to maintain a steady temperature at all module terminations. When you use the IFM, we recommend you mount it so that the black anodized aluminum bar is in the horizontal position.

If you connect a CJS via an IFM, configure the module as shown in the screen below.

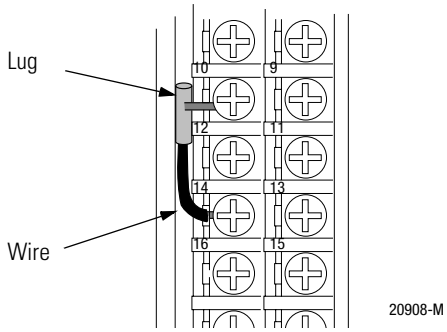


If you are using a CJS on an IFM, check the Remote CJ Compensation field.

Connecting a Cold Junction Sensor to the 1756-IT6I Module

You must connect the CJS to the 1756-IT6I module at terminals 10 and 14. To ease installation, wire terminal #12 (RTN-3) before connecting the cold junction sensor.

Figure 6.3

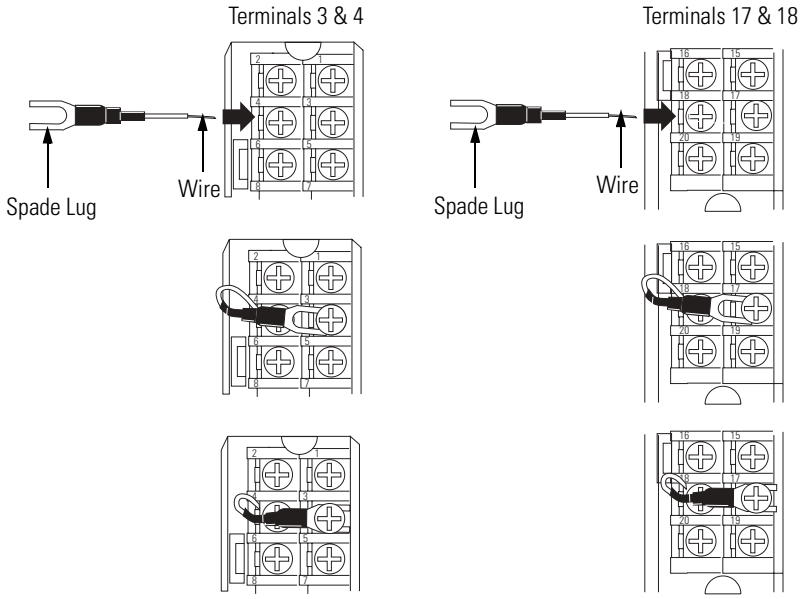


The CJS is part number 94238301. Contact your local distributor or Rockwell Automation sales representative to order additional sensors.

Connecting a Cold Junction Sensor to the 1756-IT6I2 Module

You must connect two CJSs to the 1756-IT6I2 when using an RTB. The additional CJS offers greater accuracy when measuring temperature on the module. Connect the cold junction sensors to terminals 3 & 4 and 17 & 18 as shown in Figure 6.4.

Figure 6.4



The CJS for the 1756-IT6I2 module is part number 94286501. Contact your local distributor or Rockwell Automation sales representative to order additional sensors.

Cold Junction Disable

RSLogix 5000 offers an option to disable cold junction compensation. If used, this option removes all cold junction compensation on all module channels. Typically, this option is only used in systems that have no thermoelectric effect (e.g. test equipment in a controlled lab).

In most applications, we recommend that you do not use the Cold Junction Disable option.

Cold Junction Offset

RSLogix 5000 also offers an option to make module-wide adjustments to cold junction compensation values. If you know that your cold junction compensation values are consistently inaccurate by some level (e.g. 1.2°C), you can set the Cold Junction Offset to -1.2° to account for this inaccuracy.

Improved Module Accuracy

The 1756-IT6I2 also offers an improved Gain Drift with Temperature and Module Error over Temperature Range specifications when compared to the 1756-IT6I module. Table 6.13 highlights the differences. For a full listing of these module's specifications, see Appendix A.

Table 6.13

Catalog Number:	Gain Drift with Temperature:(1)	Module Error over Temperature Range:(1)
1756-IT6I	80 ppm	0.5%
1756-IT6I2	25 ppm	0.15%

(1) To read a detailed explanation of this specification, see Appendix E.

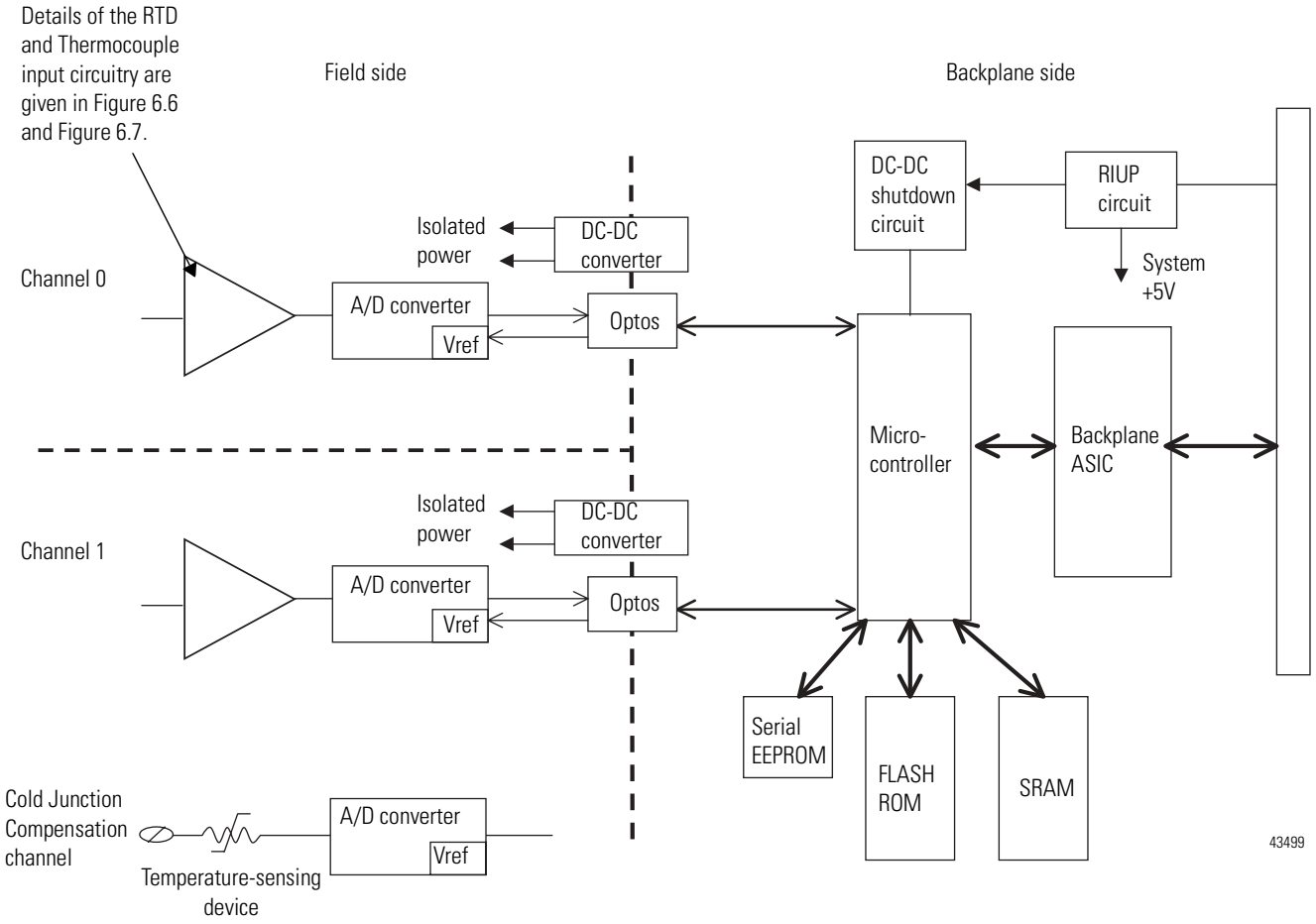
Using Module Block and Input Circuit Diagrams

This section shows the 1756-IR6I, 1756-IT6I and 1756-IT6I2 modules' block diagrams and input circuit diagrams.

Module Block Diagram

Figure 6.5 1756-IR6I, 1756-IT6I and 1756-IT6I2 Module Block Diagram

This diagram shows 2 channels. There are 6 channels on on the temperature measuring modules.



IMPORTANT: The cold junction compensation (CJC) channel is used on thermocouple modules only. The 1756-IT6I module has one CJC channel, and the 1756-IT6I2 module has two CJC channels.

= Channel isolation

Field Side Circuit Diagrams

Figure 6.6 1756-IR6I Input Circuit

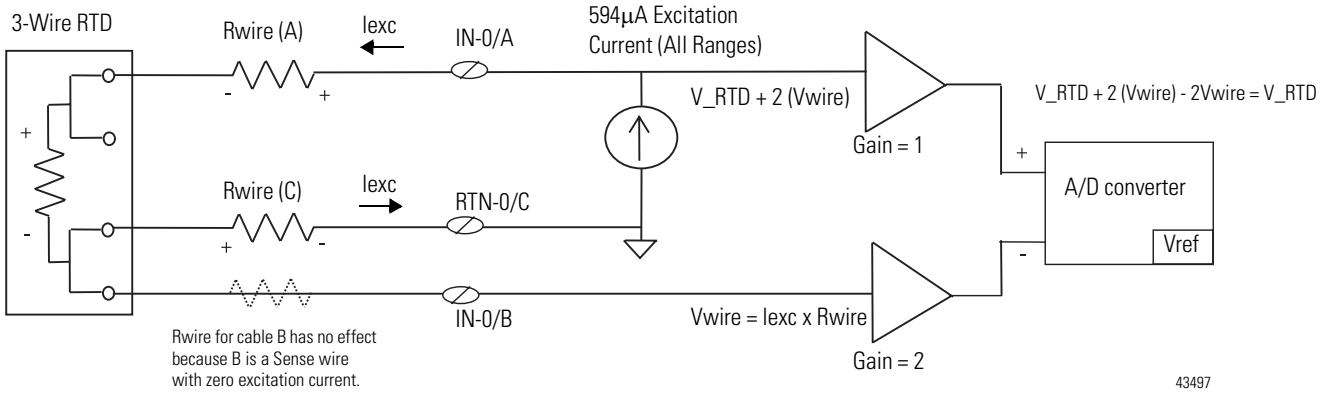
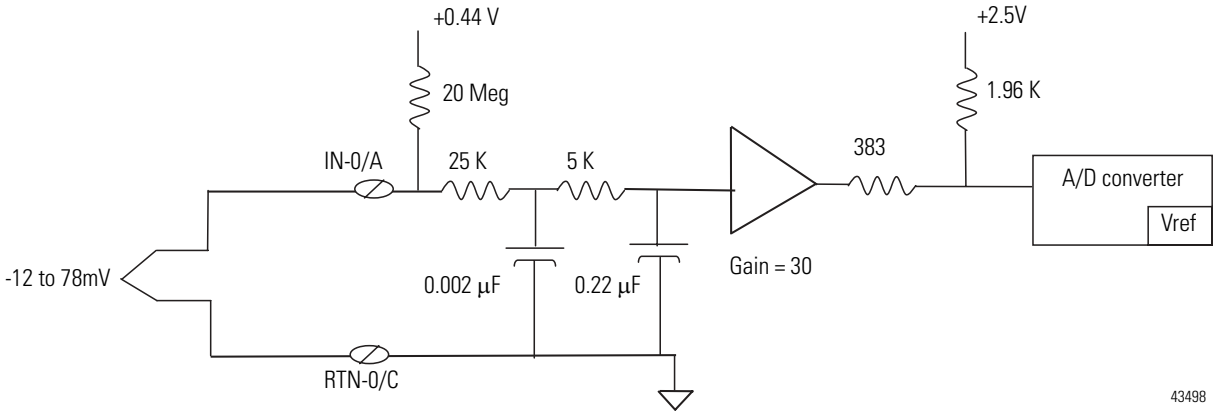
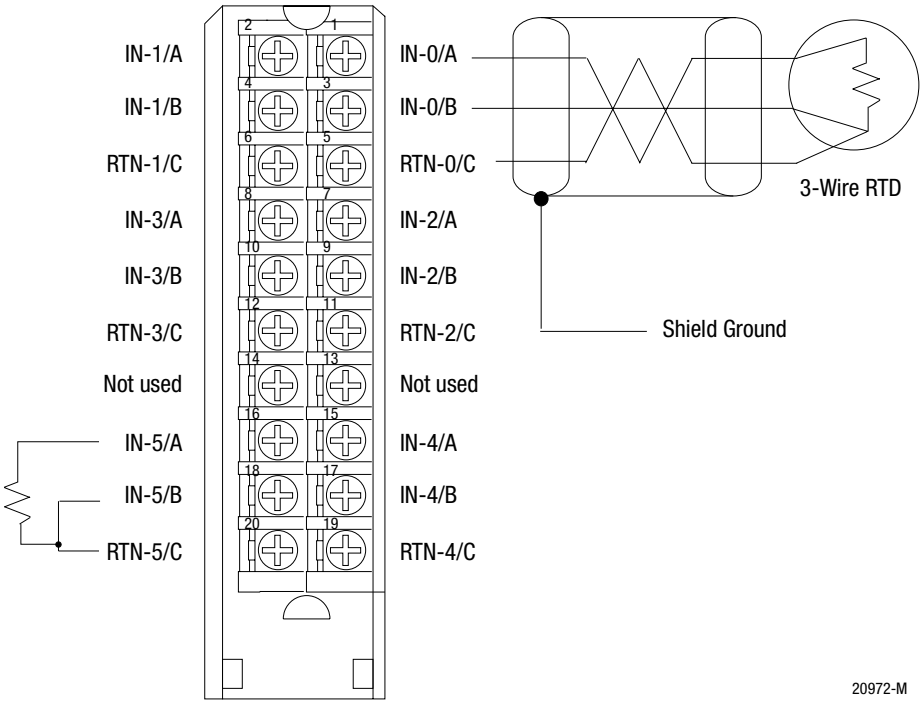


Figure 6.7 1756-IT6I and 1756-IT6I2 Input Circuit



Wiring the 1756-IR6I Module

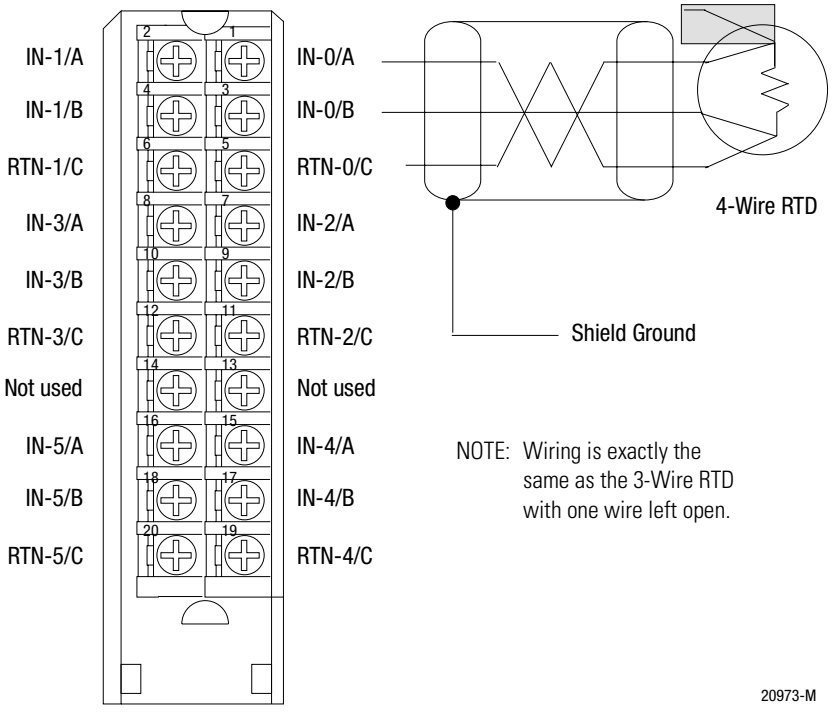
Figure 6.8 1756-IR6I 3-Wire RTD wiring example



IMPORTANT: For 2-wire resistor applications including calibration, make sure IN-x/B and RTN-x/C are shorted together as shown.

NOTE: Do not connect more than 2 wires to any single terminal.

Figure 6.9 1756-IR6I 4-Wire RTD wiring example

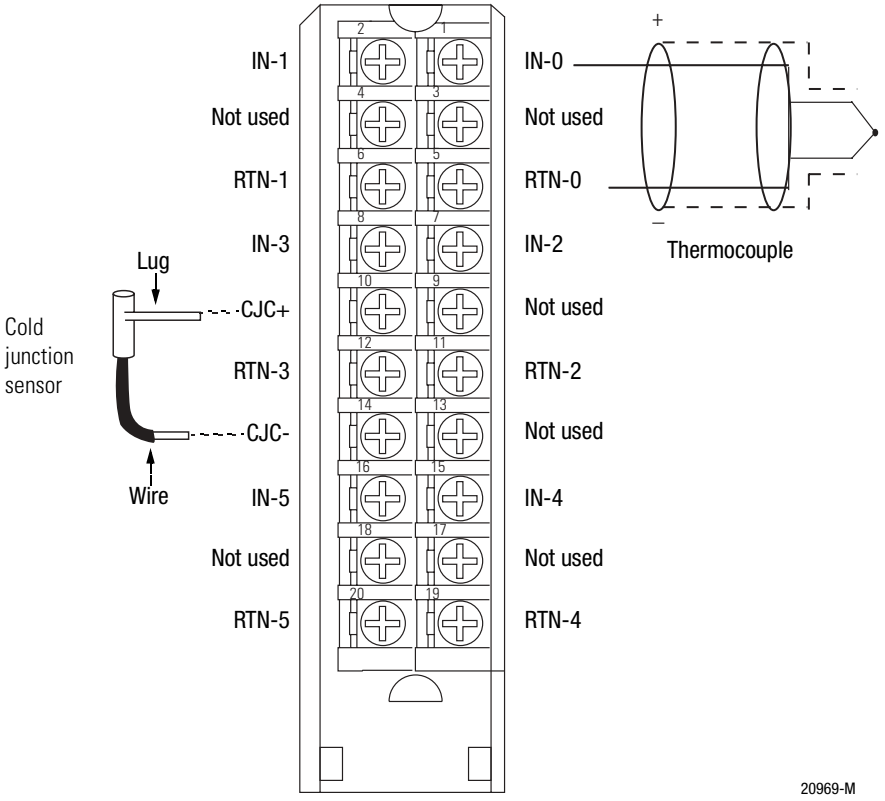


NOTE: Wiring is exactly the same as the 3-Wire RTD with one wire left open.

NOTE: Do not connect more than 2 wires to any single terminal.

Wiring the 1756-IT6I Module

Figure 6.10 1756-IT6I wiring example

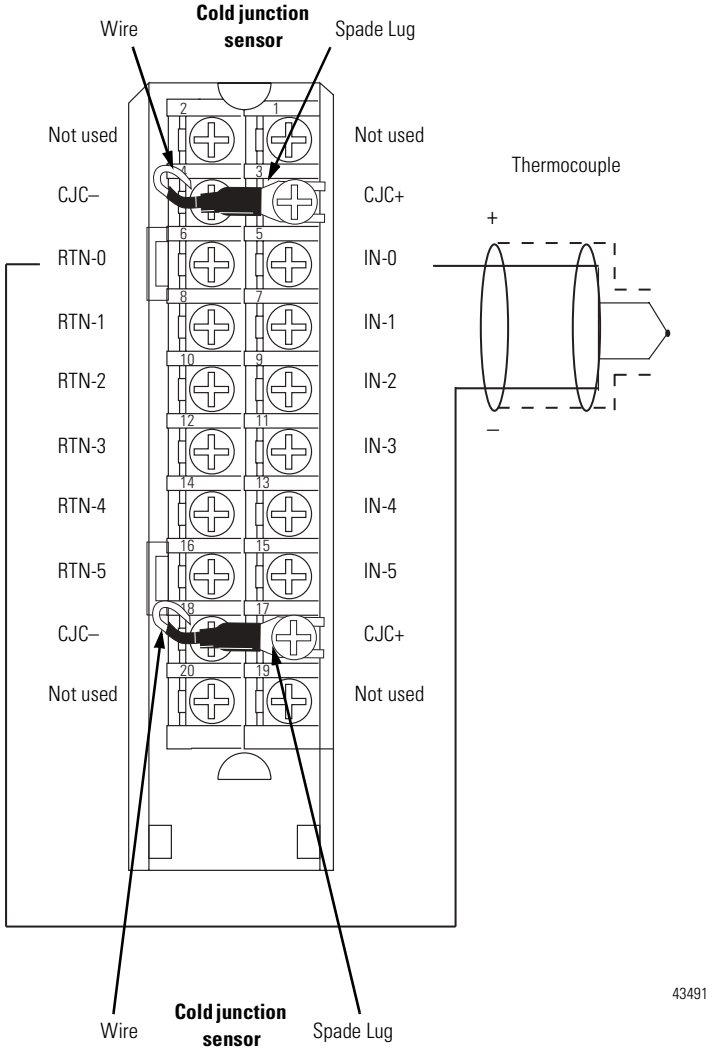


NOTES:

1. Do not connect more than 2 wires to any single terminal.
2. The part number for the cold junction sensor used on the 1756-IT6I module is 94238301.

Wiring the 1756-IT6I2 Module

Figure 6.11 1756-IT6I2 wiring example



NOTES:

1. Do not connect more than 2 wires to any single terminal.
2. The part number for the cold junction sensor used on the 1756-IT6I module is 94286501.

1756-IR6I, 1756-IT6I and 1756-IT6I2 Fault and Status Reporting

The 1756-IR6I, 1756-IT6I and 1756-IT6I2 modules multicast status/fault data to the owner/listening controller with its channel data. The fault data is arranged in such a manner as to allow the user to choose the level of granularity he desires for examining fault conditions.

Three levels of tags work together to provide increasing degree of detail as to the specific cause of faults on the module.

Table 6.14 lists tags that can be examined in ladder logic to indicate when a fault has occurred:

Table 6.14

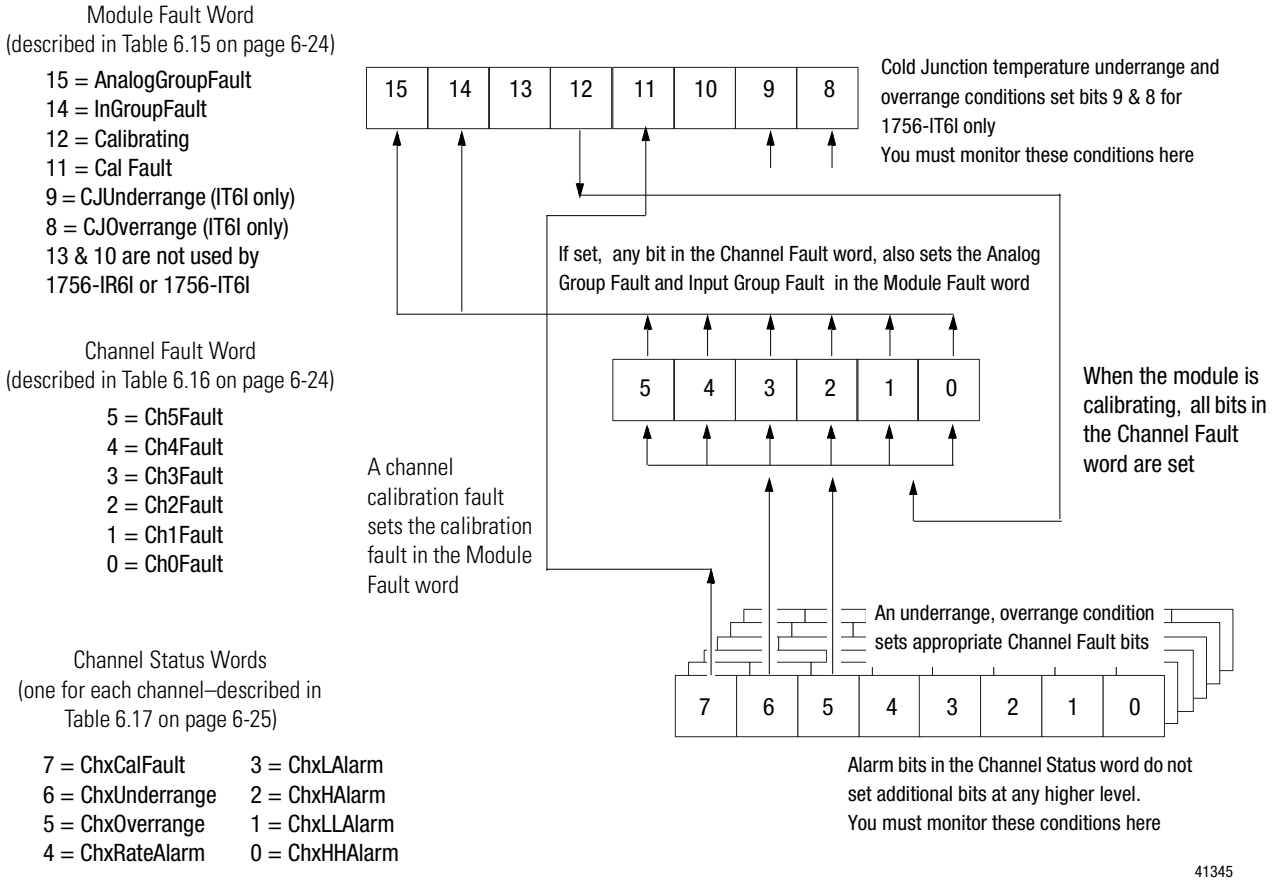
Tag:	Description:
Module Fault Word	This word provides fault summary reporting. Its tag name is ModuleFaults.
Channel Fault Word	This word provides underrange, overrange and communications fault reporting. Its tag name is ChannelFaults.
Channel Status Words	This word provides individual channel underrange and overrange fault reporting for process alarms, rate alarms and calibration faults. Its tag name is ChxStatus.

IMPORTANT Differences exist between floating point and integer modes as they relate to module fault reporting. These differences are explained in the following two sections.

Fault Reporting in Floating Point Mode

Figure 6.12 offers an overview of the fault reporting process in floating point mode.

Figure 6.12



Module Fault Word Bits – Floating Point Mode

Bits in this word provide the highest level of fault detection. A nonzero condition in this word reveals that a fault exists on the module. You can examine further down to isolate the fault.

Table 6.15 lists tags that are found in the Module Fault Word:

Table 6.15

Tag:	Description:
Analog Group Fault	This bit is set when any bits in the Channel Fault word are set. Its tag name is AnalogGroupFault.
Input Group Fault	This bit is set when any bits in the Channel Fault word are set. Its tag name is InputGroup.
Calibrating	This bit is set when any channel is being calibrated. When this bit is set, all bits in the Channel Fault word are set. Its tag name is Calibrating.
Calibration Fault	This bit is set when any of the individual Channel Calibration Fault bits are set. Its tag name is CalibrationFault.
Cold Junction Underrange – 1756-IT6I and 1756-IT6I2only	This bit is set when the ambient temperature around the Cold Junction Sensor is below 0^{o}C. Its tag name is CJUnderrange.
Cold Junction Overrange – 1756-IT6I and 1756-IT6I2only	This bit is set when the ambient temperature around the Cold Junction Sensor is above 86^{o}C. Its tag name is CJOverrange.

Channel Fault Word Bits – Floating Point Mode

During normal module operation, bits in the Channel Fault word are set if any of the respective channels has an Under or Overrange condition. Checking this word for a nonzero value is a quick way to check for Under or Overrange conditions on the module.

Table 6.16 lists the conditions that set **all** Channel Fault word bits:

Table 6.16

This condition sets all Channel Fault word bits:	And causes the module to display the following in the Channel Fault word bits:
A channel is being calibrated	"003F" for all bits
A communications fault occurred between the module and its owner-controller	"FFFF" for all bits

Your logic can monitor the Channel Fault Word bit for a particular input to determine the state of that point.

Channel Status Word Bits – Floating Point Mode

Any of the 6 Channel Status words, one for each channel, will display a nonzero condition if that particular channel has faulted for the conditions listed below. Some of these bits set bits in other Fault words. When the Underrange and Overrange bits (bits 6 & 5) in any of the words are set, the appropriate bit is set in the Channel Fault word.

When the Calibration Fault bit (bit 7) is set in any of the words, the Calibration Fault bit (bit 9) is set in the Module Fault word. Table 6.17 lists the conditions that set each of the word bits.

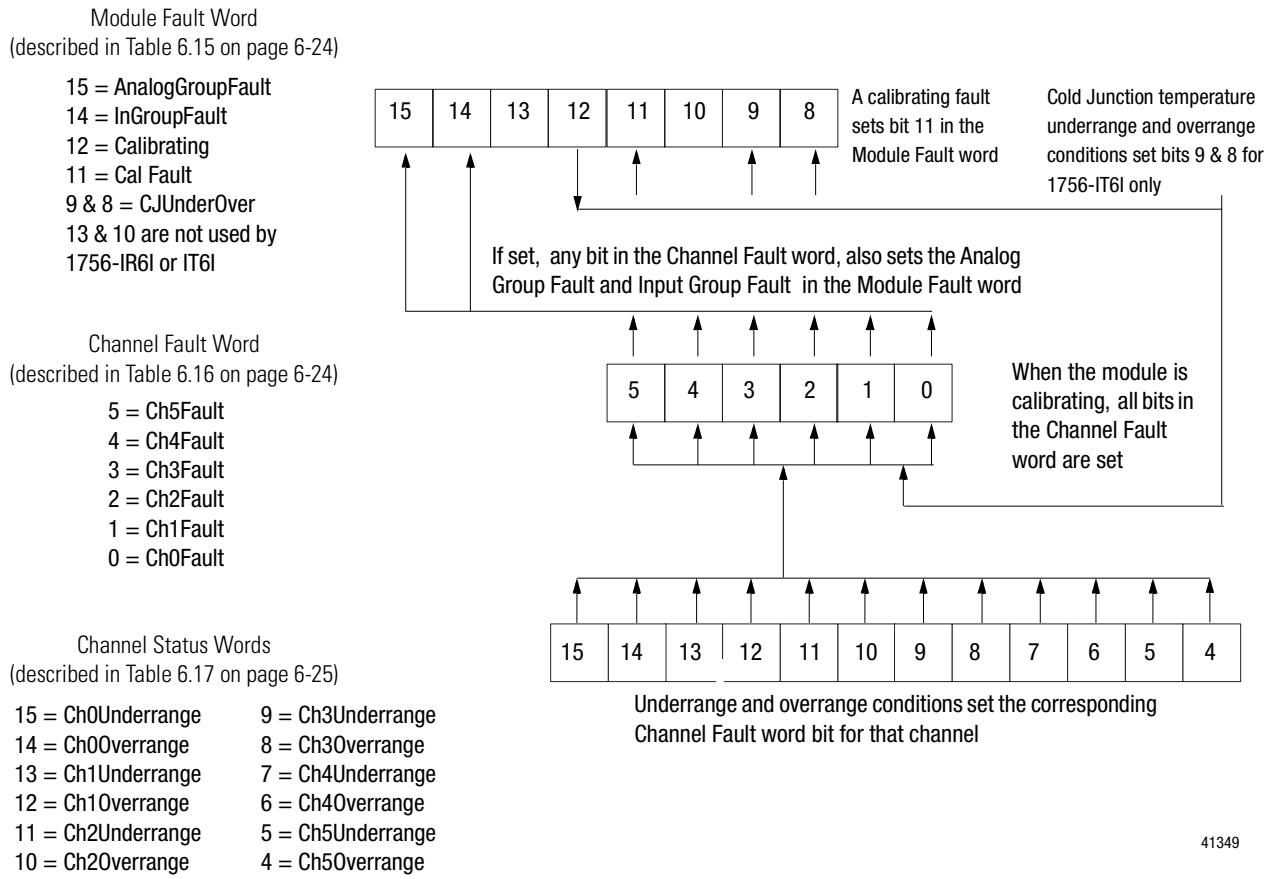
Table 6.17

Tag (Status word):	Bit:	Event that sets this tag:
ChxCalFault	Bit 7	This bit is set if an error occurs during calibration for that channel, causing a bad calibration. This bit also sets bit 9 in the Module Fault word.
Underrange	Bit 6	This bit is set when the input signal at the channel is less than or equal to the minimum detectable signal. For more information on the minimum detectable signal for each module, see Table 6.6 on page 6-5. This bit also sets the appropriate bit in the Channel Fault word.
Overrange	Bit 5	This bit is set when the input signal at the channel is greater than or equal to the maximum detectable signal. For more information on the maximum detectable signal for each module, see Table 6.6 on page 6-5. This bit also sets the appropriate bit in the Channel Fault word.
ChxRateAlarm	Bit 4	This bit is set when the input channel's rate of change exceeds the configured Rate Alarm parameter. It remains set until the rate of change drops below the configured rate. If latched, the alarm remains set until it is unlatched.
ChxLAlarm	Blt 3	This bit is set when the input signal moves beneath the configured Low Alarm limit. It remains set until the signal moves above the configured trigger point. If latched, the alarm will remain set until it is unlatched. If a deadband is specified, the alarm will also remain set as long as the signal remains within the configured deadband.
ChxHAlarm	Bit 2	This bit is set when the input signal moves above the configured High Alarm limit. It remains set until the signal moves below the configured trigger point. If latched, the alarm remains set until it is unlatched. If a deadband is specified, the alarm also remains set as long as the signal remains within the configured deadband.
ChxLLAlarm	Bit 1	This bit is set when the input signal moves beneath the configured Low-Low Alarm limit. It remains set until the signal moves above the configured trigger point. If latched, the alarm remains set until it is unlatched. If a deadband is specified, the alarm also remains latched as long as the signal remains within the configured deadband.
ChxHHAlarm	Bit 0	This bit is set when the input signal moves above the configured High-High Alarm limit. It remains set until the signal moves below the configured trigger point. If latched, the alarm remains set until it is unlatched. If a deadband is specified, the alarm also remains latched as long as the signal remains within the configured deadband.

Fault Reporting in Integer Mode

Figure 6.13 offers an overview of the fault reporting process in integer mode.

Figure 6.13



Module Fault Word Bits – Integer Mode

In integer mode, Module Fault word bits (bits 15-8) operate exactly as described in floating point mode. Table 6.18 lists tags that are found in the Module Fault Word:

Table 6.18

Tag:	Description:
Analog Group Fault	This bit is set when any bits in the Channel Fault word are set. Its tag name is AnalogGroupFault.
Input Group Fault	This bit is set when any bits in the Channel Fault word are set. Its tag name is InputGroup.
Calibrating	This bit is set when any channel is being calibrated. When this bit is set, all bits in the Channel Fault word are set. Its tag name is Calibrating.
Calibration Fault	This bit is set when any of the individual Channel Calibration Fault bits are set. Its tag name is CalibrationFault.
Cold Junction Underrange – 1756-IT6I only	This bit is set when the ambient temperature around the Cold Junction Sensor is below 0^{o}C. Its tag name is CJUnderrange.
Cold Junction Overrange – 1756-IT6I only	This bit is set when the ambient temperature around the Cold Junction Sensor is above 86^{o}C. Its tag name is CJOverrange.

Channel Fault Word Bits – Integer Mode

In integer mode, Channel Fault word bits operate exactly as described in floating point mode. Table 6.19 lists the conditions that set **all** Channel Fault word bits:

Table 6.19

This condition sets all Channel Fault word bits:	And causes the module to display the following in the Channel Fault word bits:
A channel is being calibrated	"003F" for all bits
A communications fault occurred between the module and its owner-controller	"FFFF" for all bits

Your logic can monitor the Channel Fault Word bit for a particular input to determine the state of that point.

Channel Status Word Bits – Integer Mode

The Channel Status word has the following differences when used in integer mode:

- Only Underrange and Overrange conditions are reported by the module.
- Alarming and Calibration Fault activities are not available, although the Calibration Fault bit in the Module Fault word will activate if a channel is not properly calibrated.
- There is only 1 Channel Status word for all 6 channels.

When the Calibration Fault bit (bit 7) is set in any of the words, the Calibration Fault bit (bit 9) is set in the Module Fault word. Table 6.20 lists the conditions that set each of the words.

Table 6.20

Tag (Status word):	Bit:	Event that sets this tag:
ChxUnderrange	Odd-numbered bits from bit 15 to bit 5 (e.g. bit 15 represents channel 0). For a full listing of the channels these bits represent, see Figure 6.13 on page 6-26.	The underrange bit is set when the input signal at the channel is less than or equal to the minimum detectable signal. For more information on the minimum detectable signal for each module, see Table 6.6 on page 6-5. This bit also sets the appropriate bit in the Channel Fault word.
ChxOverrange	Even-numbered bits from bit 14 to bit 4 (e.g. bit 14 represents channel 0). For a full listing of the channels these bits represent, see Figure 6.13 on page 6-26.	The overrange bit is set when the input signal at the channel is greater than or equal to the maximum detectable signal. For more information on the maximum detectable signal for each module, see Table 6.6 on page 6-5. This bit also sets the appropriate bit in the Channel Fault word.

Chapter Summary and What's Next

In this chapter you read about features specific to the Temperature Measuring Analog Modules (1756-IR6I, 1756-IT6I & 1756-IT6I2).

Chapter 7 describes features specific to the Non-Isolated Analog Output Modules (1756-OF4 & 1756-OF8).

Non-Isolated Analog Output Modules (1756-OF4 & 1756-OF8)

What This Chapter Contains

This chapter describes features specific to ControlLogix non-isolated analog output modules.

For information about:	See page:
Choosing a Data Format	7-2
Features Specific to Analog Output Modules	7-2
Using Module Block and Output Circuit Diagrams	7-6
Wiring the 1756-OF4 Module	7-9
Wiring the 1756-OF8 Module	7-10
1756-OF4 and 1756-OF8 Module Fault and Status Reporting	7-11

The non-isolated analog output modules also support features described in Chapter 3. Table 7.1 lists those additional features.

Table 7.1 Additional Features Supported by the Non-Isolated Analog Output Modules

Feature:	Page of description:
Removal and Insertion Under Power (RIUP)	3-2
Module Fault Reporting	3-3
Fully Software Configurable	3-3
Electronic Keying	3-4
Access to System Clock for Timestamping Functions	3-6
Rolling Timestamp	3-6
Producer/Consumer Model	3-6
Status Indicator Information	3-7
Full Class I Division 2 Compliance	3-7
UL, CSA, FM, CE, C-Tick, EEx, TUV Agency Certification	3-7
Field Calibration	3-8
Sensor Offset	3-8
Latching of Alarms	3-8

Choosing a Data Format

Data format defines the format of channel data sent from the controller to the module, defines the format of the "data echo" that the module produces, and determines the features that are available to your application. You choose a data format when you choose a Communications Format. For more information on Communications Format, see page 10-6.

You can choose one of the two following data formats:

- Integer mode
- Floating point mode

Table 7.2 lists the features that are available in each format.

Table 7.2 Features Available in Each Data Format

Data format:	Features available:	Features not available:
Integer mode	Ramp to program value	Clamping
	Ramp to fault value	Ramp in Run mode
	Hold for initialization	Rate and Limit alarms
	Hold Last State or User Value in fault or program mode	Scaling
Floating point mode	All features	N/A

Features Specific to Analog Output Modules

Table 7.3 lists features that are specific to the non-isolated analog output modules. The features are described later in this section.

Table 7.3

Feature:	Page of description:
Ramping/Rate Limiting	7-3
Hold for Initialization	7-4
Open Wire Detection	7-4
Clamping/Limiting	7-5
Clamp/Limit Alarms	7-5
Data Echo	7-6

Ramping/Rate Limiting

Ramping limits the speed at which an analog output signal can change. This prevents fast transitions in the output from damaging the devices that an output module controls. Ramping is also known as **rate limiting**.

Table 7.4 describes the types of ramping that are possible:

Table 7.4

Ramping type:	Description:
Run mode ramping	This type of ramping occurs when the module is in Run mode and begins operation at the configured maximum ramp rate when the module receives a new output level. **IMPORTANT**: This is only available in floating point mode.
Ramp to program mode	This type of ramping occurs when the present output value changes to the Program Value after a Program Command is received from the controller.
Ramp to fault mode	This type of ramping occurs when the present output value changes to the Fault Value after a communications fault occurs.

The maximum rate of change in outputs is expressed in engineering units per second and called the **maximum ramp rate**. To see how to enable Run mode ramping and set the maximum ramp rate, see page 10-13.

Hold for Initialization

Hold for Initialization causes outputs to hold present state until the value commanded by the controller matches the value at the output screw terminal within 0.1% of full scale, providing a bumpless transfer.

If Hold for Initialization is selected, outputs hold if any of the three conditions occur:

- Initial connection is established after power-up
- A new connection is established after a communications fault occurs
- There is a transition to Run mode from Program state

The InHold bit for a channel indicates that the channel is holding. To see how to enable the Hold for Initialization bit, see page 10-12.

Open Wire Detection

This feature detects when current flow is not present at any channel. The 1756-OF4 and 1756-OF8 modules must be configured for 0-20mA operation to use this feature. At least 0.1mA of current must be flowing from the output for detection to occur.

When an open wire condition occurs at any channel, a status bit is set for that channel. For more information on the use of status bits, see page 7-11.

Clamping/Limiting

Clamping limits the output from the analog module to remain within a range configured by the controller, even when the controller commands an output outside that range. This safety feature sets a high clamp and a low clamp.

Once clamps are determined for a module, any data received from the controller that exceeds those clamps sets an appropriate limit alarm and transitions the output to that limit but not beyond the requested value.

For example, an application may set the high clamp on a module for 8V and the low clamp for -8V. If a controller sends a value corresponding to 9V to the module, the module will only apply 8V to its screw terminals.

Clamping alarms can be disabled or latched on a per channel basis.

IMPORTANT Clamping is only available in floating point mode.

To see how to set the clamping limits, see page 10-13.

Clamp/Limit Alarms

This function works directly with clamping. When a module receives a data value from the controller that exceeds clamping limits, it applies signal values to the clamping limit but also sends a status bit to the controller notifying it that the value sent exceeds the clamping limits.

Using the example above, if a module has clamping limits of 8V and -8V but then receives data to apply 9V, only 8V is applied to the screw terminals and the module sends a status bit back to the controller informing it that the 9V value exceeds the module's clamping limits.

IMPORTANT Limit alarms are only available in floating point mode.

To see how to enable all alarms, see page 10-13.

Data Echo

Data Echo automatically multicasts channel data values which match the analog value that was sent to the module's screw terminals at that time.

Fault and status data is also sent.This data is sent in the format (floating point or integer) selected at the Requested Packet Interval (RPI).

Using Module Block and Output Circuit Diagrams

This section shows the 1756-OF4 and 1756-OF8 modules' block diagrams and output circuit diagrams.

Module Block Diagram

Figure 7.1 1756-OF4 Module Block Diagram

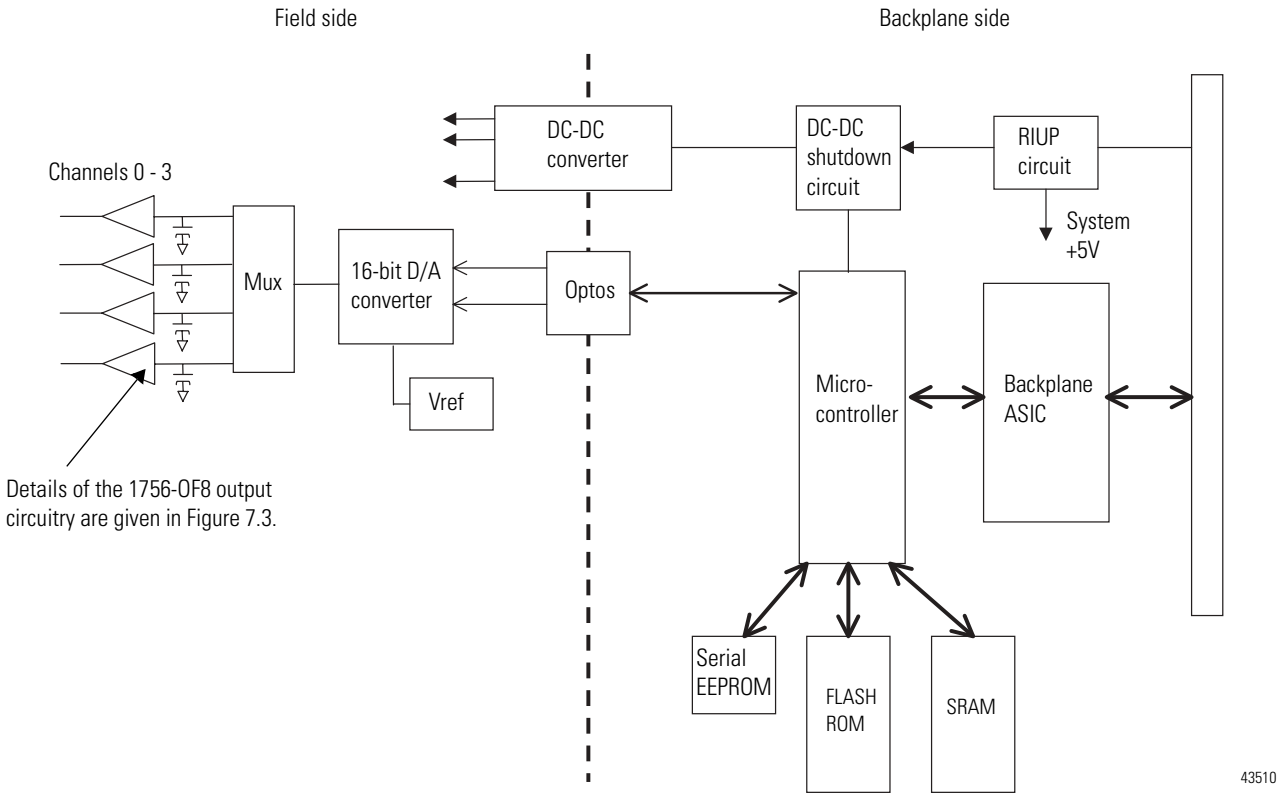
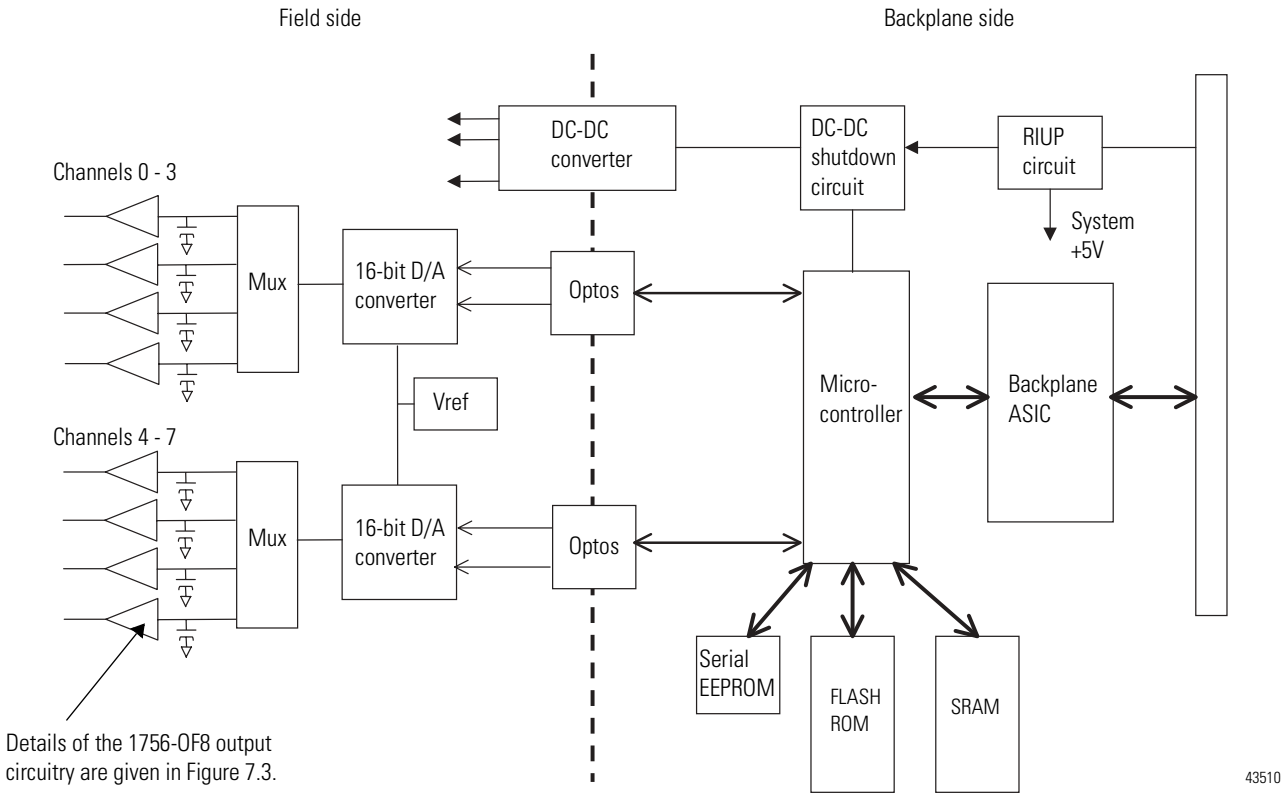
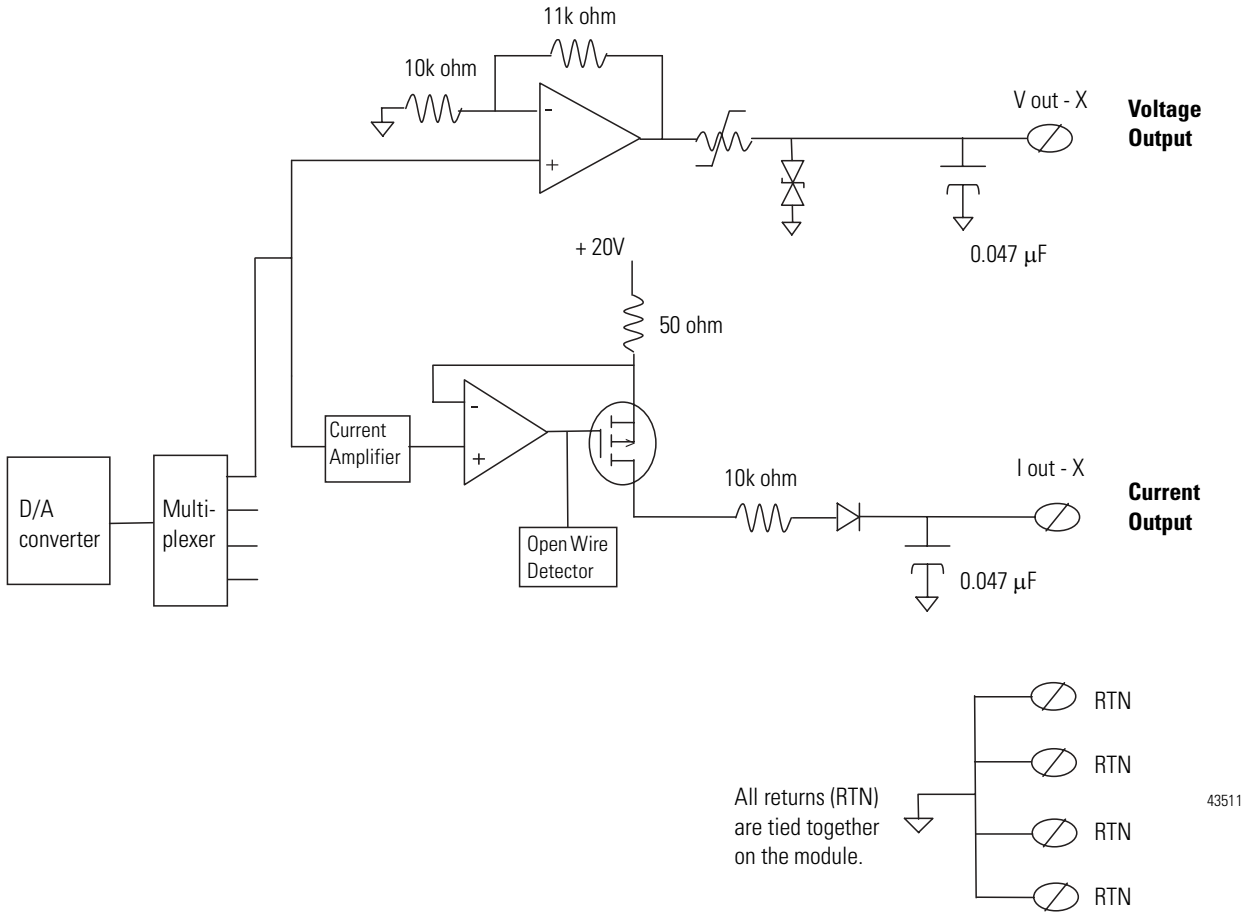


Figure 7.2 1756-OF8 Module Block Diagram



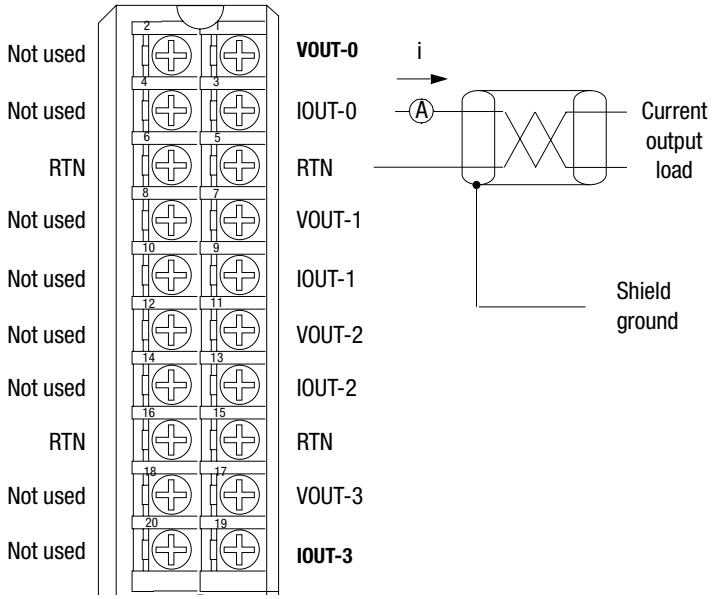
Field Side Circuit Diagrams

Figure 7.3 1756-OF4 and 1756-OF8 Output Circuit



Wiring the 1756-OF4 Module

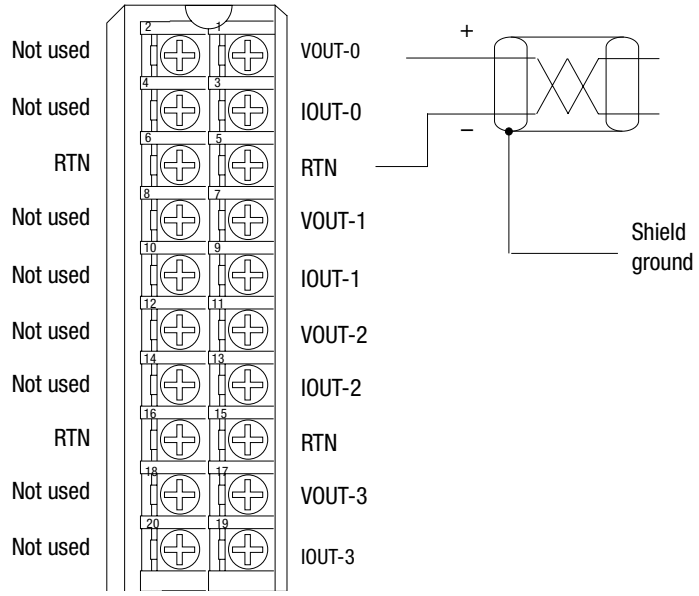
Figure 7.4 1756-OF4 Current wiring example



NOTES:

1. Place additional loop devices (e.g. strip chart recorders, etc.) at the A location noted above.
2. Do not connect more than 2 wires to any single terminal.
3. All terminals marked RTN are connected internally.

Figure 7.5 1756-OF4 Voltage wiring example

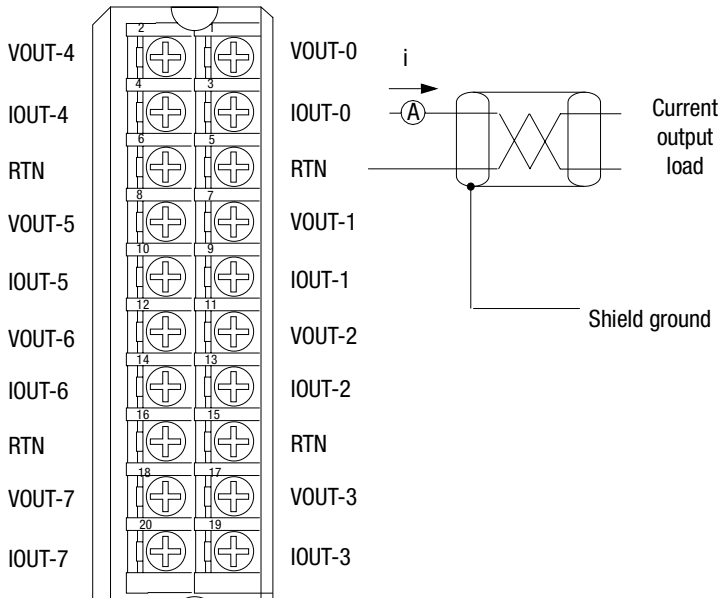


NOTES:

1. Do not connect more than 2 wires to any single terminal.
2. All terminals marked RTN are connected internally.

Wiring the 1756-OF8 Module

Figure 7.6 1756-OF8 Current wiring example

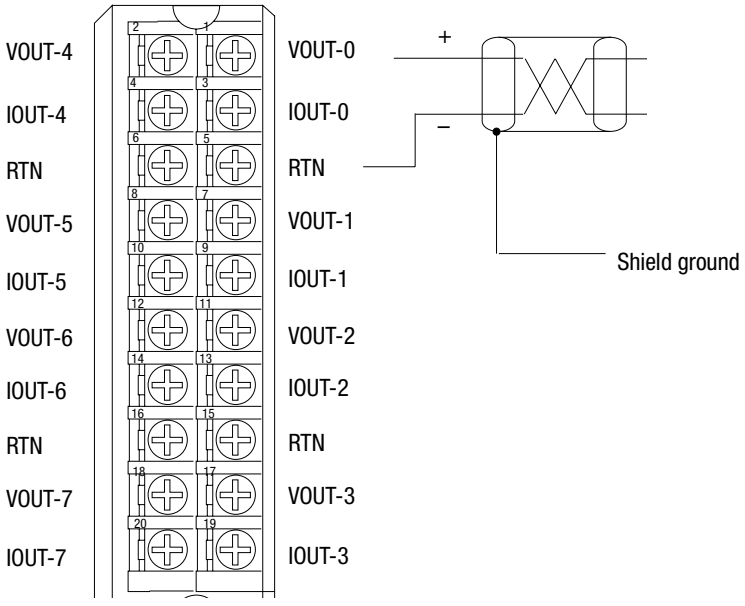


NOTES:

1. Place additional loop devices (e.g. strip chart recorders, etc.) at the A location noted above.
2. Do not connect more than 2 wires to any single terminal.
3. All terminals marked RTN are connected internally.

40916-M

Figure 7.7 1756-OF8 Voltage wiring example



NOTES:

1. Do not connect more than 2 wires to any single terminal.
2. All terminals marked RTN are connected internally.

40917-M

1756-OF4 and 1756-OF8 Module Fault and Status Reporting

The 1756-OF4 and 1756-OF8 modules multicast status/fault data to the owner/listening controller with their channel data. The fault data is arranged in such a manner as to allow the user to choose the level of granularity he desires for examining fault conditions.

Three levels of tags work together to provide increasing degree of detail as to the specific cause of faults on the module.

Table 7.5 lists tags that can be examined in ladder logic to indicate when a fault has occurred:

Table 7.5

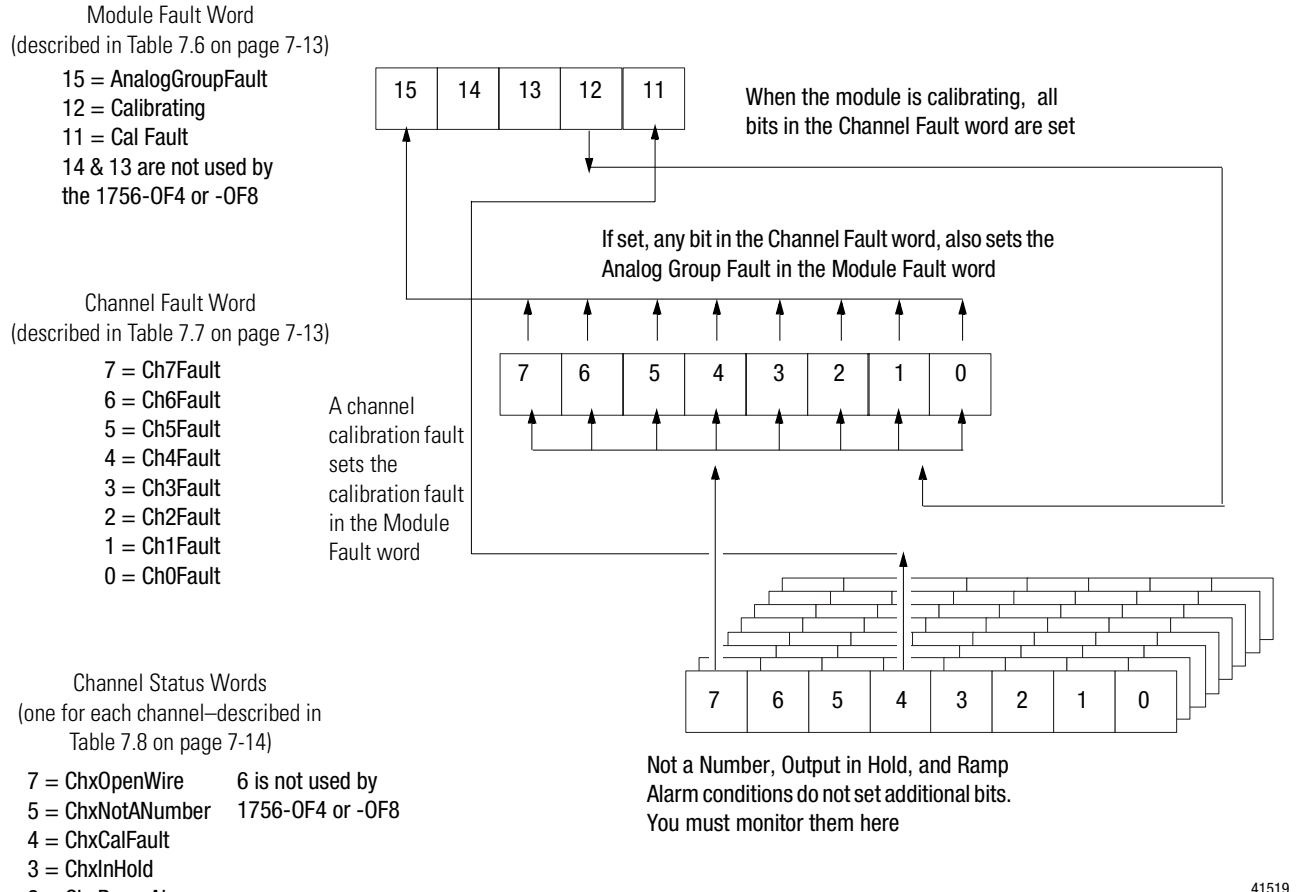
Tag:	Description:
Module Fault Word	This word provides fault summary reporting. Its tag name is ModuleFaults.
Channel Fault Word	This word provides underrange, overrange and communications fault reporting. Its tag name is ChannelFaults.
Channel Status Words	This word provides individual channel underrange and overrange fault reporting for process alarms, rate alarms and calibration faults. Its tag name is ChxStatus.

IMPORTANT Differences exist between floating point and integer modes as they relate to module fault reporting. These differences are explained in the following two sections.

1756-OF4 and 1756-OF8 Fault Reporting in Floating Point Mode

Figure 7.8 offers an overview of the fault reporting process in floating point mode.

Figure 7.8



IMPORTANT: 1756-OF4 uses 4 Channel Status Words. 1756-OF8 uses 8 Channel Status words. This graphic shows 8 words.

Module Fault Word Bits – Floating Point Mode

Bits in this word provide the highest level of fault detection. A nonzero condition in this word reveals that a fault exists on the module. You can examine further down to isolate the fault.

Table 7.6 lists tags that are found in the Module Fault Word:

Table 7.6

Tag:	Description:
Analog Group Fault	This bit is set when any bits in the Channel Fault word are set. Its tag name is AnalogGroupFault.
Calibrating	This bit is set when any channel is being calibrated. When this bit is set, all bits in the Channel Fault word are set. Its tag name is Calibrating.
Calibration Fault	This bit is set when any of the individual Channel Calibration Fault bits are set. Its tag name is CalibrationFault.

Channel Fault Word Bits – Floating Point Mode

During normal module operation, Channel Fault word bits are set if any of the respective channels has a High or Low Limit Alarm or an Open Wire condition (0-20mA configuration only). When using the Channel Fault Word, the 1756-OF4 module uses bits 0-3, and the 1756-OF8 uses bits 0-7. Checking this word for a nonzero condition is a quick way to check for these conditions on a channel.

Table 7.7 lists the conditions that set **all** Channel Fault word bits:

Table 7.7

This condition sets all Channel Fault word bits:	And causes the module to display the following in the Channel Fault word bits:
A channel is being calibrated	"000F" for all bits on the 1756-OF4 module "00FF" for all bits on the 1756-OF8 module
A communications fault occurred between the module and its owner-controller	"FFFF" for all bits on either module

Your logic should monitor the Channel Fault bit for a particular output, if you either:

- enable output clamping

or

- are checking for a open wire condition (0-20mA configuration only).

Channel Status Words Bits – Floating Point Mode

Any of the Channel Status words (4 words for 1756-OF4 and 8 words for 1756-OF8), one for each channel, will display a nonzero condition if that particular channel has faulted for the conditions listed below. Some of these bits set bits in other Fault words.

When the High or Low Limit Alarm bits (bits 1 & 0) in any of the words are set, the appropriate bit is set in the Channel Fault word.

When the Calibration Fault bit (bit 4) is set in any of the words, the Calibration Fault bit (bit 11) is set in the Module Fault word. Table 7.8 lists the conditions that set each of the word bits.

Table 7.8

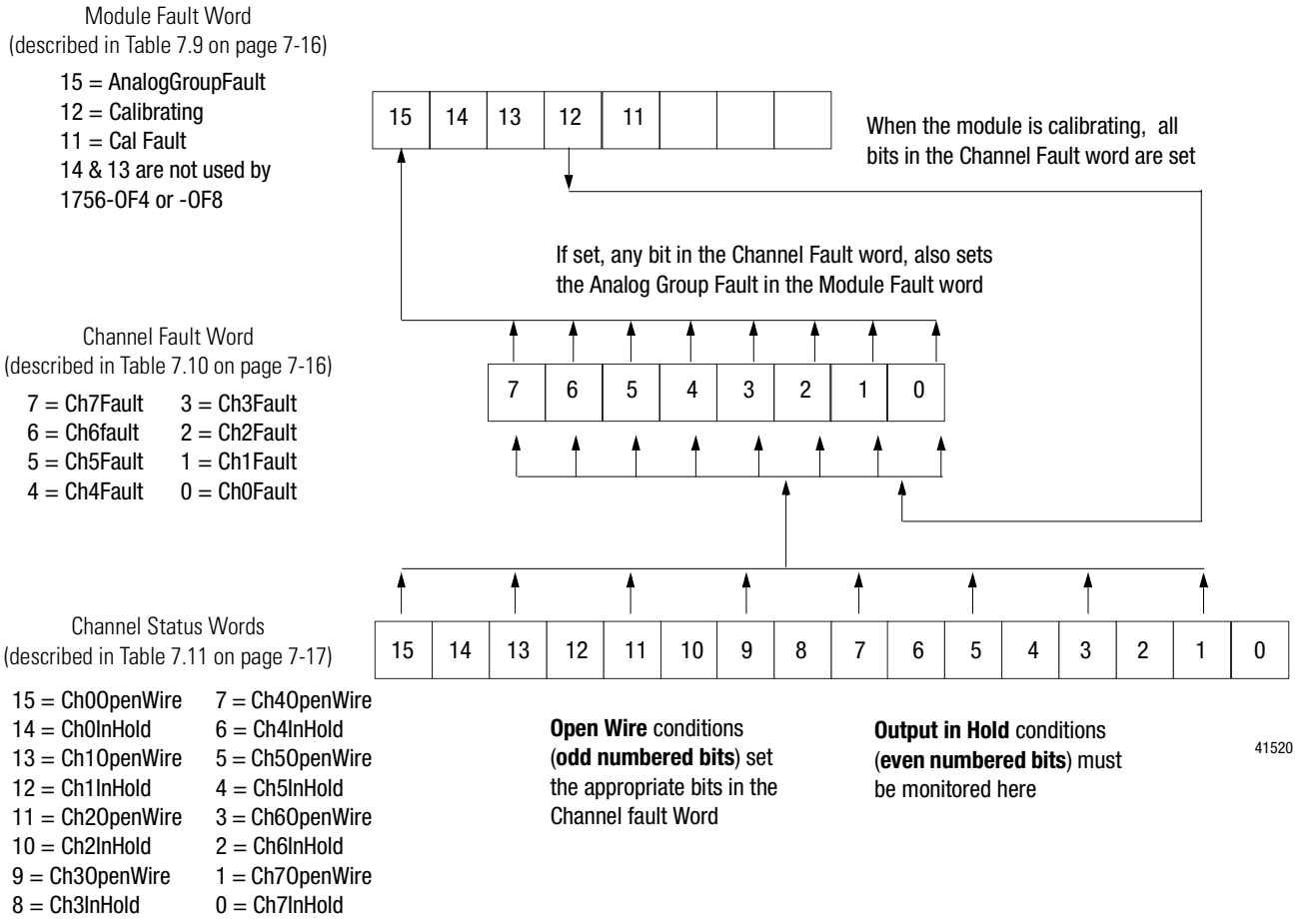
Tag (Status word):	Bit:	Event that sets this tag:
ChxOpenWire	Bit 7	This bit is set only if the configured Output Range is 0-20mA, and the circuit becomes open due to a wire falling or being cut when the output being driven is above 0.1mA. The bit will remain set until correct wiring is restored.
ChxNotaNumber	Bit 5	This bit is set when the output value received from the controller is NotANumber (the IEEE NAN value). The output channel will hold its last state.
ChxCalFault	Bit 4	This bit is set when an error occurred when calibrating This bit also sets the appropriate bit in the Channel Fault word.
ChxInHold	Blt 3	This bit is set when the output channel is currently holding. The bit resets when the requested Run mode output value is within 0.1% of full-scale of the current echo value.
ChxRampAlarm	Bit 2	This bit is set when the output channel's requested rate of change would exceed the configured maximum ramp rate requested parameter. It remains set until the output reaches its target value and ramping stops. If the bit is latched, it will remain set until it is unlatched.
ChxLLimitAlarm	Bit 1	This bit is set when the requested output value is beneath the configured low limit value. It remains set until the requested output is above the low limit. If the bit is latched, it will remain set until it is unlatched.
ChxHLimitAlarm	Bit 0	This bit is set when the requested output value is above the configured high limit value. It remains set until the requested output is below the high limit. If the bit is latched, it will remain set until it is unlatched.

IMPORTANT Notice that the 1756-OF4 and 1756-OF8 modules do not use **bit 6**.

1756-OF4 and 1756-OF8 Fault Reporting in Integer Mode

The following graphic provides an overview of the fault reporting process in integer mode.

Figure 7.9



IMPORTANT: Bits 0-7 not used on 1756-OF4

Module Fault Word Bits – Integer Mode

In integer mode, Module Fault word bits (bits 15-11) operate exactly as described in floating point mode. Table 7.9 lists tags that are found in the Module Fault Word:

Table 7.9

Tag:	Description:
Analog Group Fault	This bit is set when any bits in the Channel Fault word are set. Its tag name is AnalogGroupFault.
Calibrating	This bit is set when any channel is being calibrated. When this bit is set, all bits in the Channel Fault word are set. Its tag name is Calibrating.
Calibration Fault	This bit is set when any of the individual Channel Calibration Fault bits are set. Its tag name is CalibrationFault.

Channel Fault Word Bits – Integer Mode

In integer mode, Channel Fault word bits (bits 7-0) operate exactly as described in floating point mode for calibration and communications faults. During normal operation, these bits are only set for an open wire condition. Table 7.10 lists the conditions that set **all** Channel Fault word bits:

Table 7.10

This condition sets all Channel Fault word bits:	And causes the module to display the following in the Channel Fault word bits:
A channel is being calibrated	"000F" for all bits on the 1756-OF4 module "00FF" for all bits on the 1756-OF8 module
A communications fault occurred between the module and its owner-controller	"FFFF" for all bits on either module

Your logic should monitor the Channel Fault bit for a particular output, if you either:

- enable output clamping

  or

- are checking for a open wire condition (0-20mA configuration only).

Channel Status Word Bits – Integer Mode

The Channel Status word has the following differences when used in integer mode:

- Only the Output in Hold and Open Wire conditions are reported by the module.
- Calibration Fault reporting is not available in this word, although the Calibration Fault bit in the Module Fault word will still activate when that condition exists on any channel.
- There is only 1 Channel Status word for all 4 channels on 1756-OF4 and all 8 channels on 1756-OF8.

Table 7.11 lists the conditions that set each of the Status Word bits.

Table 7.11

Tag (Status word):	Bit:	Event that sets this tag:
ChxOpenWire	Odd-numbered bits from bit 15 to bit 1 (e.g. bit 15 represents channel 0). For a full listing of the channels these bits represent, see Figure 7.9 on page 7-15.	The Open Wire bit is set only if the configured Output Range is 0-20mA, and the circuit becomes open due to a wire falling or being cut when the output being driven is above 0.1mA. The bit will remain set until correct wiring is restored.
ChxInHold	Even-numbered bits from bit 14 to bit 0 (e.g. bit 14 represents channel 0). For a full listing of the channels these bits represent, see Figure 7.9 on page 7-15.	The Output In Hold bit is set when the output channel is currently holding. The bit resets when the requested Run mode output value is within 0.1% of full-scale of the current echo value.

Chapter Summary and What's Next

In this chapter you read about Non-Isolated Analog Output Modules (1756-OF4 & 1756-OF8).

Chapter 8 describes the Isolated Analog Output Modules (1756-OF6CI & 1756-OF6VI).

Notes:

Isolated Analog Output Modules (1756-OF6CI & 1756-OF6VI)

What This Chapter Contains

This chapter describes features specific to ControlLogix non-isolated analog output modules.

For information about:	See page:
Choosing a Data Format	8-2
Features Specific to Analog Output Modules	8-2
Using Module Block and Output Circuit Diagrams	8-5
Wiring the 1756-OF6CI Module	8-9
Wiring the 1756-OF6VI Module	8-10
1756-OF6CI and 1756-OF6VI Module Fault and Status Reporting	8-11

The non-isolated analog output modules also support features described in Chapter 3. Table 8.1 lists those additional features.

Table 8.1 Additional Features Supported by the Isolated Analog Output Modules

Feature:	Page of description:
Removal and Insertion Under Power (RIUP)	3-2
Module Fault Reporting	3-3
Fully Software Configurable	3-3
Electronic Keying	3-4
Access to System Clock for Timestamping Functions	3-6
Rolling Timestamp	3-6
Producer/Consumer Model	3-6
Status Indicator Information	3-7
Full Class I Division 2 Compliance	3-7
UL, CSA, FM, CE, C-Tick, EEx, TUV Agency Certification	3-7
Field Calibration	3-8
Sensor Offset	3-8
Latching of Alarms	3-8

Choosing a Data Format

Data format defines the format of channel data sent from the controller to the module, defines the format of the "data echo" that the module produces, and determines the features that are available to your application. You choose a data format when you choose a Communications Format. For more information on Communications Format, see page 10-6.

You can choose one of the two following data formats:

- Integer mode
- Floating point mode

Table 8.2 lists the features that are available in each format.

Table 8.2 Features Available in Each Data Format

Data format:	Features available:	Features not available:
Integer mode	Ramp to program value	Clamping
	Ramp to fault value	Ramp in Run mode
	Hold for initialization	Rate and Limit alarms
	Hold Last State or User Value in fault or program mode	Scaling
Floating point mode	All features	N/A

Features Specific to Analog Output Modules

Table 8.3 lists features that are specific to the non-isolated analog output modules. The features are described later in this section.

Table 8.3

Feature:	Page of description:
Ramping/Rate Limiting	8-3
Hold for Initialization	8-3
Clamping/Limiting	8-4
Clamp/Limit Alarms	8-4
Data Echo	8-5

Ramping/Rate Limiting

Ramping limits the speed at which an analog output signal can change. This prevents fast transitions in the output from damaging the devices that an output module controls. Ramping is also known as **rate limiting**.

Table 8.4 describes the types of ramping that are possible:

Table 8.4

Ramping type:	Description:
Run mode ramping	This type of ramping occurs when the module is in Run mode and begins operation at the configured maximum ramp rate when the module receives a new output level. **IMPORTANT**: This is only available in floating point mode.
Ramp to program mode	This type of ramping occurs when the present output value changes to the Program Value after a Program Command is received from the controller.
Ramp to fault mode	This type of ramping occurs when the present output value changes to the Fault Value after a communications fault occurs.

The maximum rate of change in outputs is expressed in engineering units per second and called the **maximum ramp rate**. To see how to enable Run mode ramping and set the maximum ramp rate, see page 10-13.

Hold for Initialization

Hold for Initialization causes outputs to hold present state until the value commanded by the controller matches the value at the output screw terminal within 0.1% of full scale, providing a bumpless transfer.

If Hold for Initialization is selected, outputs hold if any of the three conditions occur:

- Initial connection is established after power-up
- A new connection is established after a communications fault occurs
- There is a transition to Run mode from Program state

The InHold bit for a channel indicates that the channel is holding. To see how to enable the Hold for Initialization bit, see page 10-12.

Clamping/Limiting

Clamping limits the output from the analog module to remain within a range configured by the controller, even when the controller commands an output outside that range. This safety feature sets a high clamp and a low clamp.

Once clamps are determined for a module, any data received from the controller that exceeds those clamps sets an appropriate limit alarm and transitions the output to that limit but not beyond the requested value.

For example, an application may set the high clamp on a module for 8V and the low clamp for -8V. If a controller sends a value corresponding to 9V to the module, the module will only apply 8V to its screw terminals.

Clamping alarms can be disabled or latched on a per channel basis.

IMPORTANT Clamping is only available in floating point mode.

To see how to set the clamping limits, see page 10-13.

Clamp/Limit Alarms

This function works directly with clamping. When a module receives a data value from the controller that exceeds clamping limits, it applies signal values to the clamping limit but also sends a status bit to the controller notifying it that the value sent exceeds the clamping limits.

Using the example above, if a module has clamping limits of 8V and -8V but then receives data to apply 9V, only 8V is applied to the screw terminals and the module sends a status bit back to the controller informing it that the 9V value exceeds the module's clamping limits.

IMPORTANT Limit alarms are only available in floating point mode.

To see how to enable all alarms, see page 10-13.

Data Echo

Data Echo automatically multicasts channel data values which match the analog value that was sent to the module's screw terminals at that time.

Fault and status data is also sent.This data is sent in the format (floating point or integer) selected at the Requested Packet Interval (RPI).

Using Module Block and Output Circuit Diagrams

This section shows the 1756-OF6CI and 1756-OF6VI modules' block diagrams and output circuit diagrams.

Module Block Diagram

Figure 8.1 1756-OF6CI Module Block Diagram

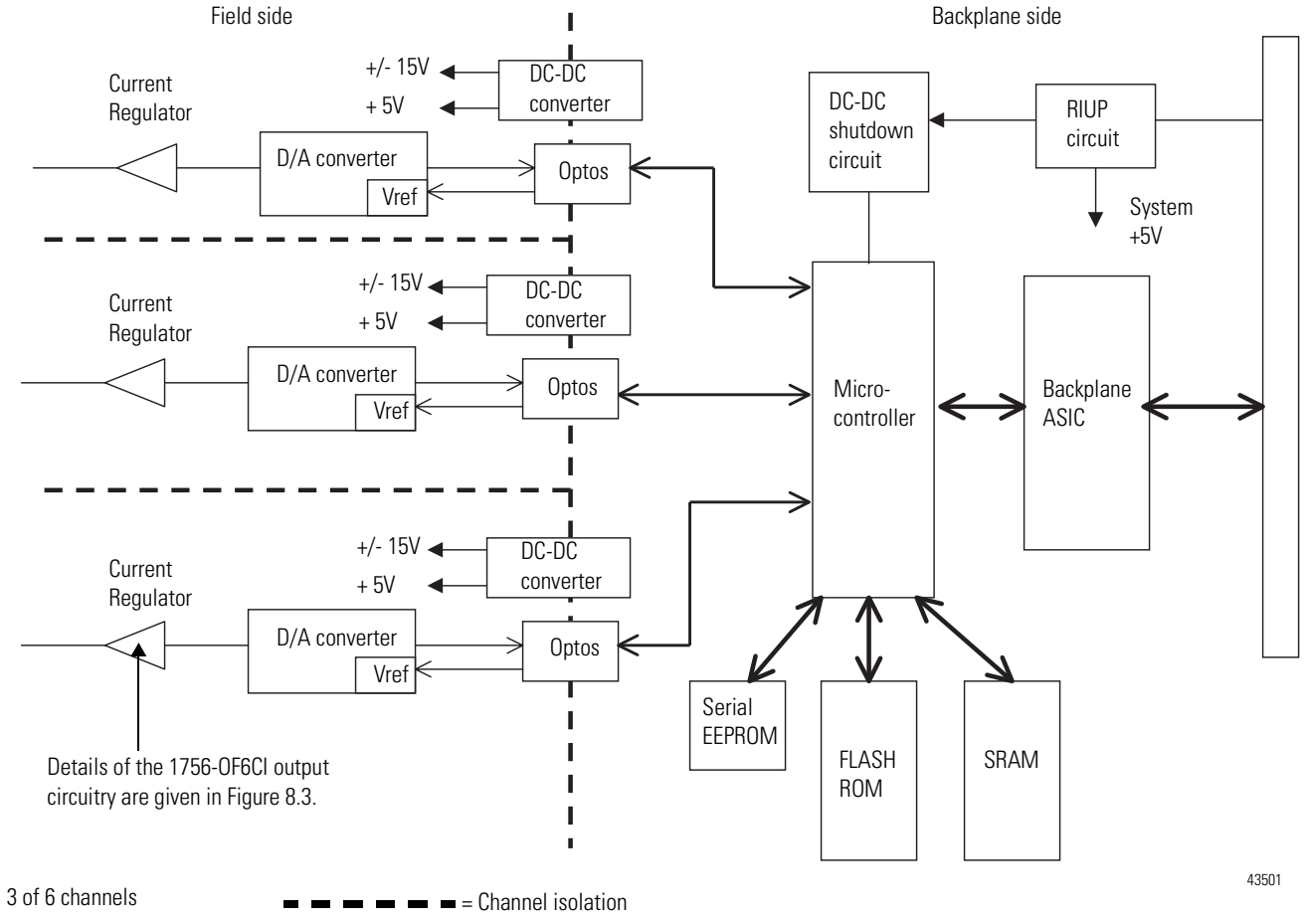
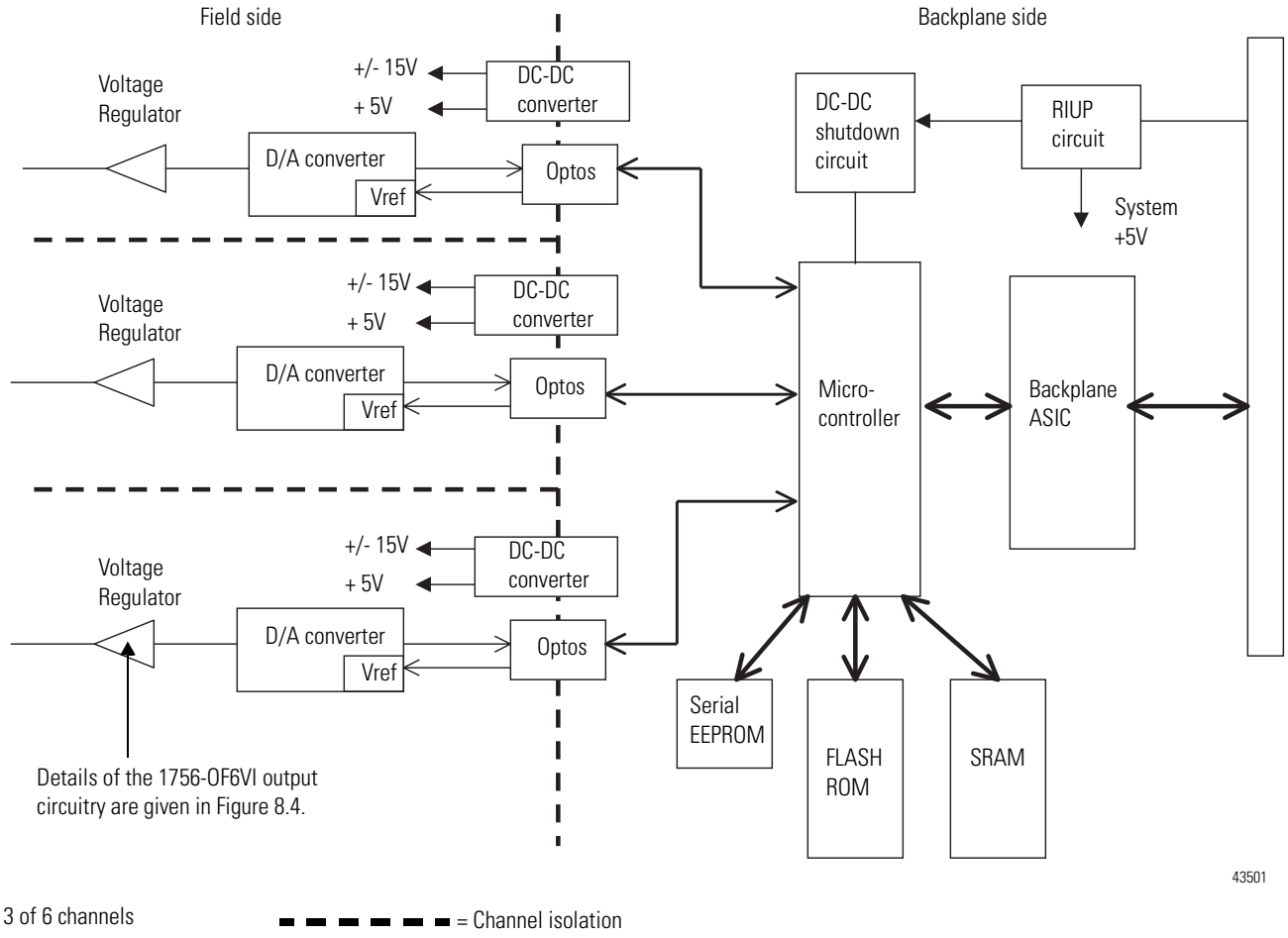
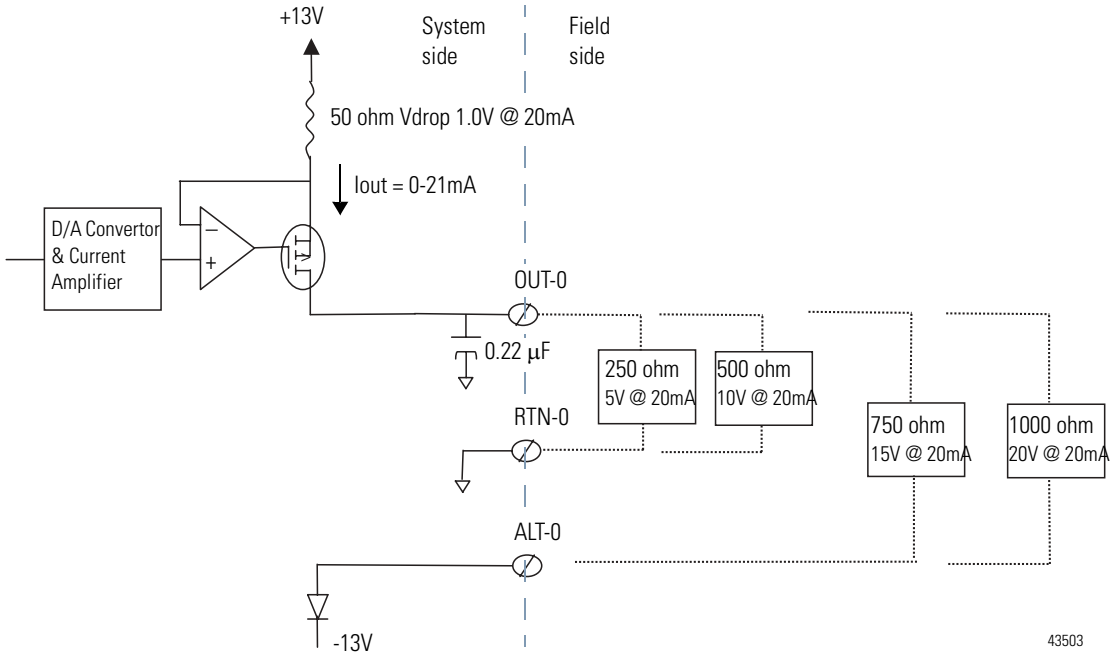


Figure 8.2 1756-OF6VI Module Block Diagram



Field Side Circuit Diagrams

Figure 8.3 1756-OF6CI Output Circuit



Driving Different Loads with the 1756-OF6CI

The 1756-OF6CI module's output stage provides a constant current that flows through its internal electronics and out through the external output load. Since the output current is constant, the only variable in the current loop is the voltage across the output electronics and the voltage across the load. For a given termination option, the sum of the individual voltage drops around the loop components must add up to the total available voltage (13V for OUT-x/RTN-x termination and 26V for OUT-x / ALT-x). As seen above, a larger external output load will drop a larger portion of the available loop voltage, allowing the module to drop less volts across its internal output electronics. This lower drop allows the power dissipation in the module to be lower, minimizing the thermal affect to adjacent modules in the same chassis.

For loads under 550 ohm, the module's +13V internal voltage source can supply voltage for currents up to 21mA. For loads over 550 ohms, additional compliance voltage is required. In this case, you must use the ALT terminal to provide the additional -13V source.

For any size load (i.e. 0-1000 ohms), the output channels function if terminated between OUT-x and ALT-x. To improve module reliability and product life, we recommend you:

- Terminate the output channels between the OUT-x and RTN-x terminals for loads of 0-550 ohms
- Terminate the output channels between the OUT-x and ALT-x terminals for loads of 551 -1000 ohms.

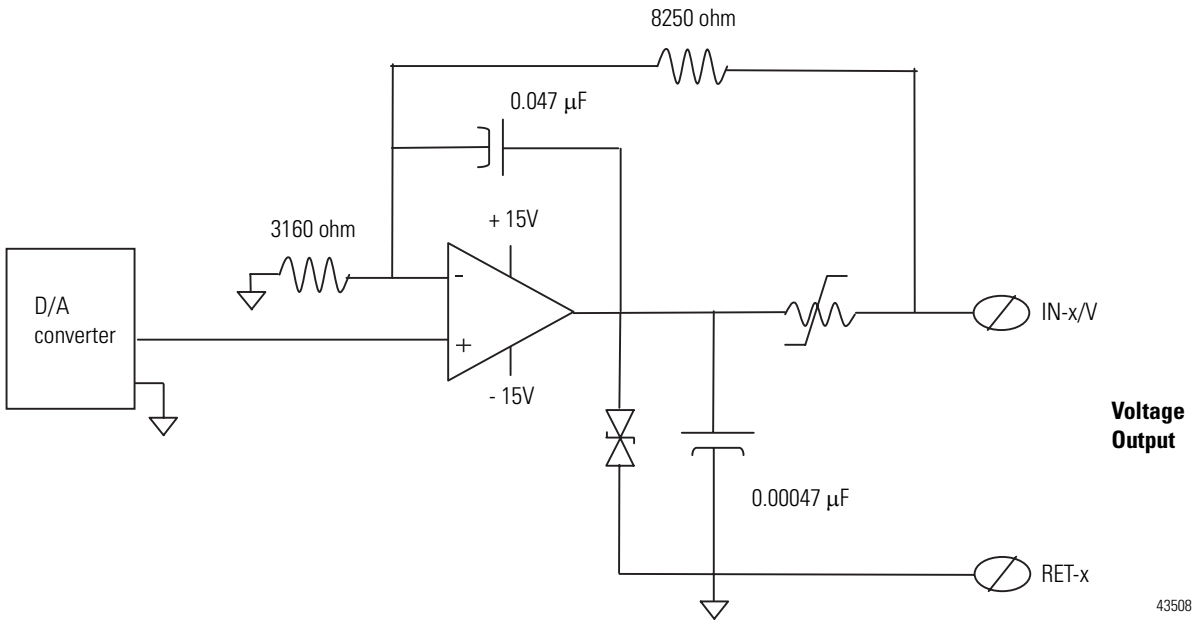
IMPORTANT

If you are unsure of the load, you can terminate the output channels between OUT-x and ALT-x and the module will operate but its reliability may be compromised at elevated temperatures.

For example, if you terminate the output channels between OUT-x and ALT-x and use a 250 ohm load, the module operates but the lower load results in higher operating temperatures and may affect the module's reliability over time.

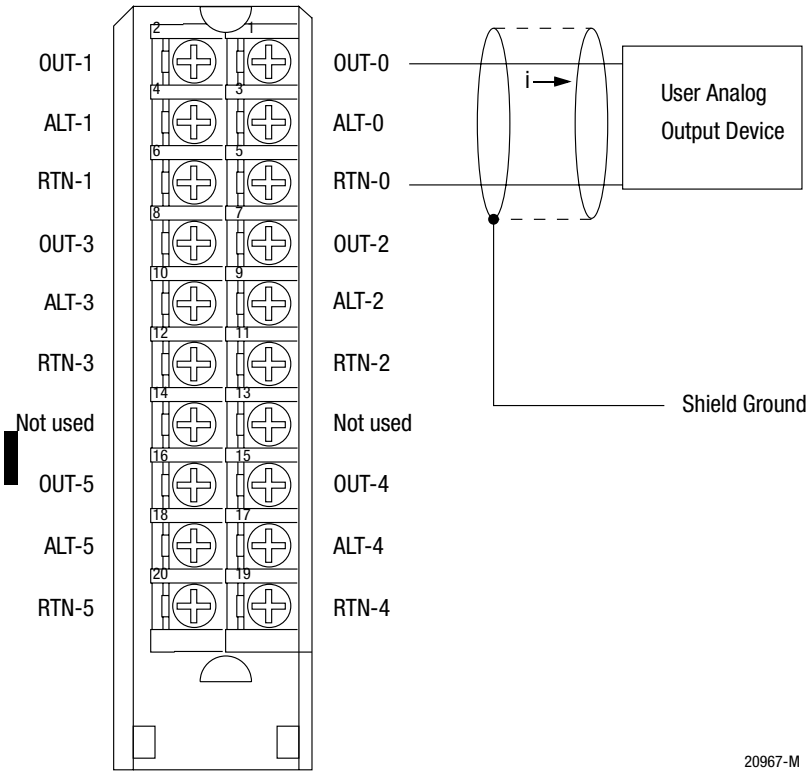
We recommend you terminate the output channels as described in the bullets above whenever possible.

Figure 8.4 1756-OF6VI Output Circuit



Wiring the 1756-OF6CI Module

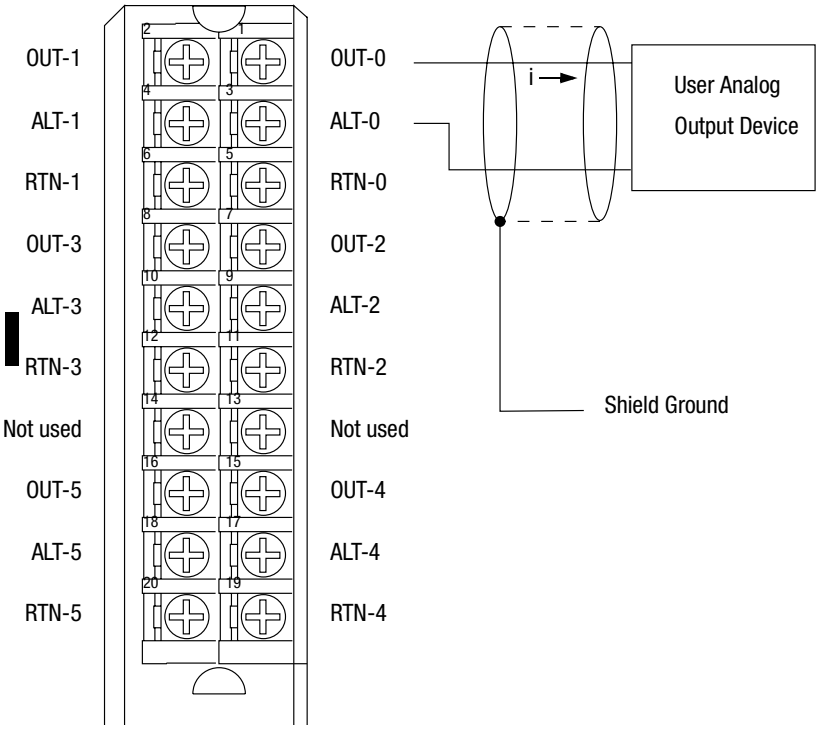
Figure 8.5 1756-OF6CI Wiring example for Loads of 0-550Ω



NOTES:

1. Place additional devices anywhere in the loop.
2. Do not connect more than 2 wires to any single terminal.

Figure 8.6 1756-OF6CI Wiring example for Loads of 551-1000Ω

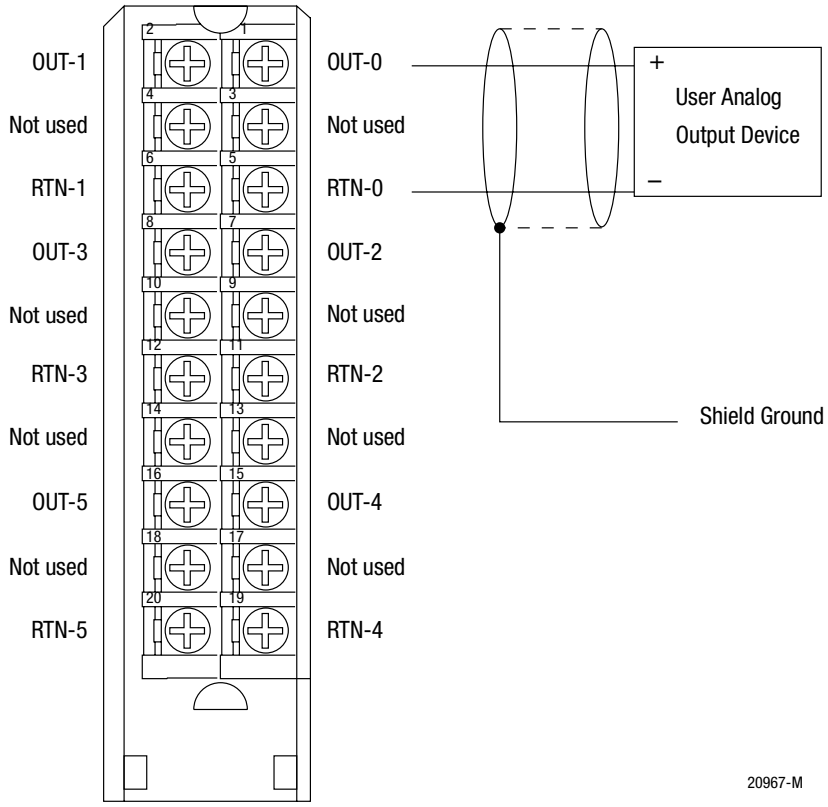


NOTES:

1. Place additional devices anywhere in the loop.
2. Do not connect more than 2 wires to any single terminal.

Wiring the 1756-OF6VI Module

Figure 8.7 1756-OF6VI Wiring example



NOTES:

1. Place additional devices anywhere in the loop.
2. Do not connect more than 2 wires to any single terminal.

1756-OF6CI and 1756-OF6VI Module Fault and Status Reporting

The 1756-OF6CI and 1756-OF6VI modules multicast status/fault data to the owner/listening controller with their channel data. The fault data is arranged in such a manner as to allow the user to choose the level of granularity he desires for examining fault conditions.

Three levels of tags work together to provide increasing degree of detail as to the specific cause of faults on the module.

Table 8.5 lists tags that can be examined in ladder logic to indicate when a fault has occurred:

Table 8.5

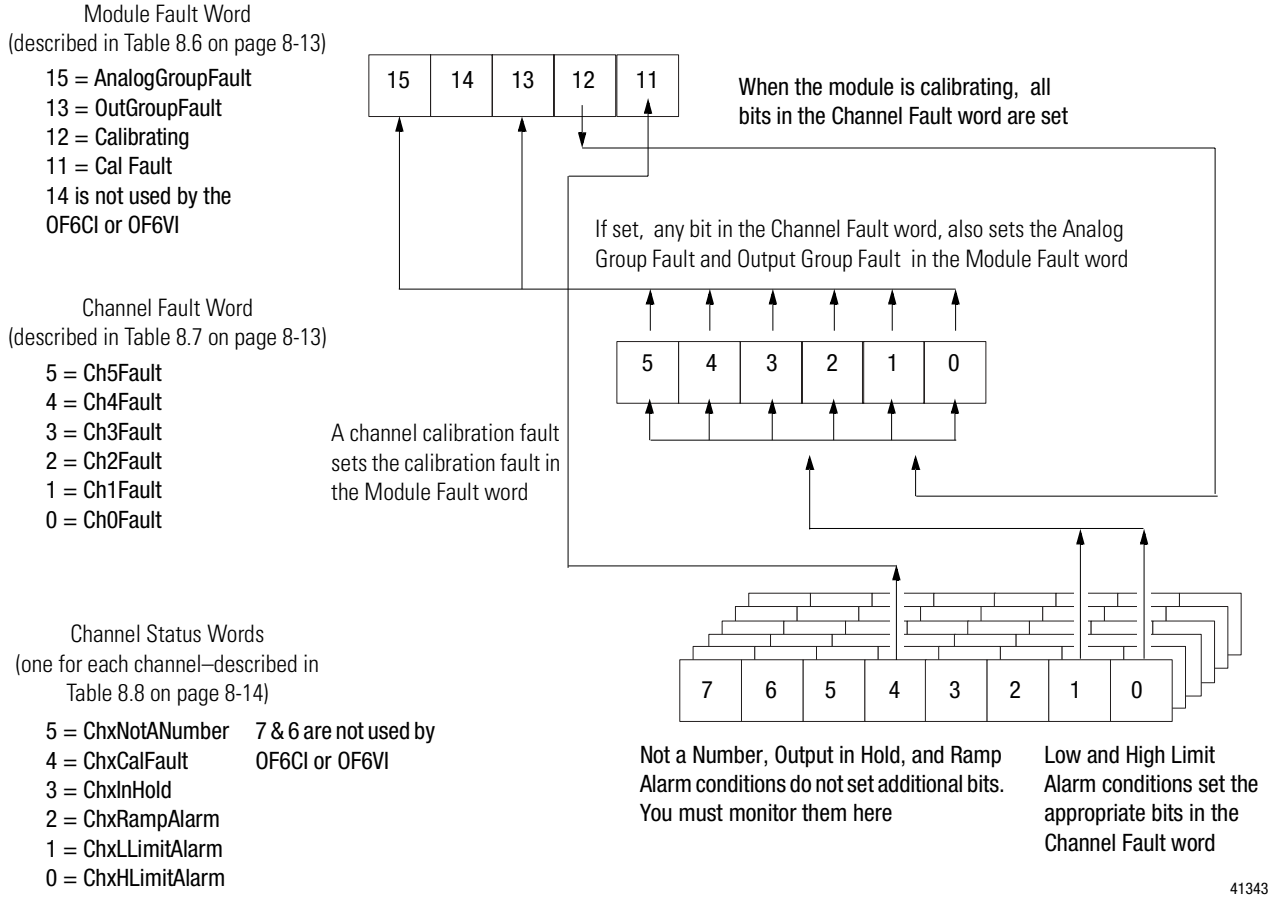
Tag:	Description:
Module Fault Word	This word provides fault summary reporting. Its tag name is ModuleFaults.
Channel Fault Word	This word provides underrange, overrange and communications fault reporting. Its tag name is ChannelFaults.
Channel Status Words	This word provides individual channel underrange and overrange fault reporting for process alarms, rate alarms and calibration faults. Its tag name is ChxStatus.

IMPORTANT Differences exist between floating point and integer modes as they relate to module fault reporting. These differences are explained in the following two sections.

Fault Reporting in Floating Point Mode

Figure 8.8 offers an overview of the fault reporting process in floating point mode.

Figure 8.8



Module Fault Word Bits – Floating Point Mode

Bits in this word provide the highest level of fault detection. A nonzero condition in this word reveals that a fault exists on the module. You can examine further down to isolate the fault.

Table 8.6 lists tags that are found in the Module Fault Word:

Table 8.6

Tag:	Description:
Analog Group Fault	This bit is set when any bits in the Channel Fault word are set. Its tag name is AnalogGroupFault.
Output Group Fault	This bit is set when any bits in the Channel Fault word are set. Its tag name is OutputGroupFault.
Calibrating	This bit is set when any channel is being calibrated. When this bit is set, all bits in the Channel Fault word are set. Its tag name is Calibrating.
Calibration Fault	This bit is set when any of the individual Channel Calibration Fault bits are set. Its tag name is CalibrationFault.

Channel Fault Word Bits – Floating Point Mode

During normal module operation, Channel Fault word bits are set if any of the respective channels has a High or Low Limit Alarm. Checking this word for a nonzero condition is a quick way to check for High or Low Limit Alarm condition on a channel.

Table 8.7 lists the conditions that set **all** Channel Fault word bits:

Table 8.7

This condition sets all Channel Fault word bits:	And causes the module to display the following in the Channel Fault word bits:
A channel is being calibrated	"003F" for all bits
A communications fault occurred between the module and its owner-controller	"FFFF" for all bits

Your logic should monitor the Channel Fault bit for a particular output, if you either:

- set the high and low limit alarms outside your operating range

or

- disable output limiting.

Channel Status Word Bits – Floating Point Mode

Any of the 6 Channel Status words, one for each channel, will display a nonzero condition if that particular channel has faulted for the conditions listed below. Some of these bits set bits in other Fault words.

When the High or Low Limit Alarm bits (bits 1 & 0) in any of the words are set, the appropriate bit is set in the Channel Fault word.

When the Calibration Fault bit (bit 4) is set in any of the words, the Calibration Fault bit (bit 11) is set in the Module Fault word. Table 8.8 lists the conditions that set each of the word bits.

Table 8.8

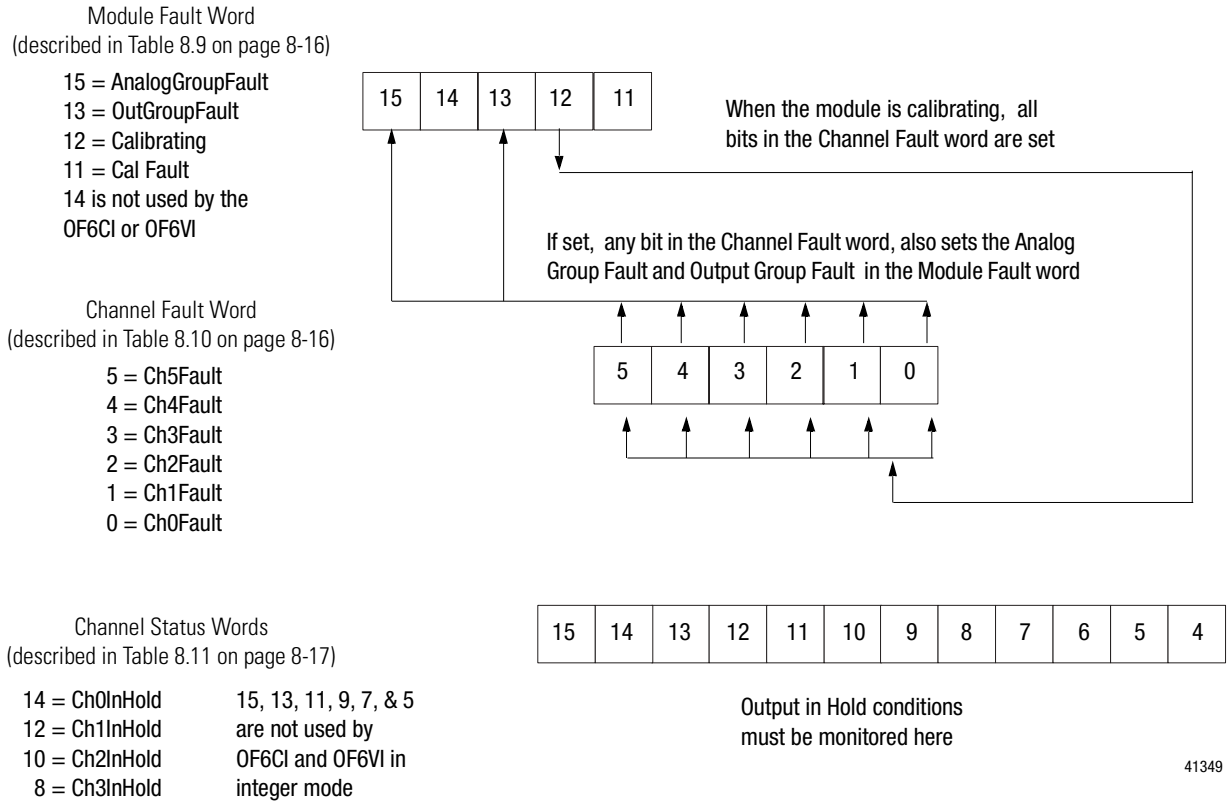
Tag (Status word):	Bit:	Event that sets this tag:
ChxNotaNumber	Bit 5	This bit is set when the output value received from the controller is NotaNumber (the IEEE NAN value). The output channel will hold its last state.
ChxCalFault	Bit 4	This bit is set when an error occurred when calibrating This bit also sets the appropriate bit in the Channel Fault word.
ChxInHold	Blt 3	This bit is set when the output channel is currently holding. The bit resets when the requested Run mode output value is within 0.1% of full-scale of the current echo value.
ChxRampAlarm	Bit 2	This bit is set when the output channel's requested rate of change would exceed the configured maximum ramp rate requested parameter. It remains set until the output reaches its target value and ramping stops. If the bit is latched, it will remain set until it is unlatched.
ChxLLimitAlarm	Bit 1	This bit is set when the requested output value is beneath the configured low limit value. It remains set until the requested output is above the low limit. If the bit is latched, it will remain set until it is unlatched.
ChxHLimitAlarm	Bit 0	This bit is set when the requested output value is above the configured high limit value. It remains set until the requested output is below the high limit. If the bit is latched, it will remain set until it is unlatched.

IMPORTANT Notice that the 1756-OF6CI and 1756-OF6VI modules do not use **bits 6 or 7** in this mode.

Fault Reporting in Integer Mode

Figure 8.9 offers an overview of the fault reporting process in integer mode.

Figure 8.9



Module Fault Word Bits – Integer Mode

In integer mode, Module Fault word bits (bits 15-11) operate exactly as described in floating point mode. Table 8.9 lists tags that are found in the Module Fault Word:

Table 8.9

Tag:	Description:
Analog Group Fault	This bit is set when any bits in the Channel Fault word are set. Its tag name is AnalogGroupFault.
Output Group Fault	This bit is set when any bits in the Channel Fault word are set. Its tag name is OutputGroupFault.
Calibrating	This bit is set when any channel is being calibrated. When this bit is set, all bits in the Channel Fault word are set. Its tag name is Calibrating.
Calibration Fault	This bit is set when any of the individual Channel Calibration Fault bits are set. Its tag name is CalibrationFault.

Channel Fault Word Bits – Integer Mode

In integer mode, Channel Fault word bits (bits 5-0) operate exactly as described in floating point mode for calibration and communications faults. Table 8.10 lists the conditions that set **all** Channel Fault word bits:

Table 8.10

This condition sets all Channel Fault word bits:	And causes the module to display the following in the Channel Fault word bits:
A channel is being calibrated	"003F" for all bits
A communications fault occurred between the module and its owner-controller	"FFFF" for all bits

Your logic should monitor the Channel Fault bit for a particular output, if you either:

- set the high and low limit alarms outside your operating range

or

- disable output limiting.

Channel Status Word Bits in Integer Mode

The Channel Status word has the following differences when used in integer mode:

- Only the Output in Hold condition is reported by the module.
- Calibration Fault reporting is not available in this word, although the Calibration Fault bit in the Module Fault word will still activate when that condition exists on any channel
- There is only 1 Channel Status word for all 6 channels.

Table 8.11 lists the conditions that set each of the word bits.

Table 8.11

Tag (Status word):	Bit:	Event that sets this tag:
ChxInHold	Even-numbered bits from bit 14 to bit 0 (e.g. bit 14 represents channel 0). For a full listing of the channels these bits represent, see Figure 8.9 on page 8-15.	The Output In Hold bit is set when the output channel is currently holding. The bit resets when the requested Run mode output value is within 0.1% of full-scale of the current echo value.

IMPORTANT Notice that the 1756-OF6CI and 1756-OF6VI modules do not use **bits 15, 13, 11, 9, 7 or 5** in this mode.

Chapter Summary and What's Next

In this chapter you read about features specific to the Isolated Analog Output Modules (1756-OF6CI & 1756-OF6VI).

Chapter 9 describes Installing ControlLogix I/O Modules.

Notes:

Installing ControlLogix I/O Modules

What this Chapter Contains

This chapter describes how to install ControlLogix modules.

For information about:	See page:
Installing the ControlLogix I/O Module	9-1
Keying the Removable Terminal Block	9-3
Connecting Wiring	9-4
Assembling The Removable Terminal Block and the Housing	9-8
Installing the Removable Terminal Block onto the Module	9-9
Removing the Removable Terminal Block from the Module	9-10
Removing the Module from the Chassis	9-11

Installing the ControlLogix I/O Module

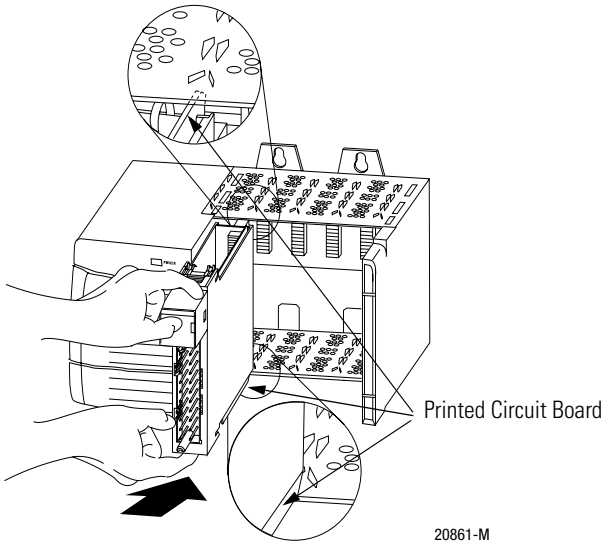
You can install or remove the module while chassis power is applied.

ATTENTION

The module is designed to support Removal and Insertion Under Power (RIUP). However, when you remove or insert an RTB with field-side power applied, **unintended machine motion or loss of process control can occur**. Exercise extreme caution when using this feature.

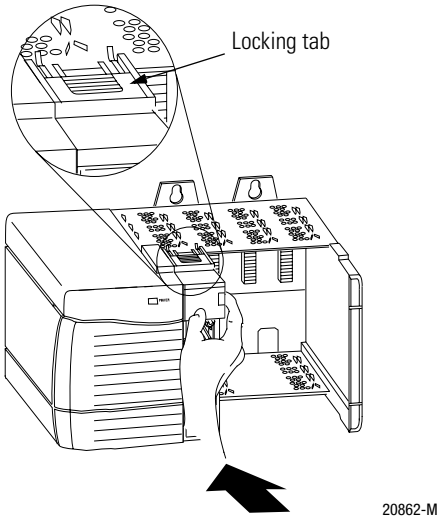
1. Align circuit board with top and bottom chassis guides as shown in Figure 9.1.

Figure 9.1



2. Slide module into chassis until module locking tab clicks.

Figure 9.2



Keying the Removable Terminal Block

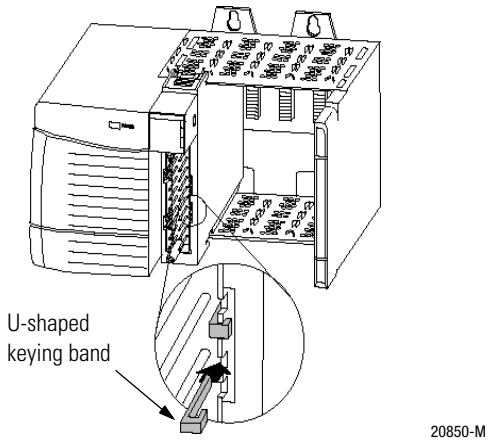
Key the RTB to prevent inadvertently connecting the incorrect RTB to your module. When the RTB mounts onto the module, keying positions will match up.

For example, if you place a U-shaped keying band in position #4 on the module, you cannot place a wedge-shaped tab in #4 on the RTB or your RTB will not mount on the module. We recommend that you use a unique keying pattern for each slot in the chassis.

1. Insert the U-shaped band with the long side near the terminals.

2. Push the band onto the module until it snaps into place.

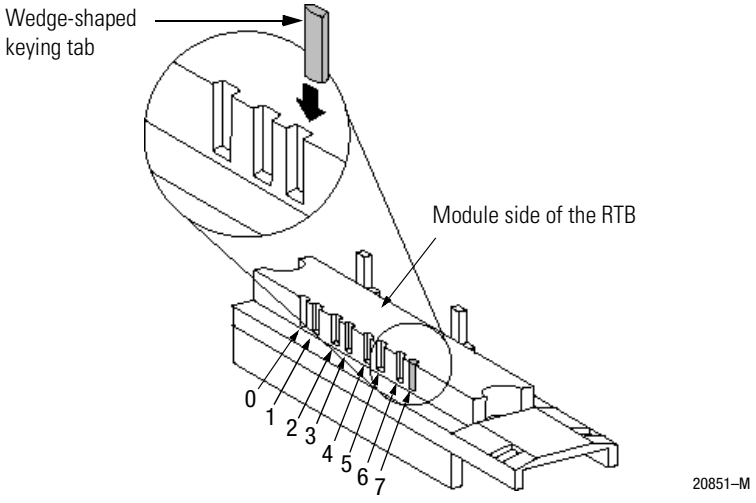
Figure 9.3



3. Key the RTB in positions that correspond to unkeyed module positions. Insert the wedge-shaped tab on the RTB with the rounded edge first. Push the tab onto the RTB until it stops.

IMPORTANT When keying your RTB and module, you must begin with a wedge-shaped tab in position #6 or #7.

Figure 9.4



Connecting Wiring

You can use an RTB or a Bulletin 1492 prewired Interface Module (IFM)[1] to connect wiring to your module. If you are using an RTB, follow the directions below to connect wires to the RTB. An IFM has been prewired before you received it.

If you are using an IFM to connect wiring to the module, skip this section and go to page 9-8. To see a listing of the IFMs available for use with the ControlLogix analog I/O modules, see Appendix F, Using 1492 Wiring Systems with Your Analog I/O Module

IMPORTANT For all ControlLogix analog modules, except the 1756-IR6I, we recommend you use Belden 8761 cable to wire the RTB. For the 1756-IR6I module, we recommend you use Belden 9533 or 83503 cable to wire the RTB. The RTB terminations can accommodate 22-14 gauge shielded wire.

This chapter shows how the general guidelines for wiring your analog I/O modules, including grounding the cable and connecting wiring to each RTB type. For more specific information on wiring individual catalog numbers, refer to Table 9.1.

Table 9.1 Wiring Diagrams

Catalog number:	Wiring diagram on:
1756-IF16	page 4-15
1756-IF8	page 4-19
1756-IF6CIS	page 5-14
1756-IF6I	page 5-17
1756-IR6I	page 6-19
1756-IT6I	page 6-20
1756-IT6I2	page 6-21
1756-OF4	page 7-9
1756-OF8	page 7-10
1756-OF6CI	page 8-9
1756-OF6VI	page 8-10

[1] The Bulletin 1492 IFM may not be used in any application that requires agency certification of the ControlLogix system. Use of the IFM violates the UL, CSA and FM certifications of this product.

Connect Grounded End of the Cable

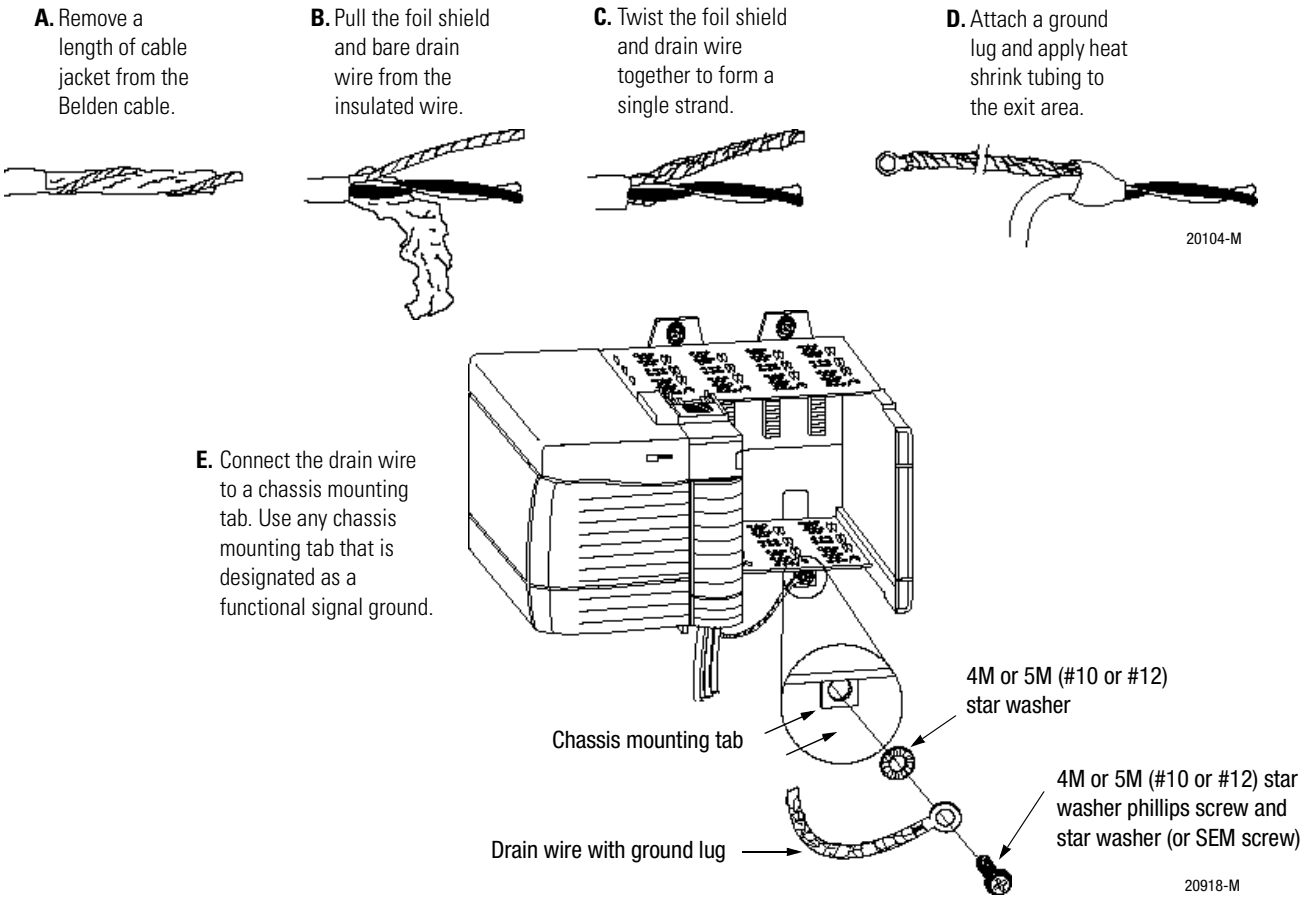
Before wiring the RTB, you must connect ground wiring.

1. Ground the drain wire.

IMPORTANT For all ControlLogix analog I/O modules except the 1756-IF6CIS module, we recommend you ground the drain wire at the field-side. If you cannot ground at the field-side, ground at an earth ground on the chassis as shown in Figure 9.5.

For the 1756-IF6CIS, we recommend you ground the module as shown in Figure 9.5.

Figure 9.5



2. Connect the insulated wires to the field-side.

Connect Ungrounded End of the Cable

1. Cut the foil shield and drain wire back to the cable casing and apply shrink wrap.

2. Connect the insulated wires to the RTB, as shown below.

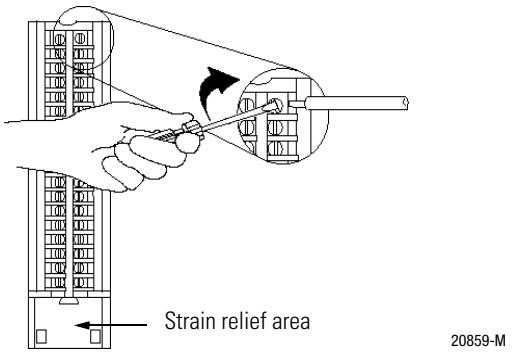
Three Types of RTBs (each RTB comes with housing)

- **Cage clamp** - Catalog number 1756-TBCH

1. Insert the wire into the terminal.

2. Turn the screw clockwise to close the terminal on the wire.

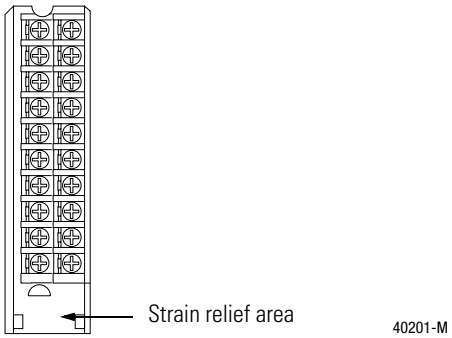
Figure 9.6



- **NEMA clamp** - Catalog number 1756-TBNH

Terminate wires at the screw terminals.

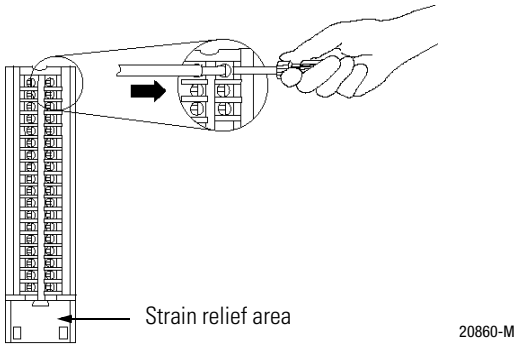
Figure 9.7



- **Spring clamp** - Catalog number 1756-TBSH or TBS6H

1. Insert the screwdriver into the outer hole of the RTB.
2. Insert the wire into the open terminal and remove the screwdriver.

Figure 9.8



Recommendations for Wiring Your RTB

We recommend you follow these guidelines when wiring your RTB:

1. Begin wiring the RTB at the bottom terminals and move up.
2. Use a tie to secure the wires in the strain relief area of the RTB.
3. Order and use an extended-depth housing (Cat. No.1756-TBE) for applications that require heavy gauge wiring.

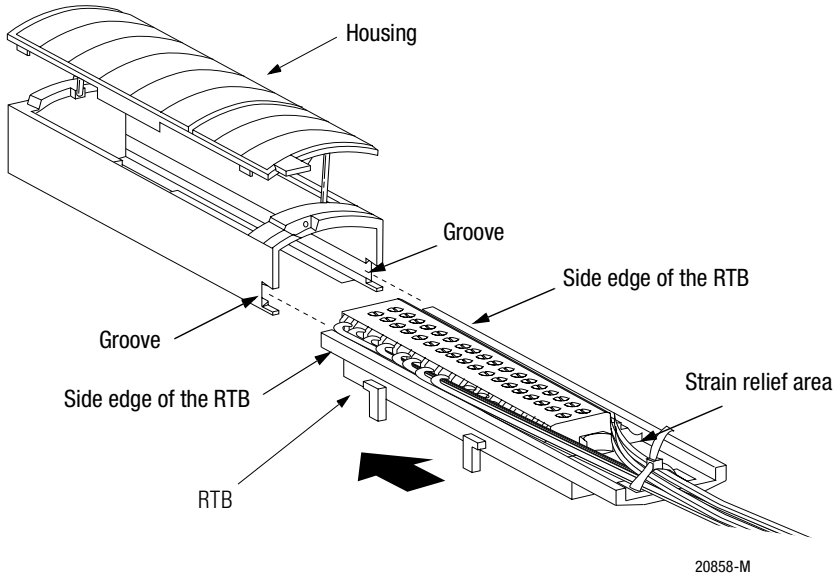
Assembling The Removable Terminal Block and the Housing

Removable housing covers the wired RTB to protect wiring connections when the RTB is seated on the module.

1. Align the grooves at the bottom of each side of the housing with the side edges of the RTB.

2. Slide the RTB into the housing until it snaps into place.

Figure 9.9



IMPORTANT If additional wire routing space is required for your application, use extended-depth housing 1756-TBE.

Installing the Removable Terminal Block onto the Module

Install the RTB onto the module to connect wiring.

ATTENTION

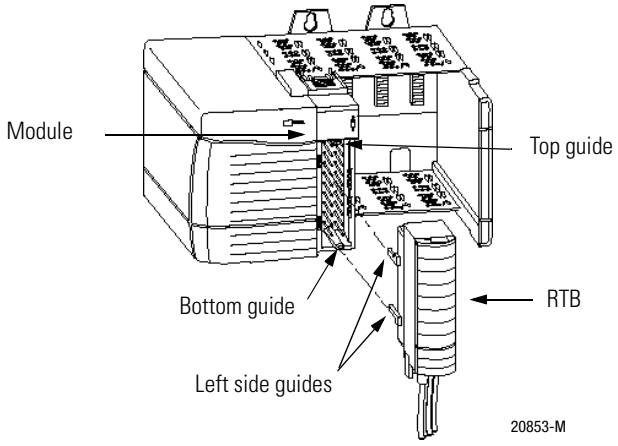
Shock hazard exists. If the RTB is installed onto the module while the field-side power is applied, the RTB will be electrically live. Do not touch the RTB's terminals. Failure to observe this caution may cause personal injury.

The RTB is designed to support Removal and Insertion Under Power (RIUP). However, when you remove or insert an RTB with field-side power applied, **unintended machine motion or loss of process control can occur**. Exercise extreme caution when using this feature. It is recommended that field-side power be removed before installing the RTB onto the module.

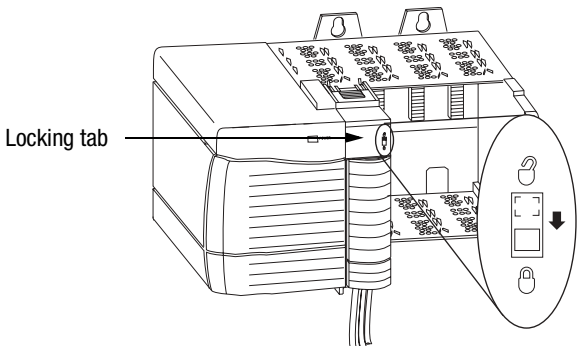
Before installing the RTB, make certain:

- field-side wiring of the RTB has been completed.
- the RTB housing is snapped into place on the RTB.
- the RTB housing door is closed.
- the locking tab at the top of the module is unlocked.

1. Align the top, bottom and left side guides of the RTB with matching guides on the module.



2. Press quickly and evenly to seat the RTB on the module until the latches snap into place.



3. Slide the locking tab down to lock the RTB onto the module.

Removing the Removable Terminal Block from the Module

If you need to remove the module from the chassis, you must first remove the RTB from the module.

ATTENTION

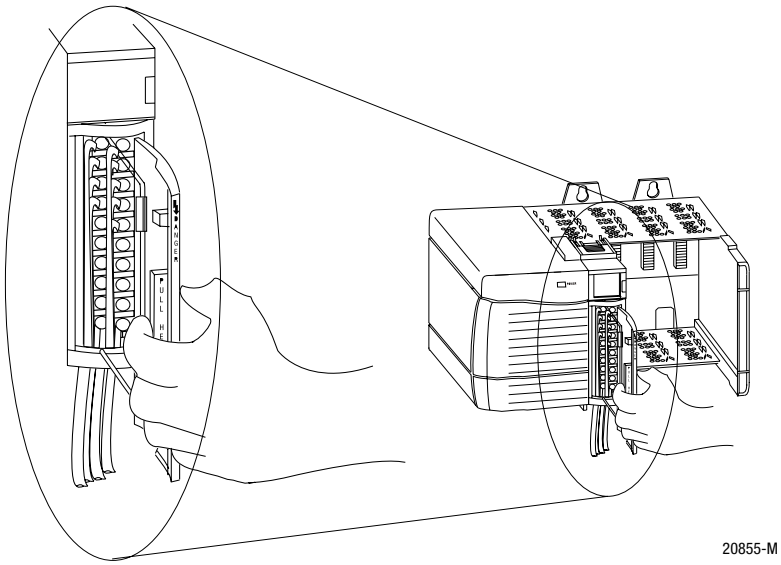
Shock hazard exists. If the RTB is removed from the module while the field-side power is applied, the module will be electrically live. Do not touch the RTB's terminals. Failure to observe this caution may cause personal injury.

The RTB is designed to support Removal and Insertion Under Power (RIUP). However, when you remove or insert an RTB with field-side power applied, **unintended machine motion or loss of process control can occur**. Exercise extreme caution when using this feature. It is recommended that field-side power be removed before removing the module.

1. Unlock the locking tab at the top of the module.
2. Open the RTB door using the bottom tab.
3. Hold the spot marked PULL HERE and pull the RTB off the module.

IMPORTANT Do not wrap your fingers around the entire door. A shock hazard exists.

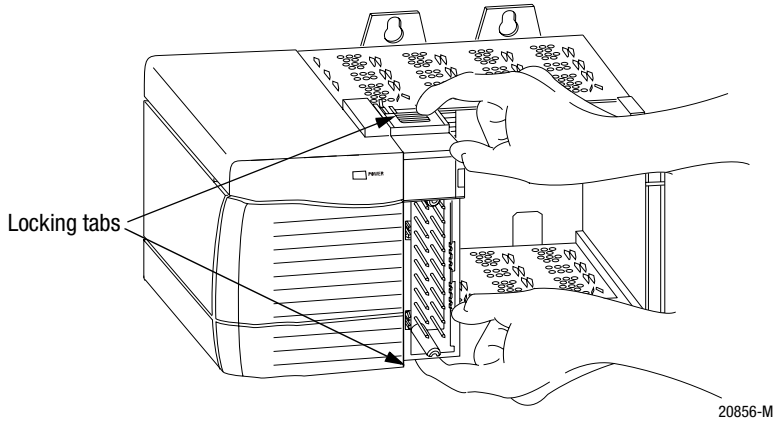
Figure 9.10



Removing the Module from the Chassis

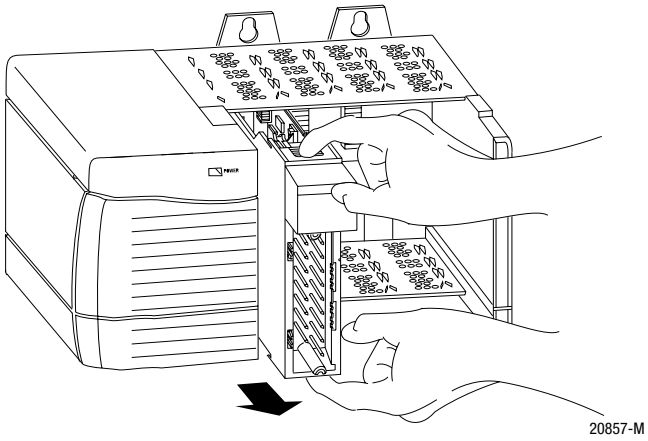
1. Push in the top and bottom locking tabs.

Figure 9.11



2. Pull module out of the chassis.

Figure 9.12



Chapter Summary and What's Next

In this chapter you read about Installing ControlLogix I/O Modules.

Chapter 10 describes Configuring ControlLogix Analog I/O Modules.

Configuring ControlLogix Analog I/O Modules

What This Chapter Contains

This chapter describes how to configure ControlLogix analog I/O modules.

For information about:	See page:
Using RSLogix 5000 Online Help	10-1
Configuring Your I/O Module	10-2
Overview of the Configuration Process	10-2
Creating a New Module	10-4
Using the Default Configuration	10-8
Altering the Default Configuration for Input Modules	10-9
Altering the Default Configuration for Output Modules	10-11
Configuring the RTD Module	10-14
Configuring the Thermocouple Modules	10-15
Downloading New Configuration Data	10-16
Editing Configuration	10-17
Reconfiguring Module Parameters in Run Mode	10-18
Reconfiguring Parameters in Program Mode	10-19
Configuring I/O Modules in a Remote Chassis	10-20
Viewing and Changing Module Tags	10-22

Using RSLogix 5000 Online Help

This chapter describes how to configure your ControlLogix analog I/O modules but is limited to a relatively brief explanation of how to use the software. For more information on the full capabilities of the software, see the software's online help.

Configuring Your I/O Module

You must configure your module upon installation. The module will not work until it has been configured.

IMPORTANT This chapter focuses on configuring I/O modules in a local chassis. To configure I/O modules in a remote chassis, you must follow all the detailed procedures with two additional steps. An explanation of the additional steps is listed at the end of this chapter.

RSLogix 5000 Configuration Software

Use RSLogix 5000 software to write configuration for your ControlLogix analog I/O module. You have the option of accepting the default configuration for your module or writing point level configuration specific to your application.

Both options are explained in detail, including views of software screens, in this chapter.

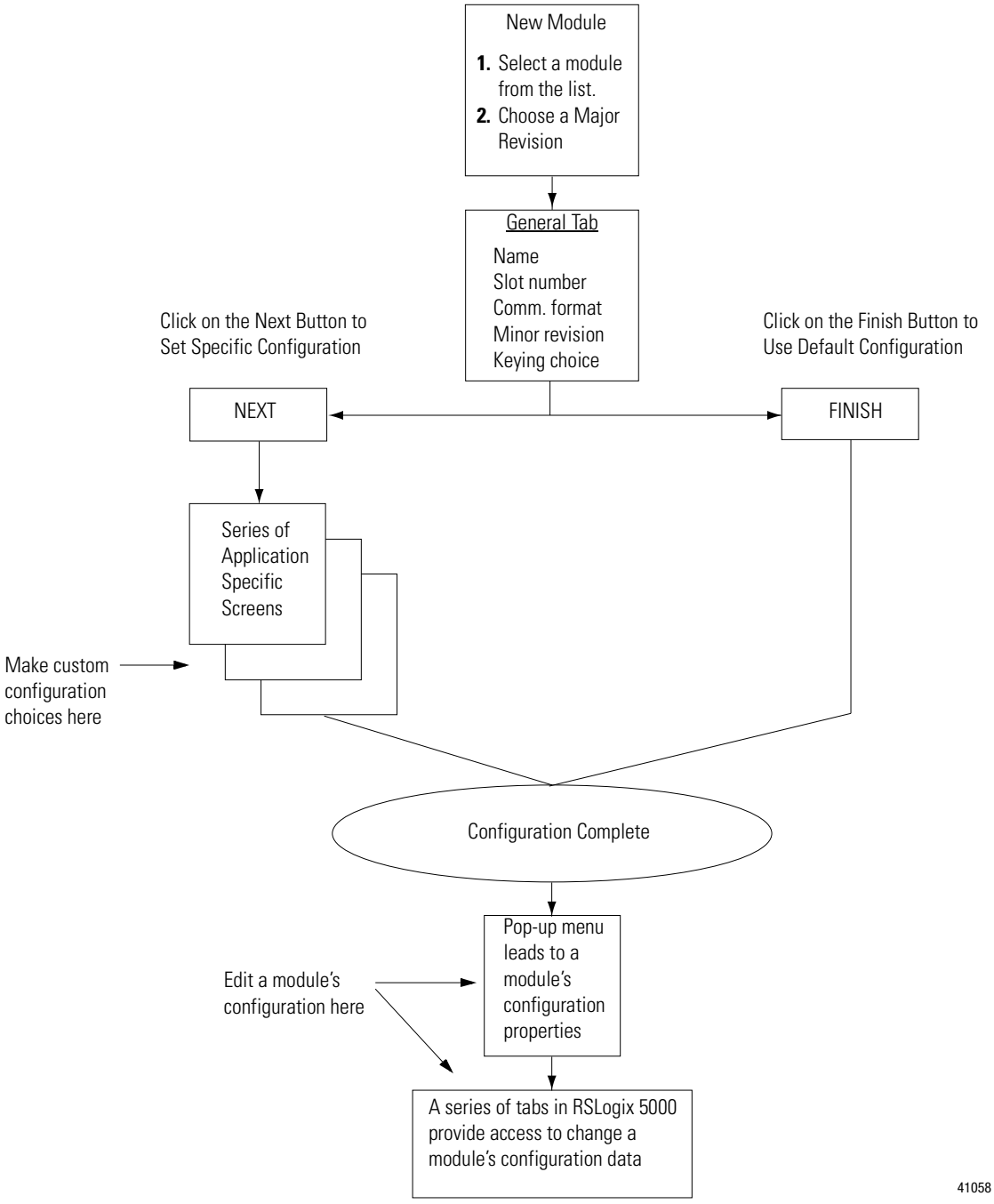
Overview of the Configuration Process

When you use the RSLogix 5000 software to configure a ControlLogix analog I/O module, you must perform the following steps:

1. Create a new module
2. Accept default configuration or write specific configuration for the module
3. Edit configuration for a module when changes are needed

Figure 10.1 shows an overview of the configuration process.

Figure 10.1



Creating a New Module

After you have started RSLogix 5000 and created a processor, you must create a new module. The wizard allows you to create a new module and configure it.

IMPORTANT You must be offline when you create a new module.

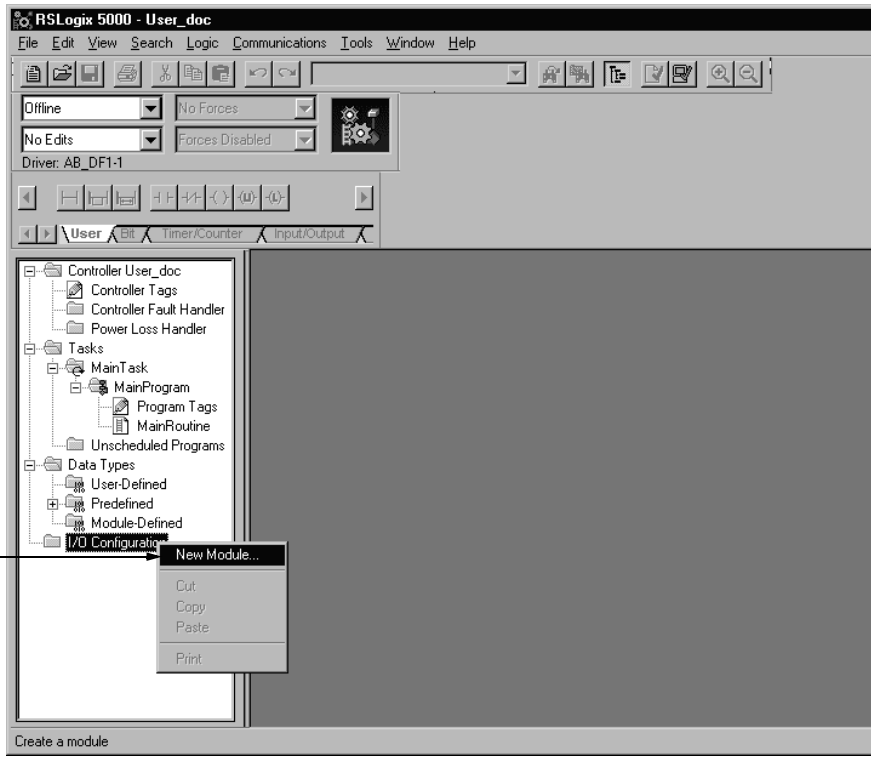
1. If your application is online, go offline.

If you are not offline, use this pull-down menu to go offline

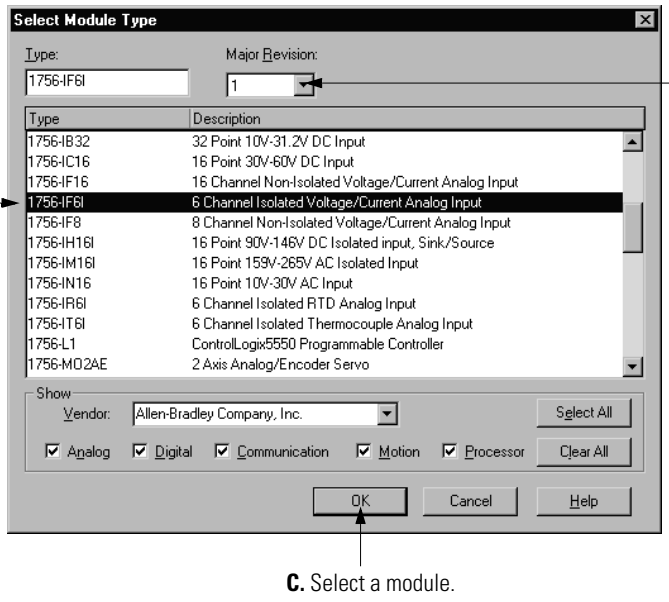
2. Access the Select Module Type screen.

A. Right-click on I/O Configuration.

B. Select New Module.



3. Select the module type.

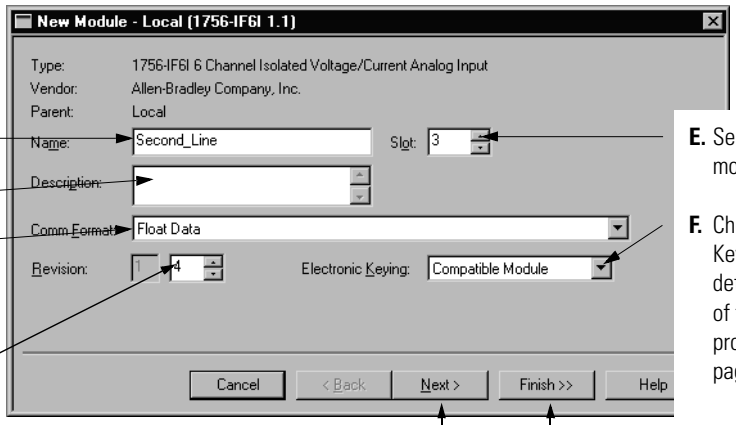


A. Select a module.

B. Make sure the Major Revision number matches the label on the side of your module

C. Select a module.

4. Begin configuration on the naming screen.



A. Name the module (optional).

B. Type a description (optional).

C. Choose a Communications Format (A detailed explanation of this field is provided on page 10-6.)

D. Make sure the Minor Revision number matches the label on the side of your module.

E. Select the slot your module resides in.

F. Choose an Electronic Keying method. (A detailed explanation of this field is provided on the next page 3-4.)

If you are altering the default configuration, click here.

Go to page 10-9

If you are using default configuration, click here and you are finished configuring your module.

Go to page 10-8

Communications Format

The communications format determines:

- what type of configuration options are made available
- what type of data is transferred between the module and its owner-controller
- what tags are generated when configuration is complete
- what type of connection is made between the controller writing the configuration and the module itself.

IMPORTANT In addition to description below, each format returns status data and rolling timestamp data.

Also, once the module is created, the communications format cannot be changed. The module must be deleted and recreated.

Input Module Formats

Table 10.1 lists the Communications Format available with ControlLogix analog input modules:

Table 10.1

If you want the input module return this data:	Choose this Communications Format:
Floating point input data	Float data
Integer input data	Integer data
Floating point input data with the value of the coordinated system time (from its local chassis) when the input data is sampled	CST timestamped float data
Integer input data with the value of the coordinated system time (from its local chassis) when the input data is sampled	CST timestamped integer data
Floating point input data with the value of the coordinated system time (from its local chassis) when the input data is sampled when the 1756-IF16 or 1756-IF8 module is operating in the differential mode	CST timestamped float data - differential mode
Floating point input data with the value of the coordinated system time (from its local chassis) when the input data is sampled when the 1756-IF16 or 1756-IF8 module is operating in the high speed mode	CST timestamped float data - high speed mode
Floating point input data with the value of the coordinated system time (from its local chassis) when the input data is sampled when the 1756-IF16 or 1756-IF8 module is operating in the single-ended mode	CST timestamped float data - single-ended mode
Integer input data with the value of the coordinated system time (from its local chassis) when the input data is sampled when the 1756-IF16 or 1756-IF8 module is operating in the differential mode	CST timestamped integer data - differential mode
Integer input data with the value of the coordinated system time (from its local chassis) when the input data is sampled when the 1756-IF16 or 1756-IF8 module is operating in the high speed mode	CST timestamped integer data - high speed mode
Integer input data with the value of the coordinated system time (from its local chassis) when the input data is sampled when the 1756-IF16 or 1756-IF8 module is operating in the single-ended mode	CST timestamped integer data - single-ended mode

Table 10.1

If you want the input module return this data:	Choose this Communications Format:
Floating point input data when the 1756-IF16 or 1756-IF8 module is operating in the differential mode only	Float data - differential mode
Returns floating point input data when the 1756-IF16 or 1756-IF8 module is operating in the high speed mode	Float data - high speed mode
Floating point input data when the 1756-IF16 or 1756-IF8 module is operating in the single-ended mode	Float data - single-ended mode
Integer input data when the 1756-IF16 or 1756-IF8 module is operating in the differential mode	Integer data - differential mode
Integer input data when the 1756-IF16 or 1756-IF8 module is operating in the high speed mode	Integer data - high speed mode
Integer input data when the 1756-IF16 or 1756-IF8 module is operating in the single-ended mode	Integer data - single-ended mode
Specific input data that is used by a controller that does not own the input module. These choices have the same definition as the similarly-named options above except that they represent listen-only connections between the analog input module and a listen-only controller.	Listen only CST timestamped float data
	Listen only CST timestamped integer data
	Listen only float data
	Listen only integer data
	Listen only CST timestamped float data - differential mode
	Listen only CST timestamped float data - high speed mode
	Listen only CST timestamped float data - single-ended mode
	Listen only CST timestamped integer data - differential mode
	Listen only CST timestamped integer data - high speed mode
	Listen only CST timestamped integer data - single-ended mode
	Listen only Float data - differential mode
	Listen only Float data - high speed mode
	Listen only Float data - single-ended mode
	Listen only Integer data - differential mode
	Listen only Integer data - high speed mode
	Listen only Integer data - single-ended mode

Output Module Formats

Table 10.2 lists the Communications Format available with ControlLogix analog input modules:

Table 10.2

If you want the output module return this data:	Choose this Communications Format:
Floating point output data	Float data
Integer output data	Integer data
Floating point output data and receives data echo values with a CST timestamp value	CST timestamped float data
Integer output data and receives data echo values with a CST timestamp value	CST timestamped integer data
Specific input data that is used by a controller that does not own the output module. These choices have the same definition as the similarly-named options above except that they represent listen-only connections between the analog output module and a listen-only controller.	Listen only float data
	Listen only integer data
	Listen only CST timestamped float data
	Listen only CST timestamped integer data

Electronic Keying

Electronic keying allows the ControlLogix system to control what modules belong in the various slots of a configured system.

During module configuration, you must choose one of the following keying options for your I/O module:

- Exact Match
- Compatible Match
- Disable Keying

For more information on electronic keying, see page 3-4.

Using the Default Configuration

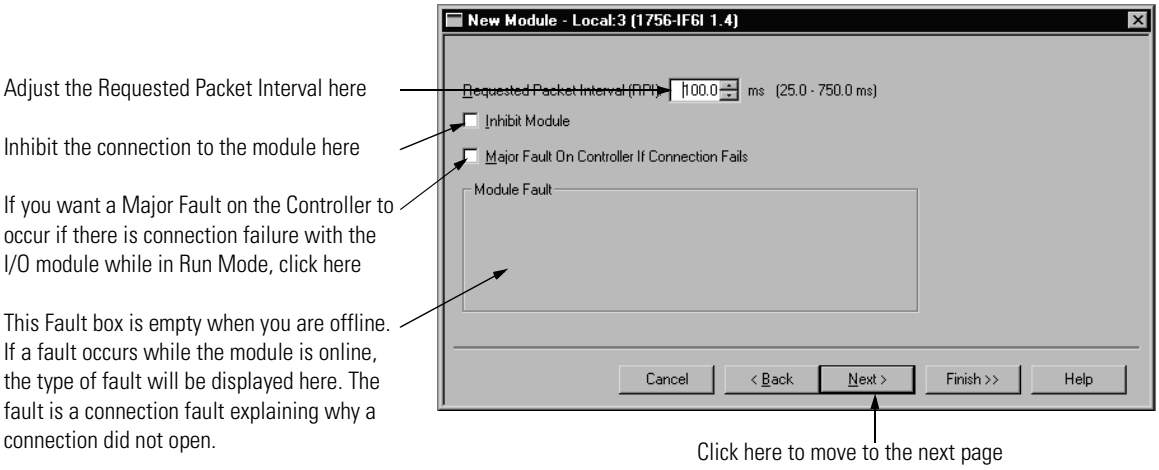
If you use the default configuration and click on Finish, you are done.

Altering the Default Configuration for Input Modules

If you write specific configuration and click on Next, you see the series of wizard screens that enable you to configure the module. This example shows the process for input modules. To see an example for output modules, see page 10-14.

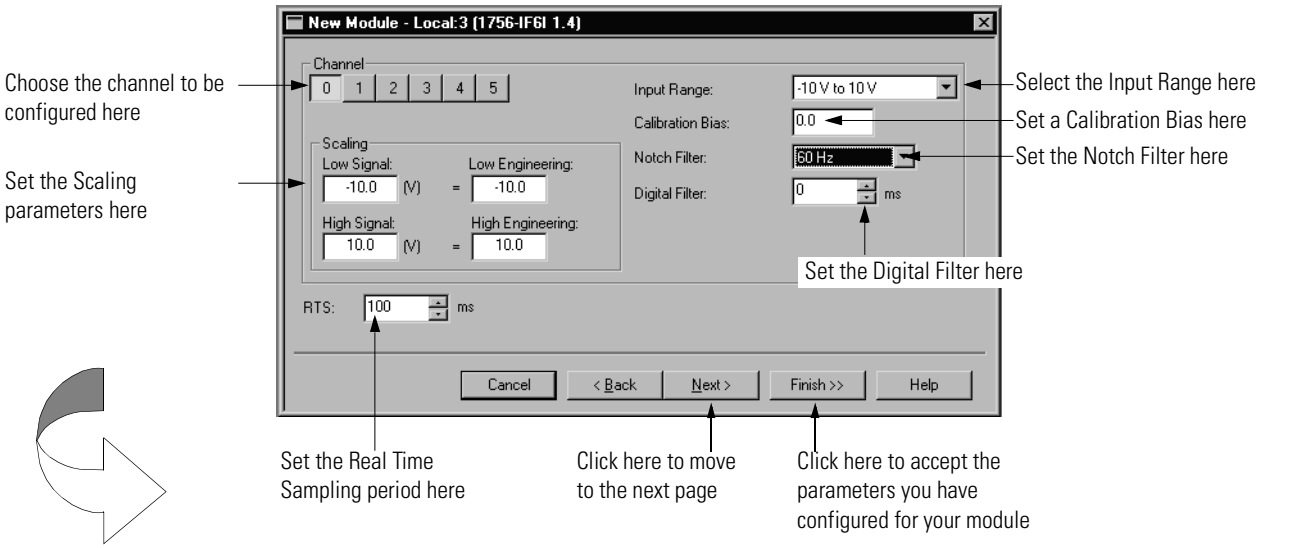
Although each screen maintains importance during online monitoring, some of the screens that appear during this initial module configuration process are blank. They are not shown here. To see these screens in use, see Appendix A.

After the naming page, this series of screens appears.

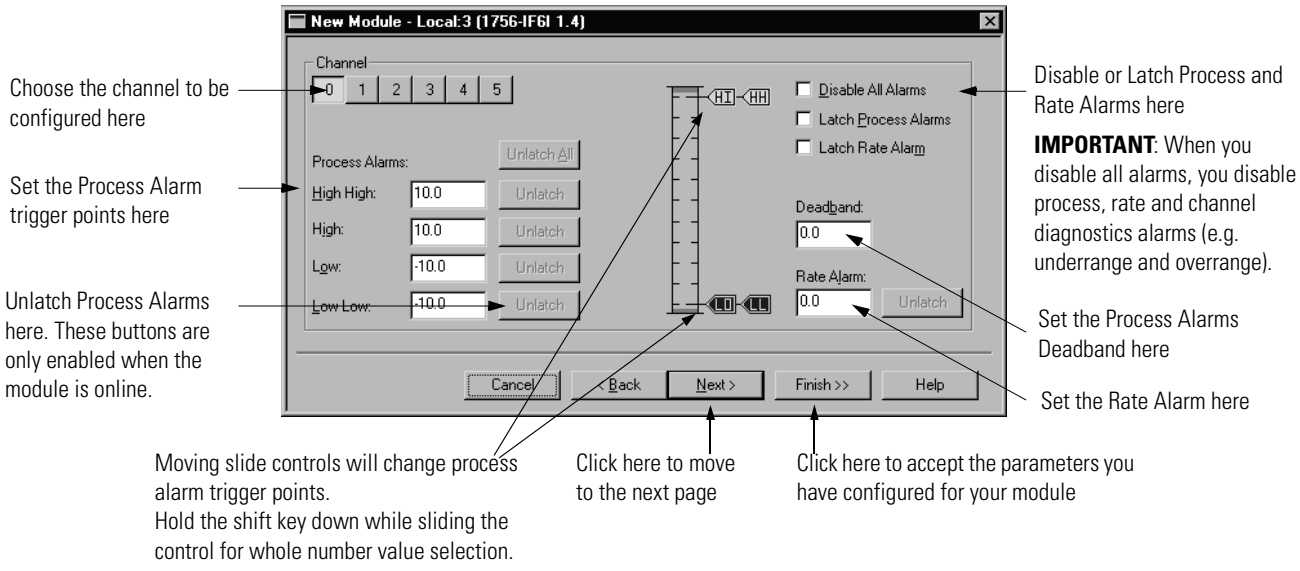


The configuration page appears next. For example, this screen appears for the 1756-IF6I module. The choices available on the configuration screen vary according to the module selected.

IMPORTANT: Set all the configuration parameters for each channel on this page before moving to the next page



IMPORTANT: Set all the configuration parameters for each channel on this page before moving to the next page

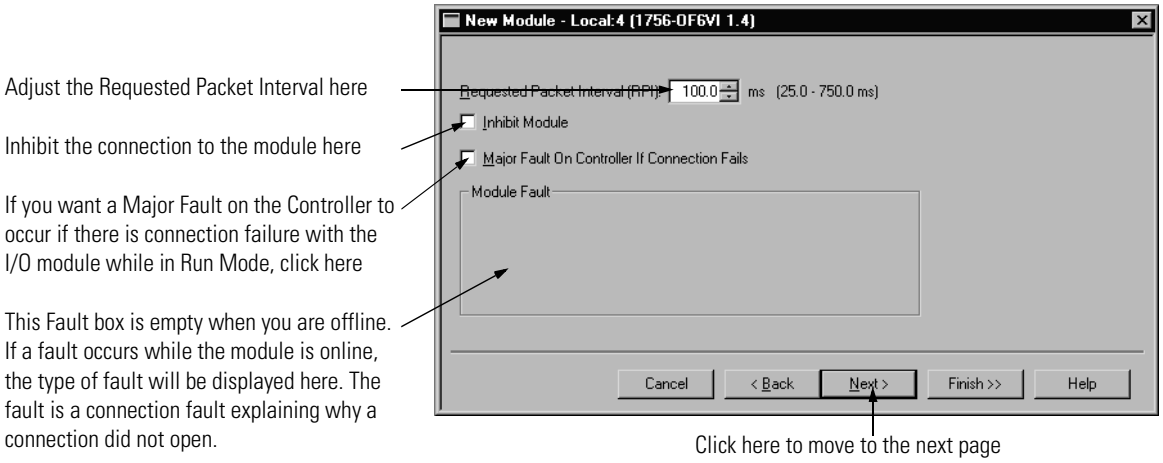


Altering the Default Configuration for Output Modules

If you write specific configuration and click on Next, you see the series of wizard screens that enable you to configure the module. This example shows the process for output modules.

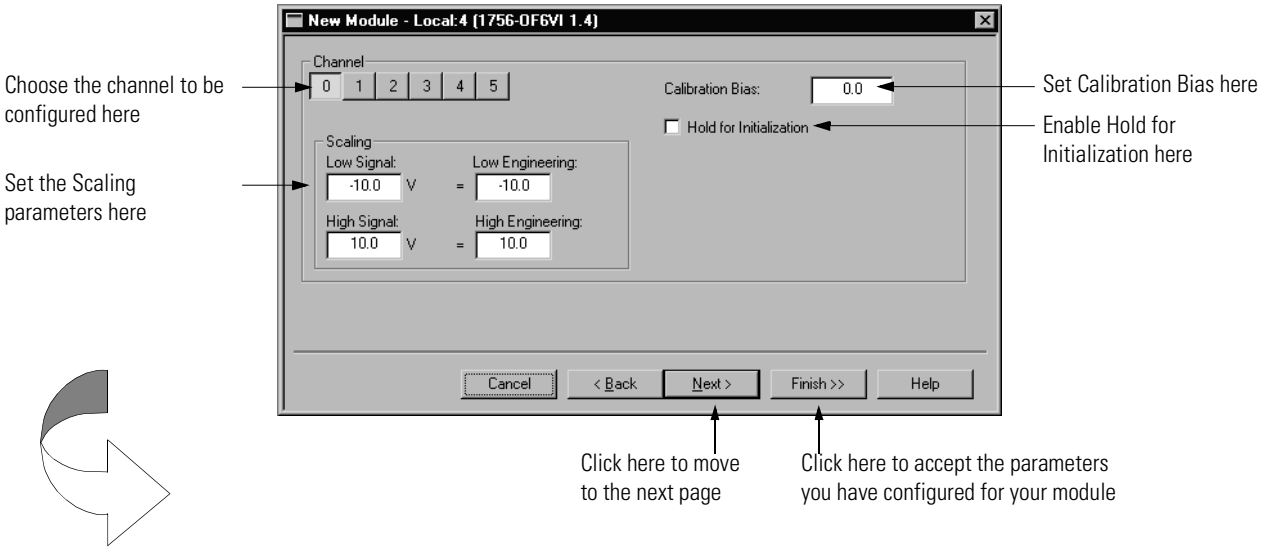
Although each screen maintains importance during online monitoring, some of the screens that appear during this initial module configuration process are blank. They are not shown here. To see these screens in use, see Appendix A.

After the naming page, this series of screens appears.

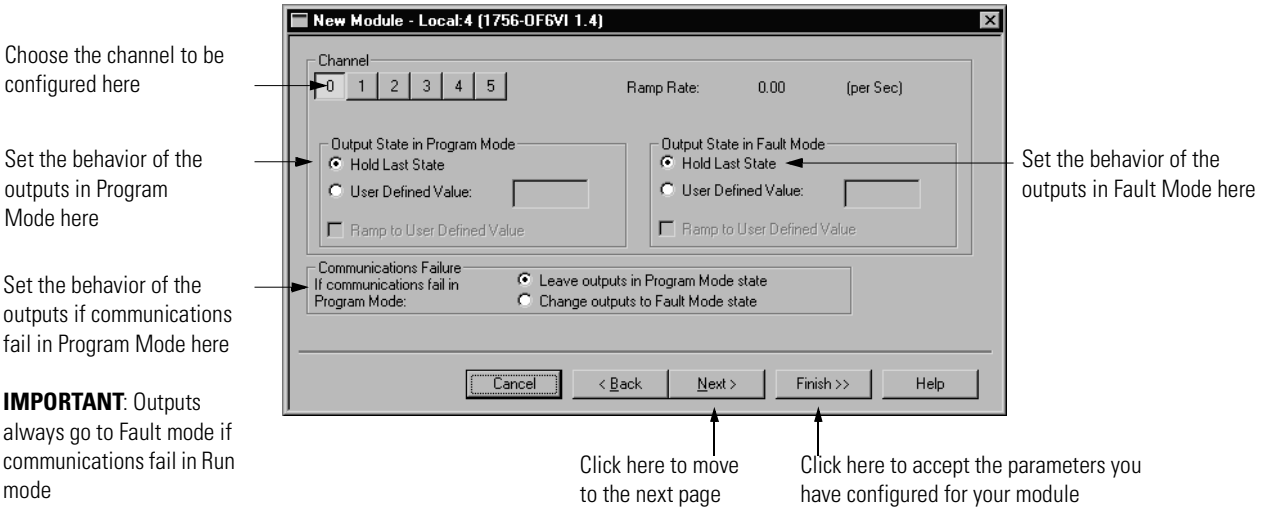


The configuration page appears next. For example, this screen appears for the 1756-OF6VI module. The choices available on the configuration screen vary according to the module selected.

IMPORTANT: Set all the configuration parameters for each channel on this page before moving to the next page



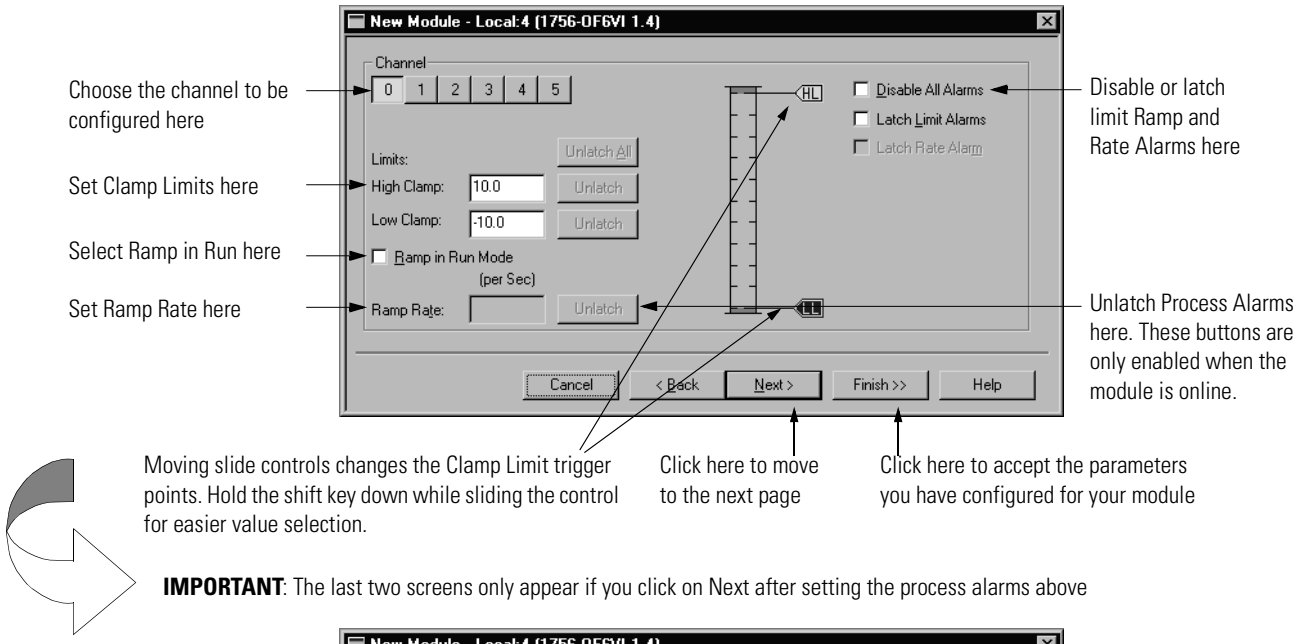
IMPORTANT: Set all the configuration parameters for each channel on this page before moving to the next page



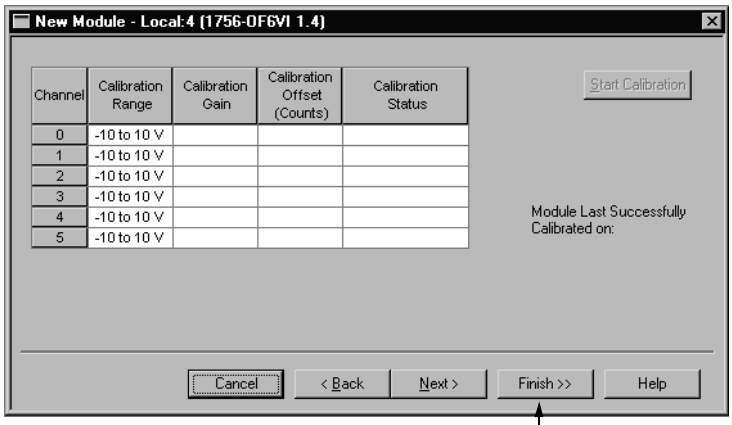
IMPORTANT: Outputs always go to Fault mode if communications fail in Run mode

These screens appear next.

IMPORTANT: Set all the configuration parameters for each channel on this page before moving to the next page



IMPORTANT: The last two screens only appear if you click on Next after setting the process alarms above



This screen appears next in the wizard series of screens. It is used during calibration but not initial configuration

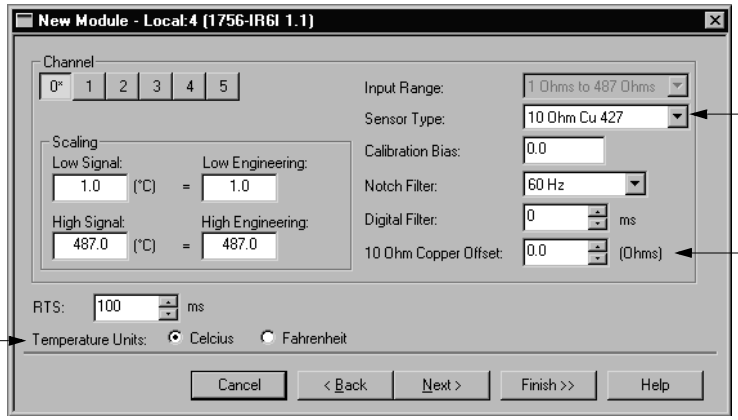
Click here to accept the parameters you have configured for your module

Configuring the RTD Module

The RTD module (1756-IR6I) has additional configurable points, temperature units and 10Ω copper offset options.

All of this module's configuration screens match the series listed for input modules beginning on page 10-9 except for the third screen. The screen below shows the aforementioned screen for the 1756-IR6I module.

IMPORTANT: Set all the configuration parameters for each channel on this page before moving to the next page All configurable options are the same except for the addition of those features that account for the module's temperature measuring capability. They are shown below.



Select RTD Sensor Type here

Select 10 Ohm Copper Offset here

This feature only needs to be set if you choose a Copper Sensor Type

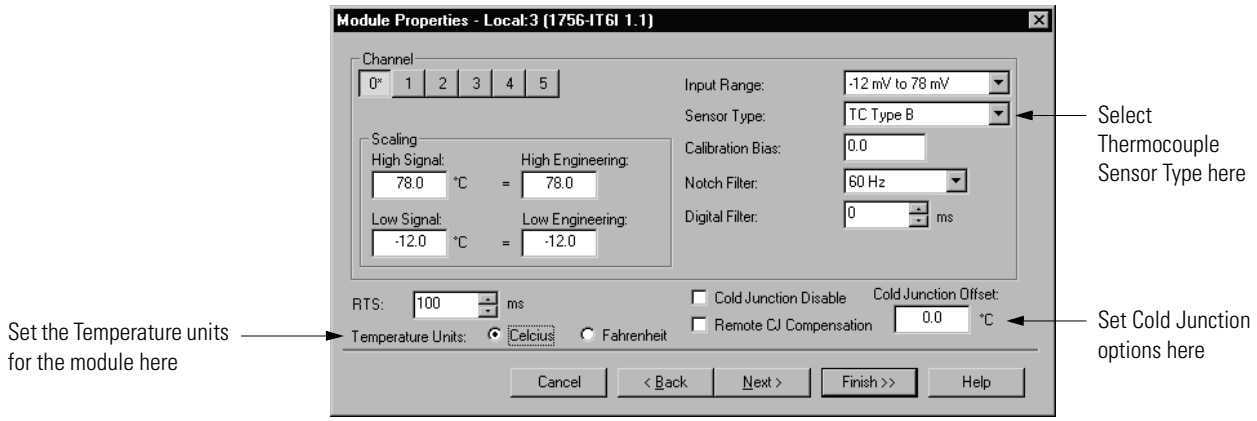
Set the Temperature units for the module here

Configuring the Thermocouple Modules

The 1756-IT6I and 1756-IT6I2 modules have additional configurable points, temperature units and cold junction options.

All of this module's configuration screens match the series listed for input modules beginning on page 10-9 except for the third screen. The screen below shows the aforementioned screen for the 1756-IT6I module.

IMPORTANT: Set all the configuration parameters for each channel on this page before moving to the next page. All configurable options are the same except for the addition of those features that account for the module's temperature measuring capability. They are shown below.



IMPORTANT

The module sends back temperature values over the entire sensor range as long as the High signal value equals the High engineering value and the Low signal value equals the Low engineering value.

For the example above, if:

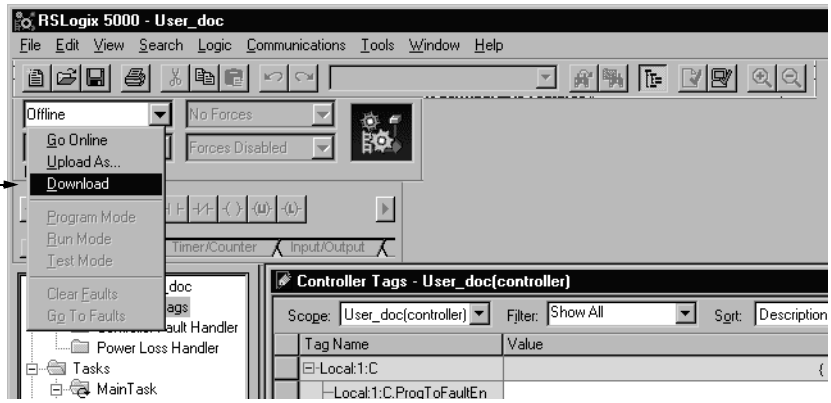
High Signal = 78.0°C, High Engineering must = 78.0.

Low signal = -12.0°C, Low Engineering must = -12.0

Downloading New Configuration Data

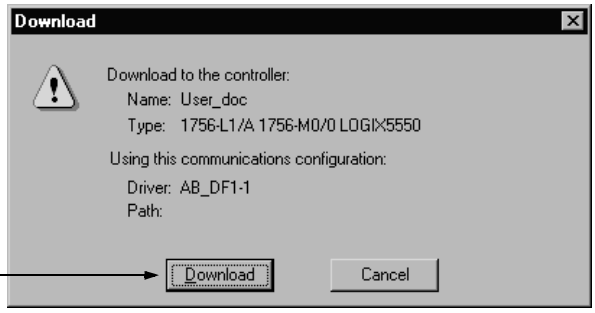
After you have changed the configuration data for a module, the change does not actually take affect until you download the new program which contains that information. This downloads the entire program to the controller overwriting any existing programs.

Pull down this menu and click here to download the new data



RSLogix 5000 verifies the download process with this pop-up screen.

Click here to download new data



This completes the download process.

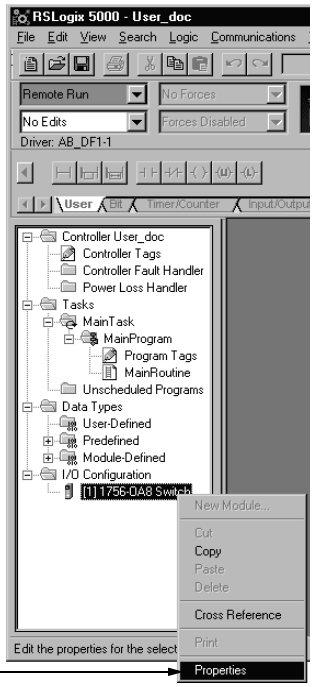
Editing Configuration

After you set configuration for a module, you can review and change it. You can change configuration data and download it to the controller while online. This is called **dynamic reconfiguration**.

Your freedom to change some configurable features, though, depends on whether the controller is in Remote Run Mode or Program Mode.

IMPORTANT Although you can change configuration while online, you must go offline to add or delete modules from the program in current RSLogix 5000 revisions.

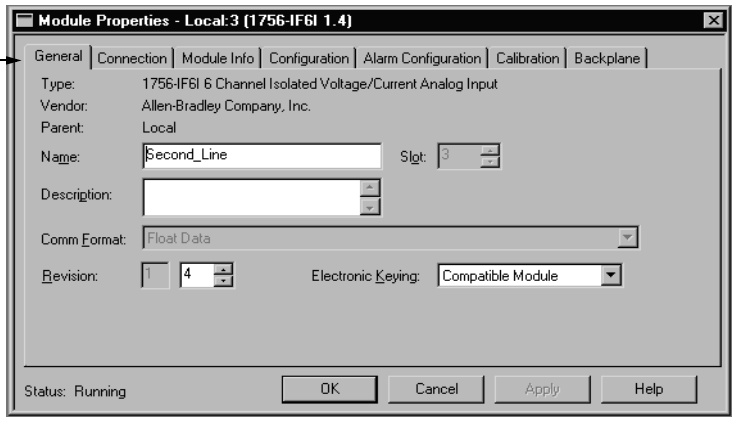
The editing process begins on the main page of RSLogix 5000.



A. Right-click on the module.

B. Select Properties.

You see this screen.



Click on the tab of the page you want to view or reconfigure

Reconfiguring Module Parameters in Run Mode

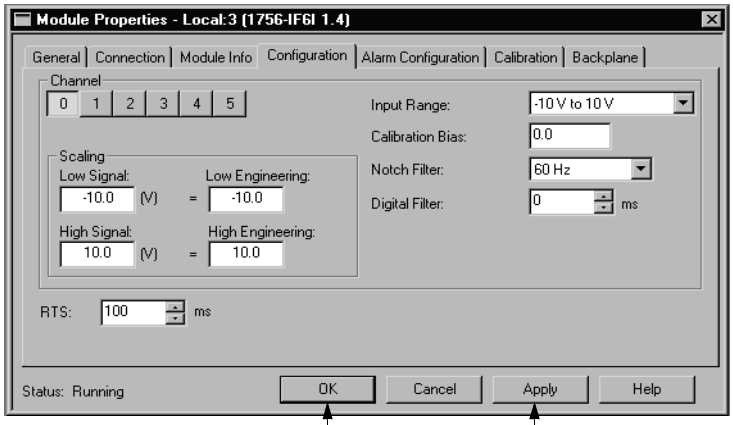
Your module can operate in Remote Run Mode or Hard Run Mode. You can only change any configurable features that are enabled by the software in Remote Run Mode.

If any feature is disabled in either Run Mode, change the controller to Program Mode and make the necessary changes.

For example, the following screen shows the configuration page for the 1756-IF6I module while it is in Run Mode.

A. Make the necessary configuration changes

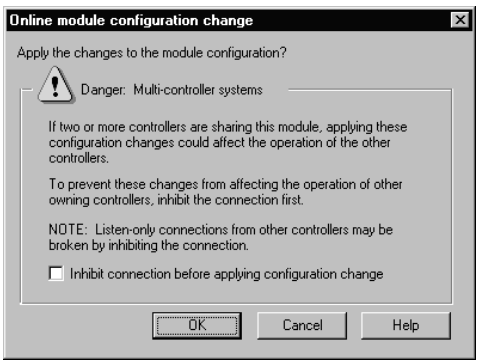
In this example, all configurable features are enabled in Run Mode.



B. Click here to transfer the new data and close the screen.

Click here to transfer the new data and keep the screen open.

When you try to download new configuration data to the module, the following warning appears.

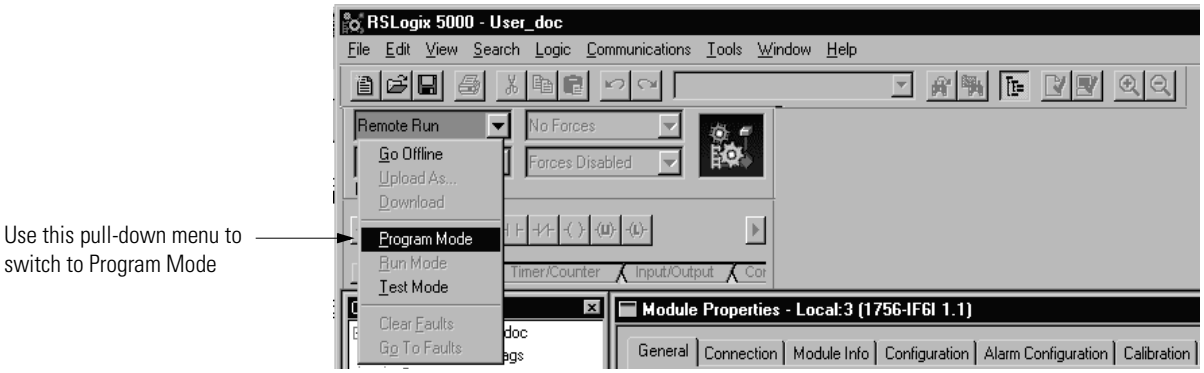


IMPORTANT If you change the configuration for a module, you must consider whether the module has more than one owner-controller. If so, be sure each owner has exactly the same configuration data as the others.

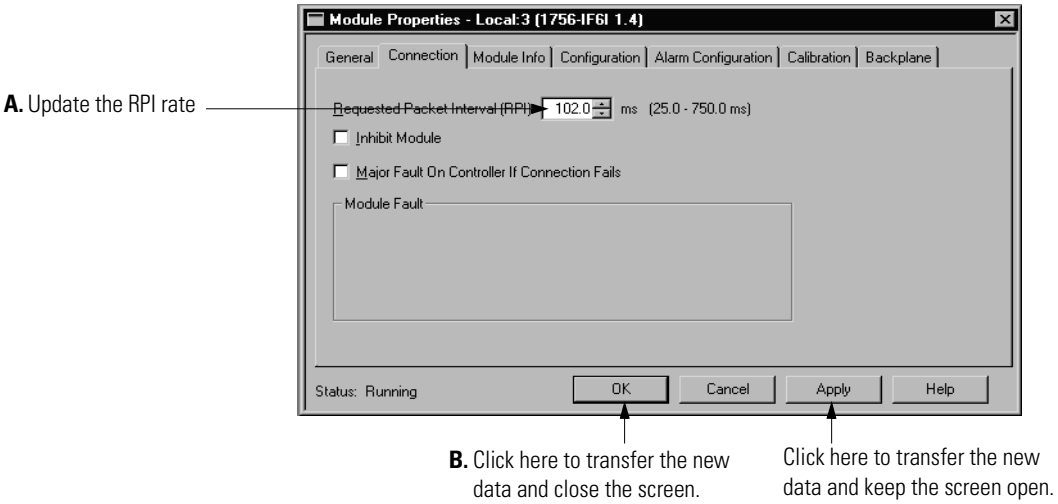
For more information on changing configuration in a module with multiple owner-controllers, see page 2-13.

Reconfiguring Parameters in Program Mode

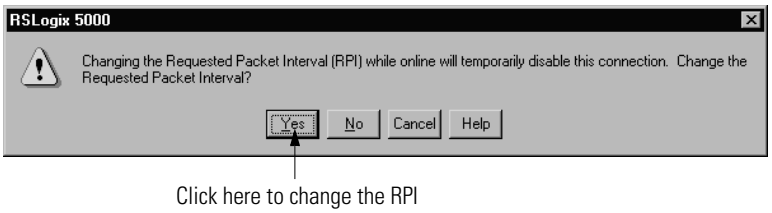
Change the module from Run Mode to Program Mode before changing configuration in the Program Mode.



Make any necessary changes. For example, the RPI can only be changed in Program Mode.



Before the RPI rate is updated online, RSLogix 5000 verifies your desired change.



The RPI has been changed and the new configuration data has been transferred to the controller.

After you change your module's configuration in Program Mode, we recommend that you change the module back to Run Mode.

Configuring I/O Modules in a Remote Chassis

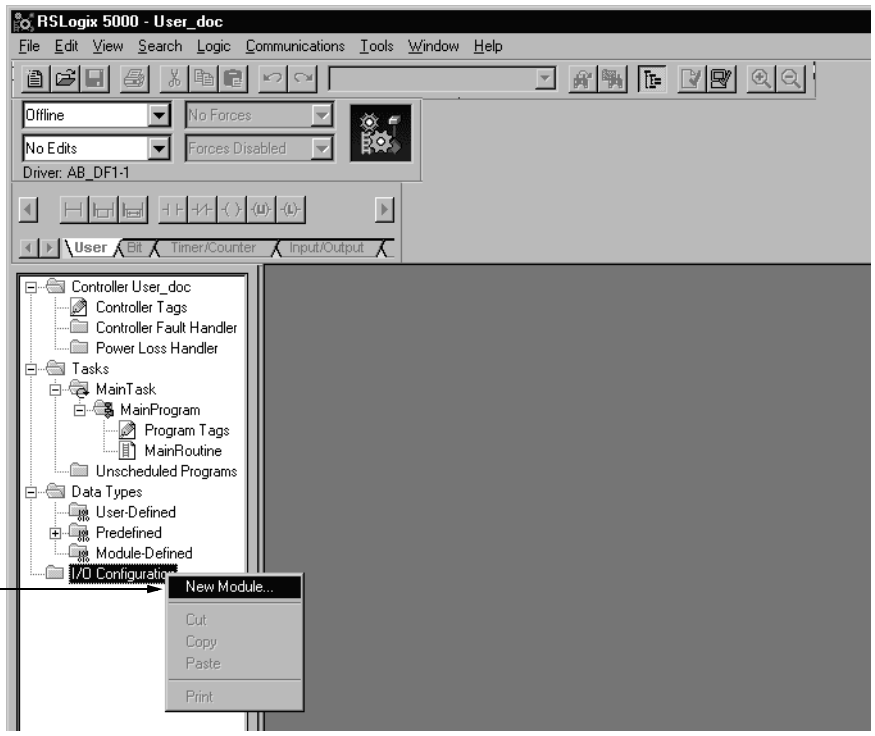
ControlLogix ControlNet Interface modules (1756-CNB or 1756-CNBR) or EtherNet/IP Bridge module (1756-ENBT) are required to communicate with I/O modules in a remote chassis.

You must configure the communications module in the local chassis and the remote chassis before adding new I/O modules to the program.

1. Configure a communications module for the local chassis. This module handles communications between the controller chassis and the remote chassis.

A. Right-click on I/O Configuration.

B. Select New Module.



2. Choose a communications module and configure it.

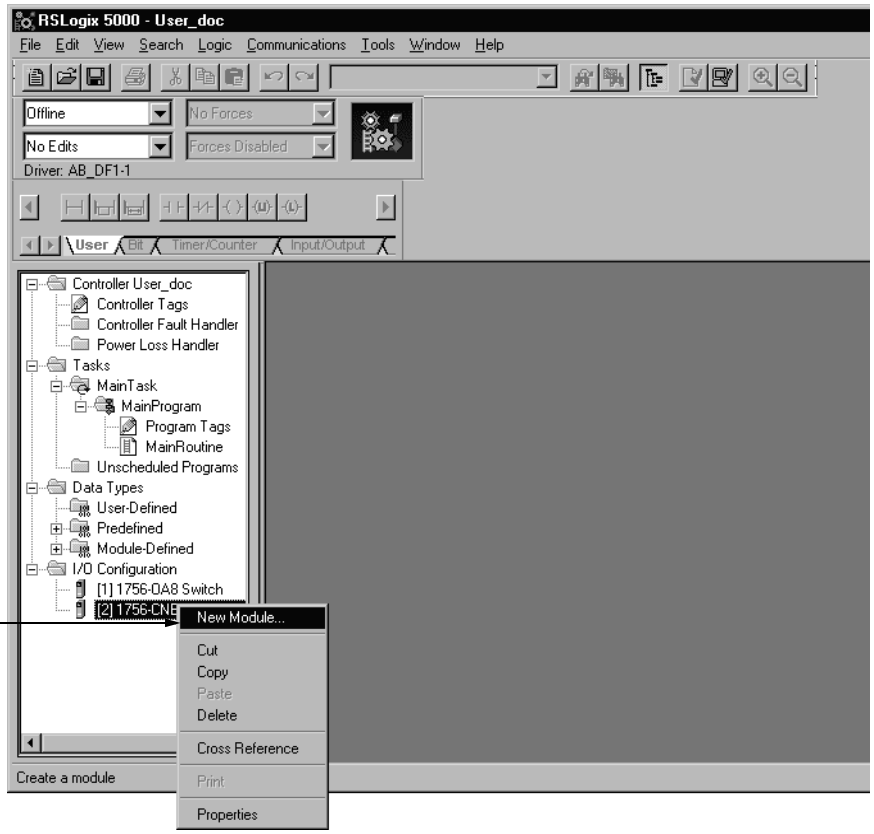
   For more information on the ControlLogix ControlNet Interface modules, see the ControlLogix ControlNet Interface user manual, publication 1756-6.5.3.

   For more information on the ControlLogix EtherNet/IP Bridge module, see the ControlLogix EtherNet/IP Bridge module user manual, publication 1756-UM050.

3. Configure a communications module for the remote chassis.

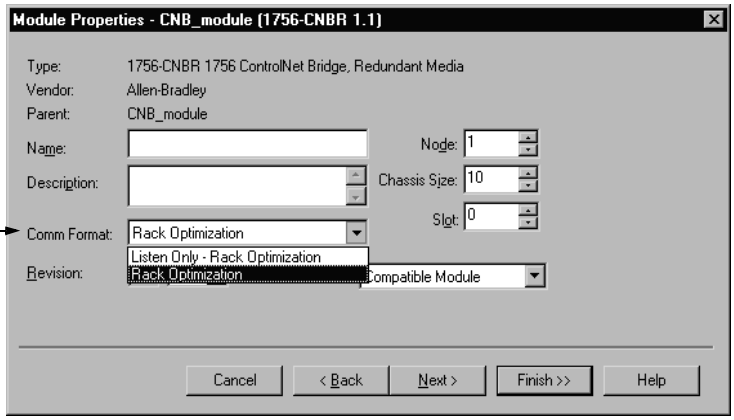
A. Right-click on the local communications module.

B. Select New Module.



4. Choose a communications module and configure it.

IMPORTANT: Be aware of the two Communications Format choices available for 1756-CNB modules. For more information on the differences between Rack Optimization and Listen-Only Rack Optimization, see chapter 2 of the ControlLogix Digital I/O Modules User Manual, publication 1756-UM058.



Now you can configure the remote I/O modules by adding them to the remote communications module. Follow the same procedures as you do for configuring local I/O modules as detailed earlier in this chapter.

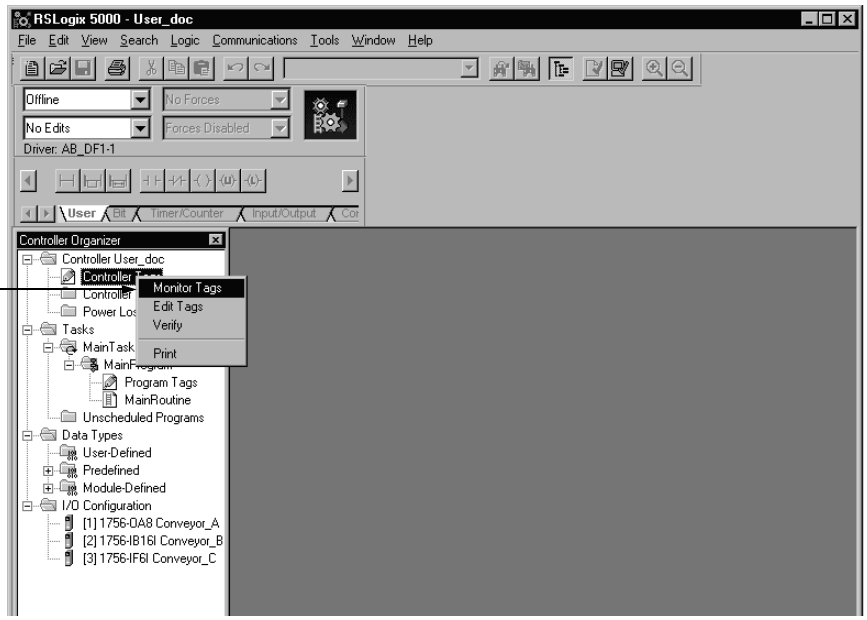
Viewing and Changing Module Tags

When you create a module, you establish a series of tags in the ControlLogix system that can be viewed in the Tag Editor of RSLogix 5000. Each configurable feature on your module has a distinct tag that can be used in the processor's ladder logic.

You can access a module's tags through RSLogix 5000 as shown below.

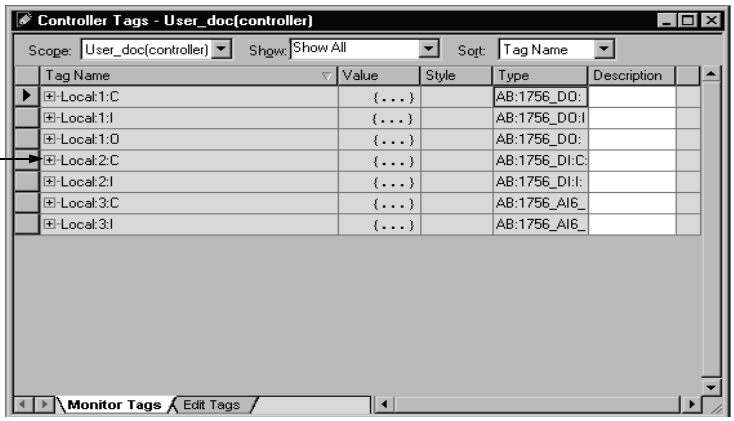
A. Right-click on Controller Tags.

B. Select Monitor Tags.



You can view the tags from here.

Click on the slot number of the module you want to see



Because the process of viewing and changing a module's configuration tags is broader in scope than can be addressed in this chapter.

For more information and sample tag collections, see Appendix B, Tag Definitions.

Chapter Summary and What's Next

In this chapter, you read about Configuring ControlLogix Analog I/O Modules.

Chapter 11 explains Calibrating the ControlLogix Analog I/O Modules.

Notes:

Calibrating the ControlLogix Analog I/O Modules

What This Chapter Contains

This chapter describes how to calibrate ControlLogix analog modules.

For information about:	See page:
Difference Between Calibrating An Input Module and Calibrating An Output Module	11-2
Calibrating Input Modules	11-4
Calibrating Output Modules	11-22

Your ControlLogix analog I/O module comes from the factory with a default calibration. You may choose to recalibrate your module to increase its accuracy for your specific application.

You do not have to configure a module before you calibrate it. If you decide to calibrate your analog I/O modules first, you must add them to your program. To see how to add a new module to your program, see page 10-4.

IMPORTANT

Analog I/O modules can be calibrated on a channel by channel basis or with the channels grouped together. Regardless of which option you choose, we recommend you calibrate all channels on your module each time you calibrate. This will help you maintain consistent calibration readings and improve module accuracy.

Calibration is meant to correct any hardware inaccuracies that may be present on a particular channel. The calibration procedure compares a known standard, either input signal or recorded output, with the channel's performance and then calculating a linear correction factor between the measured and the ideal.

The linear calibration correction factor is applied on every input or output same to obtain maximum accuracy.

Difference Between Calibrating An Input Module and Calibrating An Output Module

Although the purpose of calibrating analog modules is the same for input and output modules, to improve the module's accuracy and repeatability, the procedures involved differs for each.

- When you calibrate input modules, you use current, voltage or ohms calibrators to send a signal to the module to calibrate it.
- When you calibrate output modules, you use a digital multimeter (DMM) to measure the signal the module is sending out.

To maintain your module's accuracy specifications, we recommend you use calibration instruments with specific ranges. Table 11.1 lists the recommended instruments for each module.

Table 11.1 Recommended Calibration Instruments for 1756 Analog I/O Modules

Modules:	Recommended instrument ranges:
1756-IF16 & 1756-IF8	0 to 10.25V source +/-150μV Voltage
1756-IF6CIS	1.00 to 20.00mA source +/-0.15μA Current
1756-IF6I	0 to 10.00V source +/-150μV Voltage 1.00 to 20.00mA source +/-0.15μA Current
1756-IR6I	1.0 and 487.0Ω resistors(1) +/-0.01%
1756-IT6I & 1756-IT6I2	-12mV to 78mV source +/-0.3μV
1756-OF4 1756-OF8	DMM better than 0.3mV or 0.6μA
1756-OF6VI	DMM with resolution better than 0.5mV
1756-OF6CI	DMM with resolution better than 1.0μA

(1) We suggest you use the following precision resistors:
KRL Electronics - 534A1-1R0T 1.0 Ohm 0.01% / 534A1-487R0T 487 Ohm 0.01%

A precision decade resistor box can also be used that meets or exceeds the required accuracy specifications. The user is responsible for assuring that the decade box maintains accuracy by periodic calibration as specified by the following vendors:
Electro Scientific Industries, Portland, OR – Series DB 42
IET Labs, Westbury, NY – HARS-X Series
Julie Research Labs, New York, NY – DR100 Series

IMPORTANT

If you calibrate your module with an instrument that is less accurate than those recommended in Table 11.1 (e.g. calibrate a 1756-IF16 module with a voltage calibrator of greater than +/-150μV accuracy), the following may occur:

- Calibration appears to occur normally but the module gives inaccurate data during operation.

or

- A calibration fault occurs, forcing you to abort calibration.
- The calibration fault bits are set for the channel you attempted to calibrate. The bits remain set until a valid calibration is completed.

  In this case, you must recalibrate the module with an instrument as accurate as recommended in Table 11.1.

Calibrating in Either Program or Run Mode

You must be online to calibrate your analog I/O modules through RSLogix 5000. When you are online, you can choose either Program or Run Mode as the state of your program during calibration.

We recommend that your module be in Program Mode and not be actively controlling a process when you calibrate it.

IMPORTANT

The module freezes the state of each channel and does not update the controller with new data until after calibration ends. This could be hazardous if active control were attempted during calibration.

Calibrating Input Modules

Input calibration is a multi-step process that involves multiple services being sent to the module. This section has four parts. Each input module requires attention be paid to specific calibration ranges.

Table 11.2 lists the catalog numbers covered in this section:

Table 11.2

For information about:	See page:
Calibrating the 1756-IF16 or 1756-IF8 Modules	11-4
Calibrating the 1756-IF6CIS or 1756-IF6I Modules	11-9
Calibrating the 1756-IR6I	11-14
Calibrating the 1756-IT6I or 1756-IT6I2	11-18

Calibrating the 1756-IF16 or 1756-IF8 Modules

The 1756-IF16 or 1756-IF8 modules are used in applications requiring voltage or current. The modules offer 4 input ranges:

- -10 to 10V
- 0 to 5V
- 0 to 10V
- 0 to 20mA

However, you can only calibrate the modules using a voltage signal.

IMPORTANT Regardless of what application range is selected prior to calibration, all calibration uses a +/-10V range.

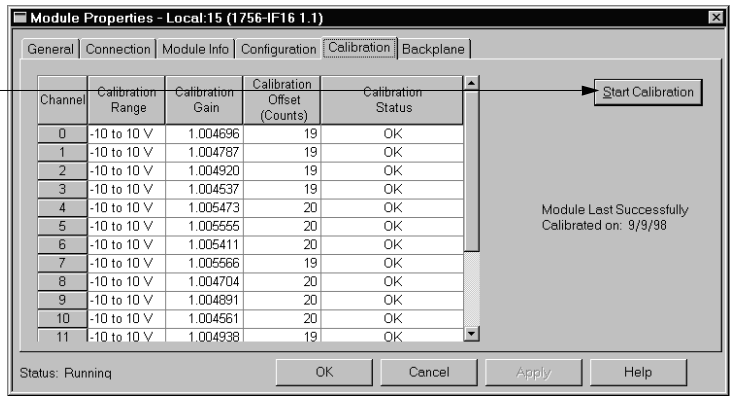
While you are online, you must access the modules' properties page. To see how to reach this page, see page 10-17.

Follow these steps:

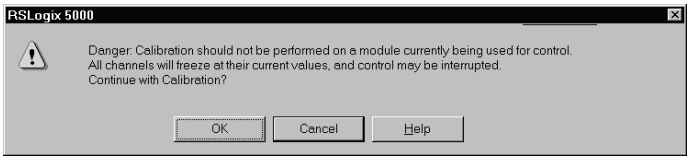
1. Connect your voltage calibrator to the module.

2. Go to the Calibration page. (Click on the tab for this page.)

Click here to start calibration



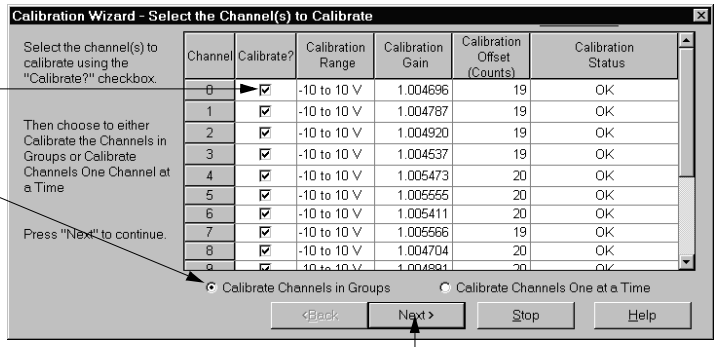
If your module is not in Program Mode, you see this warning. You must manually change the module to program mode before clicking on Yes.



3. Set the channels to be calibrated.

A. Choose the channels you want to calibrate here

B. Choose whether you want to calibrate channels in groups or one at a time here

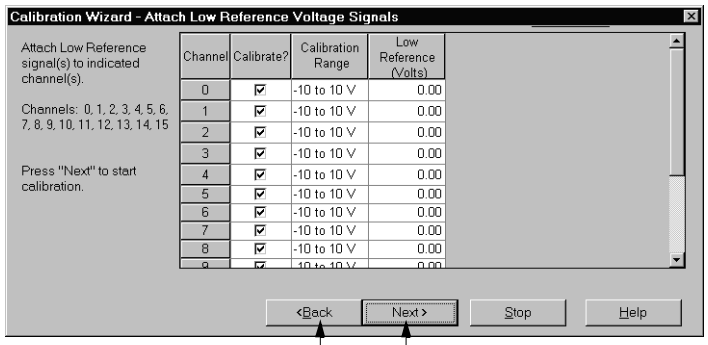


C. Click here to continue

The low reference screen appears first.

This screen shows which channels will be calibrated for a low reference and the range of that calibration.

It also shows what reference signal is expected on the input.

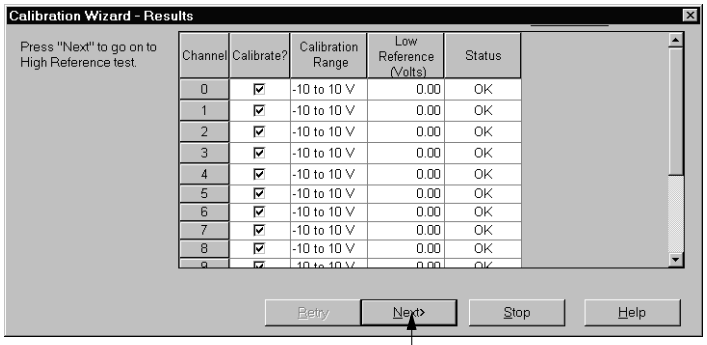


Click here to return to the last screen and make any necessary changes

Click here to calibrate the low reference

4. Set the calibrator for the low reference and apply it to the module.

This screen displays the status of each channel after calibrating for a low reference. If all channels are OK, continue, as shown below. If any channels report an Error, retry step 4 until the status is OK.

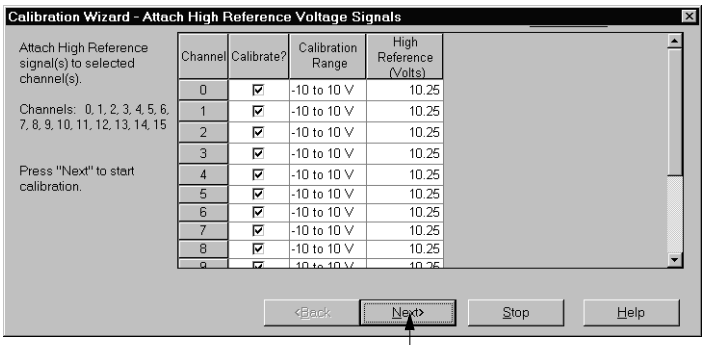


Click here to continue

5. Set the calibrator for the high reference and apply it to the module.

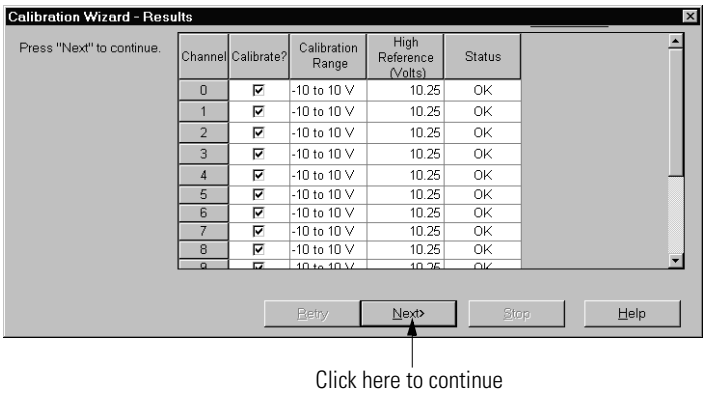
This screen shows which channels will be calibrated for a high reference and the range of that calibration.

It also shows what reference signal is expected at the input.

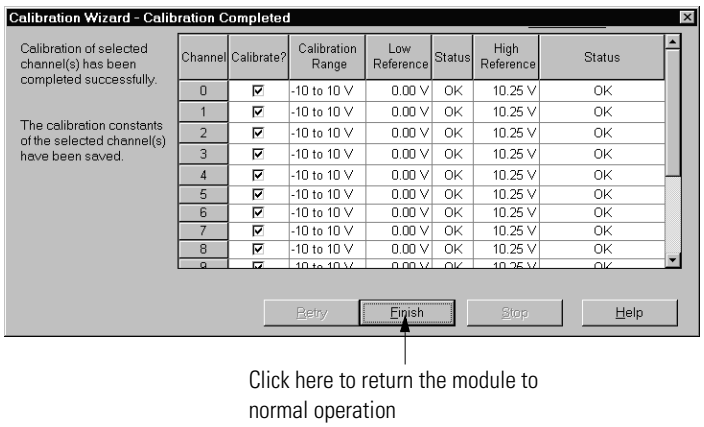


Click here to calibrate the high reference

This screen displays the status of each channel after calibrating for a high reference. If all channels are OK, continue, as shown below. If any channels report an Error, retry step 5 until the status is OK.



After you have completed both low and high reference calibration, this screen shows the status of both.



Calibrating the 1756-IF6CIS or 1756-IF6I Modules

The 1756-IF6CIS module can be used for applications that require current only. The 1756-IF6I module can be used for applications requiring voltage or current. Calibrate the modules for your specific application.

Calibrating the 1756-IF6I for Voltage Applications

During 1756-IF6I module calibration, 0.0V and +10.0V external references are applied consecutively to the module's terminals. The module records the deviation from these reference values (i.e. 0.0V and +10.0V) and stores it as calibration constants in the module's firmware. The internal calibration constants are then used in every subsequent signal conversion to compensate for circuit inaccuracies. The 0/10V user calibration compensates for all voltage ranges on the 1756-IF6I module (0-10V, +/-10V, and 0-5V) and compensates for inaccuracies of the module's entire analog circuitry, including input amplifier, resistors, and the A/D convertor.

The 1756-IF6I offers 3 input voltage ranges:

- -10 to 10V
- 0 to 5V
- 0 to 10V

IMPORTANT Regardless of what voltage application range is selected prior to calibration, all voltage calibration uses a +/-10V range.

Calibrating the 1756-IF6CIS or 1756-IF6I for Current Applications

The 1756-IF6CIS and 1756-IF6I modules offer a 0 to 20mA current range. Calibrating the modules for current uses the same process as calibrating the 1756-IF6I for voltage except the change in input signal.

IMPORTANT The following example shows how you can calibrate the 1756-IF6I module for voltage.

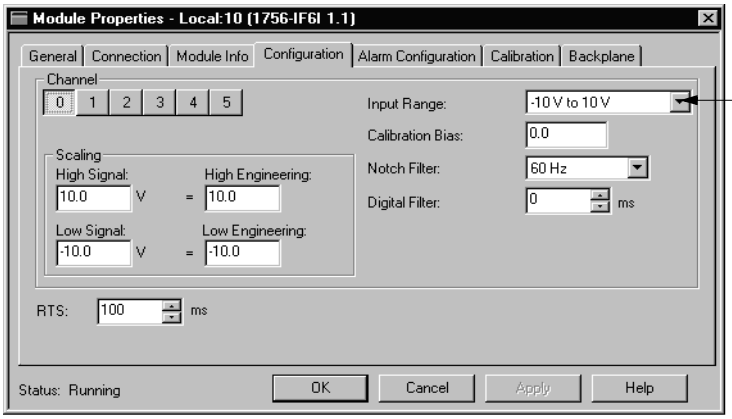
While you are online, you must access the modules' properties page. To see how to reach this page, see page 10-17.

Follow these steps:

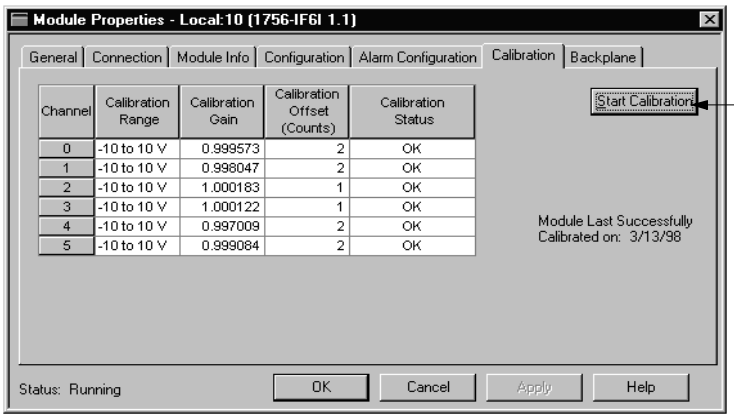
1. Connect your voltage calibrator to the module.

2. Go to the Configuration page.

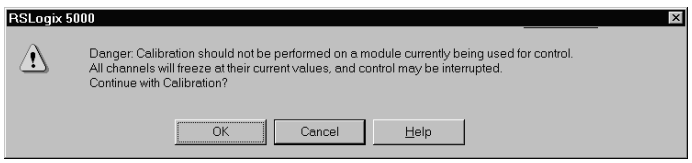
IMPORTANT: Make sure you choose the correct input range for each channel to be calibrated.



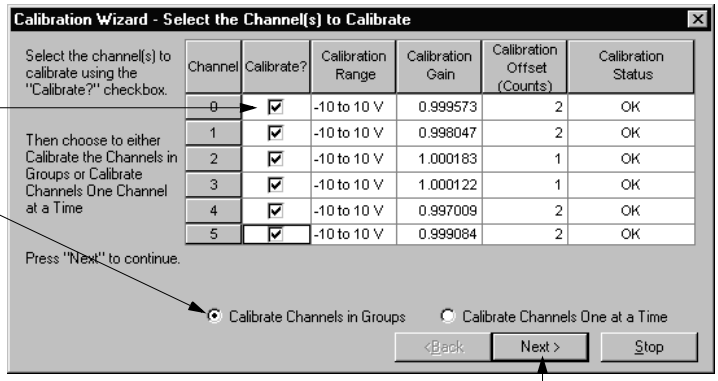
3. Go to the Calibration page. (Click on the tab for this page.)



If your module is not in Program Mode, you see this warning. You must manually change the module to program mode before clicking on Yes.



4. Set the channels to be calibrated.



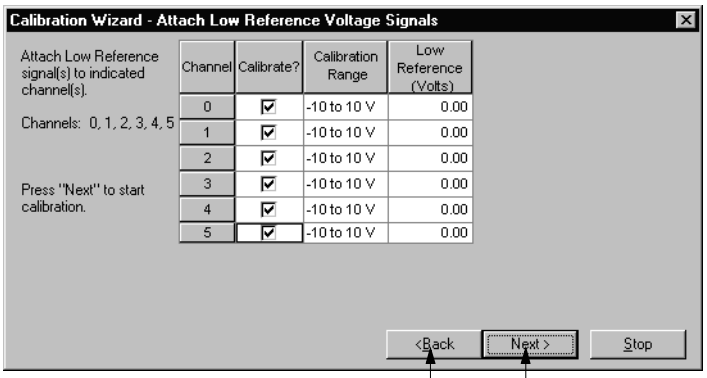
A. Choose the channels you want to calibrate here

B. Choose whether you want to calibrate channels in groups or one at a time here

C. Click here to continue

The low reference screen appears first.

5. Set the calibrator for the low reference and apply it to the module.



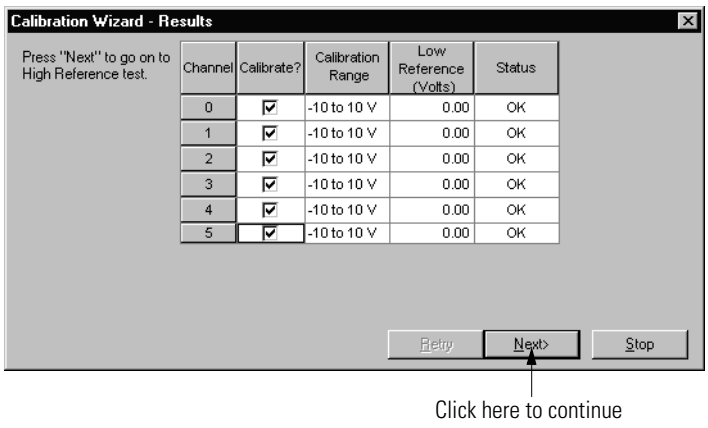
This screen shows which channels will be calibrated for a low reference and the range of that calibration.

It also shows what reference signal is expected on the input.

Click here to return to the last screen and make any necessary changes

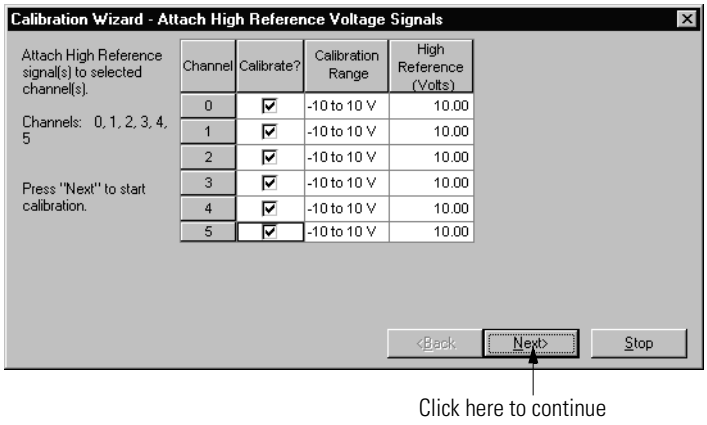
Click here to calibrate the low reference

This screen displays the status of each channel after calibrating for a low reference. If all channels are OK, continue, as shown below. If any channels report an Error, retry step 5 until the status is OK.



Now you must calibrate each channel for a high reference voltage.

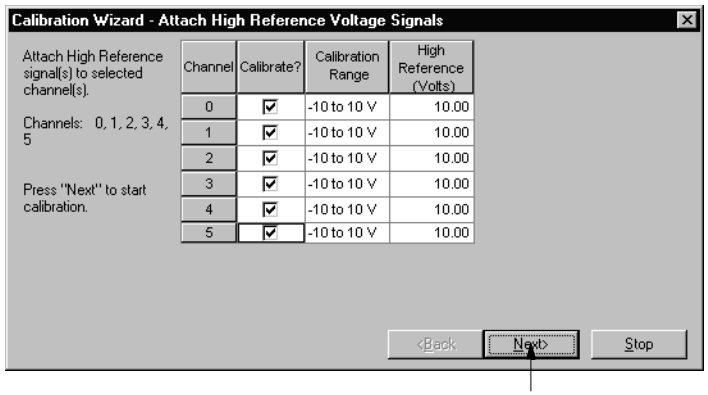
6. Set the channels to be calibrated.



7. Set the calibrator for the high reference and apply it to the module.

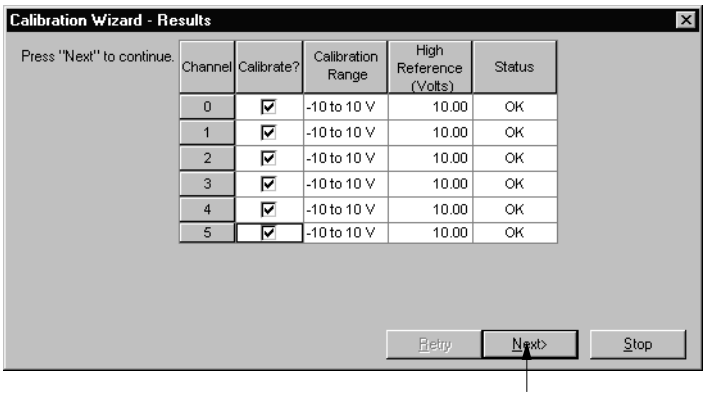
This screen shows which channels will be calibrated for a high reference and the range of that calibration.

It also shows what reference signal is expected at the input.



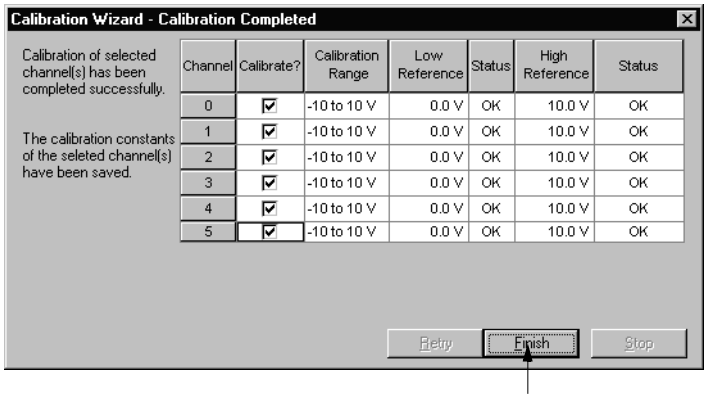
Click here to calibrate the high reference

This screen displays the status of each channel after calibrating for a high reference. If all channels are OK, continue, as shown below. If any channels report an Error, retry step 7 until the status is OK.



Click here to continue

After you have completed both low and high reference calibration, this screen shows the status of both.



Click here to finish calibration and return the module to normal operation

Calibrating the 1756-IR6I

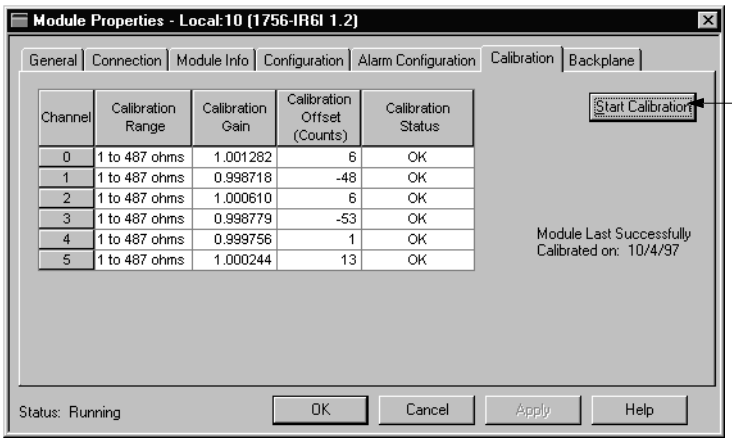
This module does not calibrate for voltage or current. It uses two precision resistors to calibrate the channels in ohms. You must connect a 1Ω precision resistor for low reference calibration and a 487Ω precision resistor for high reference calibration. The 1756-IR6I only calibrates in the 1-487Ω range.

IMPORTANT When you are wiring precision resistors for calibration, follow the wiring example on page 6-20. Make sure terminals IN-x/B and RTN-x/C are shorted together at the RTB.

While you are online, you must access the modules' properties page. To see how to reach this page, see page 10-17.

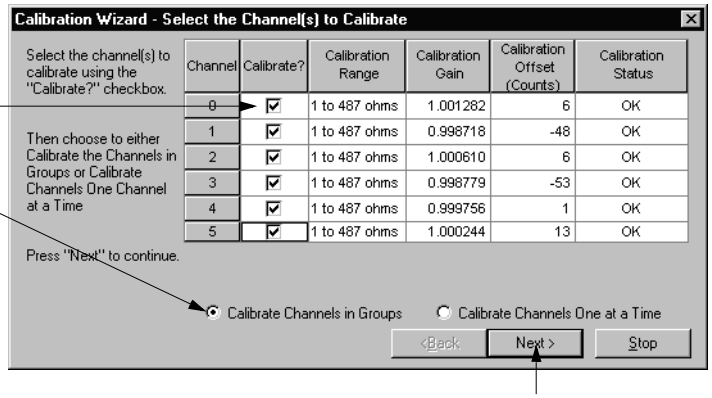
Follow these steps:

1. Go to the Calibration page. (Click on the tab for this page.)



IMPORTANT Regardless of what ohms application range is selected prior to calibration, the 1756-IR6I only calibrates in the 1-487Ω range.

2. Set the channels to be calibrated.



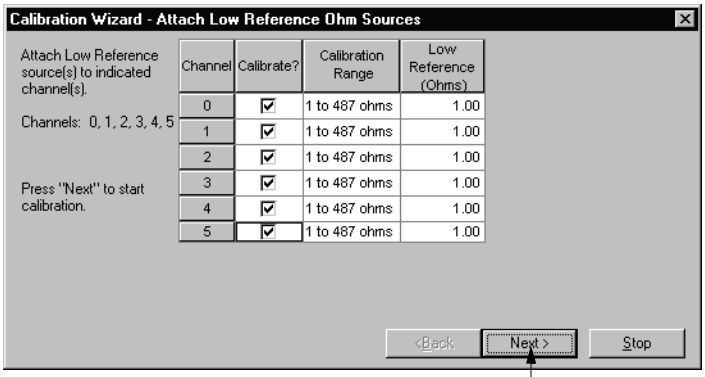
A. Choose the channels you want to calibrate here

B. Choose whether you want to calibrate channels in groups or one at a time here

C. Click here to continue

The low reference screen appears first.

3. Connect a 1Ω resistor to each channel being calibrated.

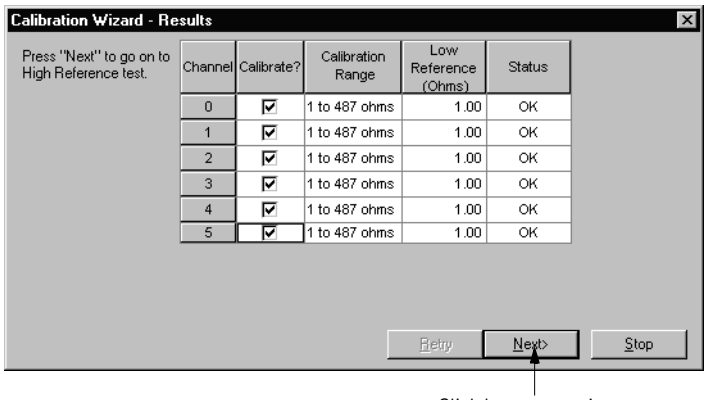


This screen shows which channels will be calibrated for a low reference and the range of that calibration.

It also shows what reference signal is expected on the input.

Click here to calibrate the low reference

This screen displays the status of each channel after calibrating for a low reference. If all channels are OK, continue, as shown below. If any channels report an Error, retry step 3 until the status is OK.



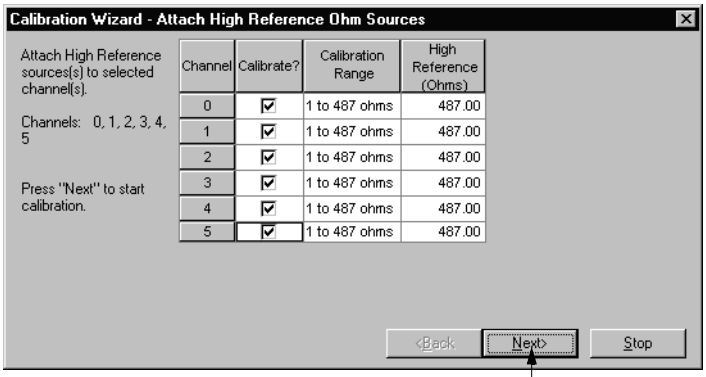
Click here to continue

Now you must calibrate each channel for a high reference.

4. Connect a 487Ω resistor to each channel being calibrated.

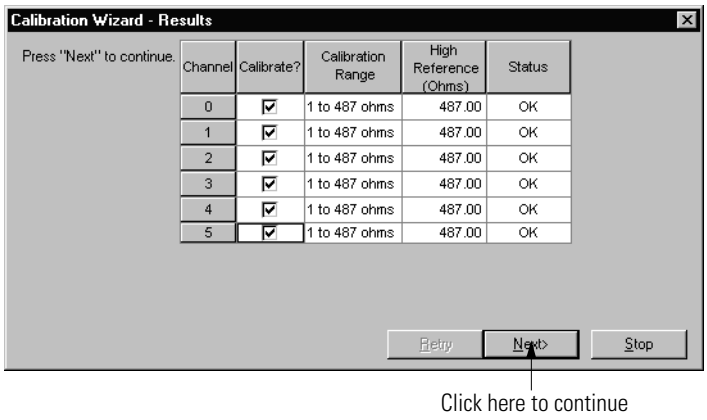
This screen shows which channels will be calibrated for a high reference and the range of that calibration.

It also shows what reference signal is expected on the input.

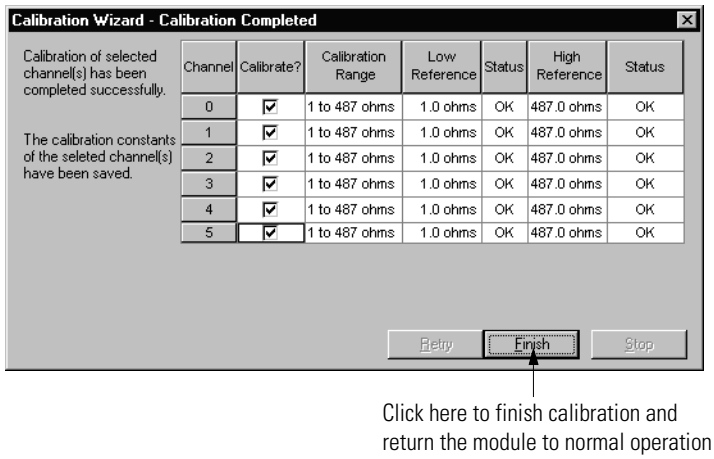


Click here to calibrate the high reference

This screen displays the status of each channel after calibrating for a high reference. If all channels are OK, continue, as shown below. If any channels report an Error, retry step 4 until the status is OK.



After you have completed both low and high reference calibration, this screen shows the status of both and allows you to finish the calibration process and return to normal operation.



Calibrating the 1756-IT6I or 1756-IT6I2

This module only calibrates in millivolts. You can calibrate the module to either a -12 to +30mV range or -12 to +78mV range, depending upon your specific application.

Calibrating the 1756-IT6I or 1756-IT6I2 for a -12mV to 30mV Range

This example shows the steps for calibrating a 1756-IT6I module for a -12mV to 30mV range. Use the same steps to calibrate for a -12mV to 78mV range.

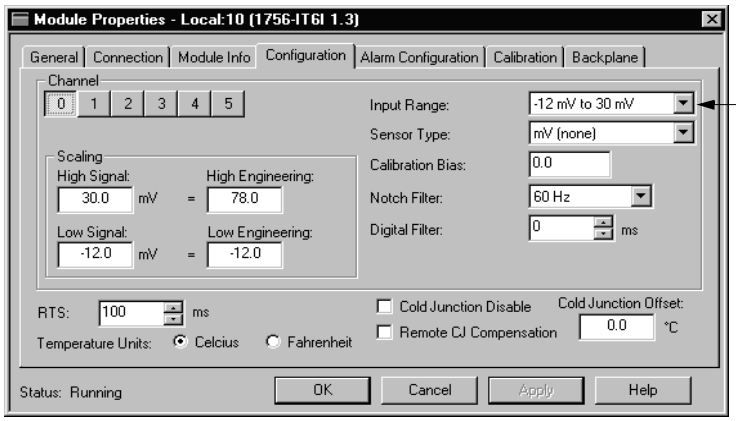
While you are online, you must access the modules' properties page. To see how to reach this page, see page 10-17.

Follow these steps:

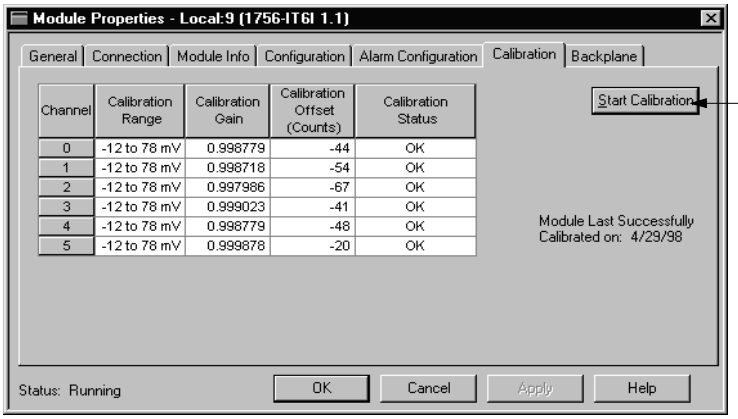
1. Connect your voltage calibrator to the module.

2. Go to the Configuration page.

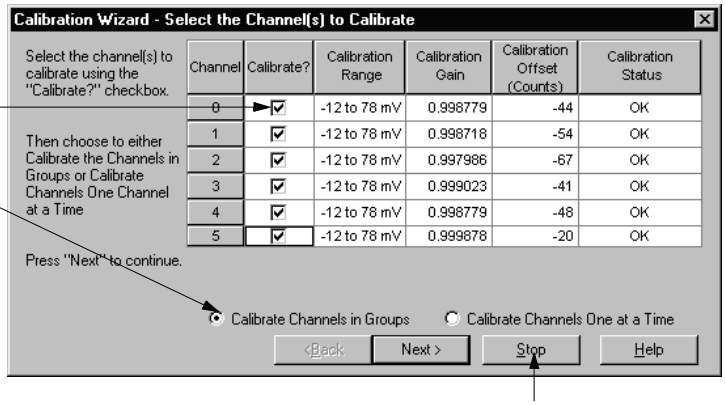
IMPORTANT: The input range selected prior to calibration is the range in which the module will calibrate.



3. Go to the Calibration page. (Click on the tab for this page.)



4. Set the channels to be calibrated.



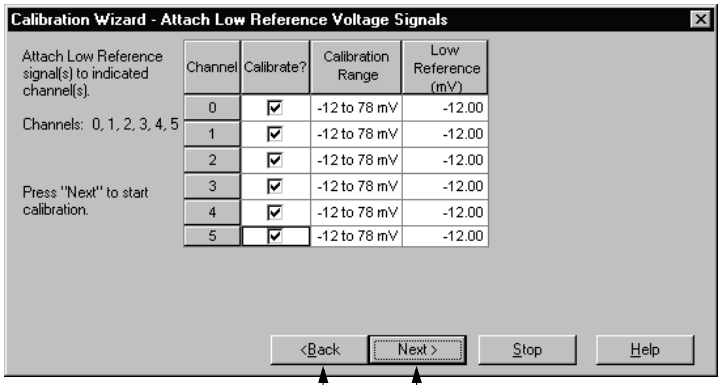
A. Choose the channels you want to calibrate here

B. Choose whether you want to calibrate channels in groups or one at a time here

C. Click here to continue

The low reference screen appears first.

5. Set the calibrator for the low reference and apply it to the module.



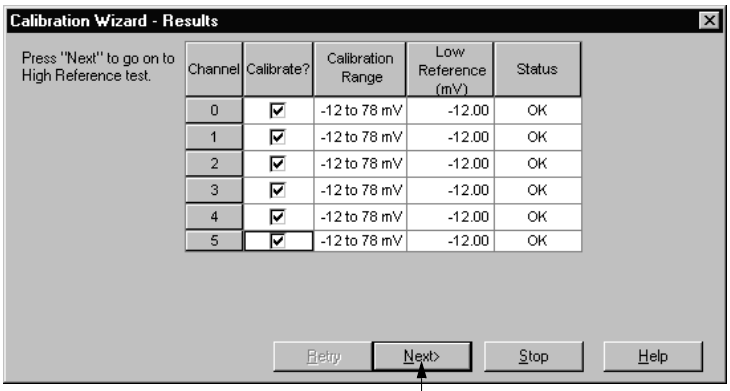
This screen shows which channels will be calibrated for a low reference and the range of that calibration.

It also shows what reference signal is expected on the input.

Click here to return to the last screen and make any necessary changes

Click here to calibrate the low reference

This screen displays the status of each channel after calibrating for a low reference. If all channels are OK, continue, as shown below. If any channels report an Error, retry step 5 until the status is OK.

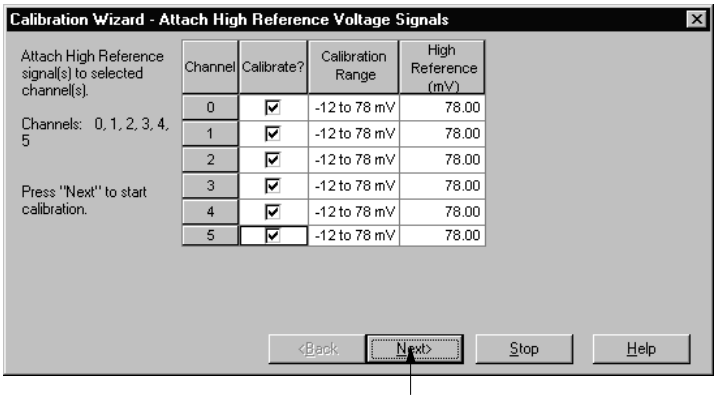


Now you must calibrate each channel for a high reference voltage.

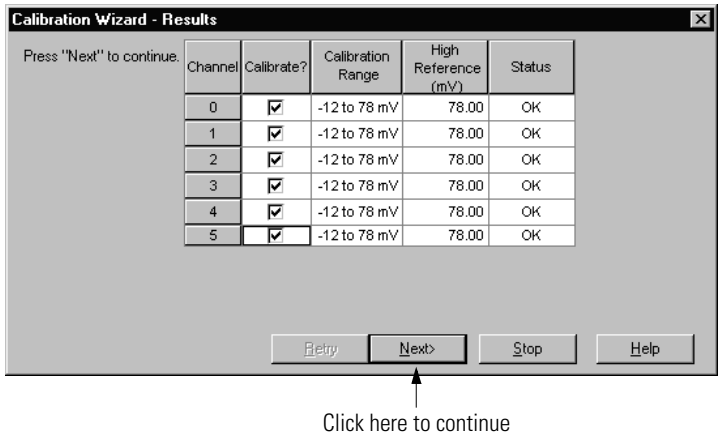
6. Set the calibrator for the high reference and apply it to the module.

This screen shows which channels will be calibrated for a high reference and the range of that calibration.

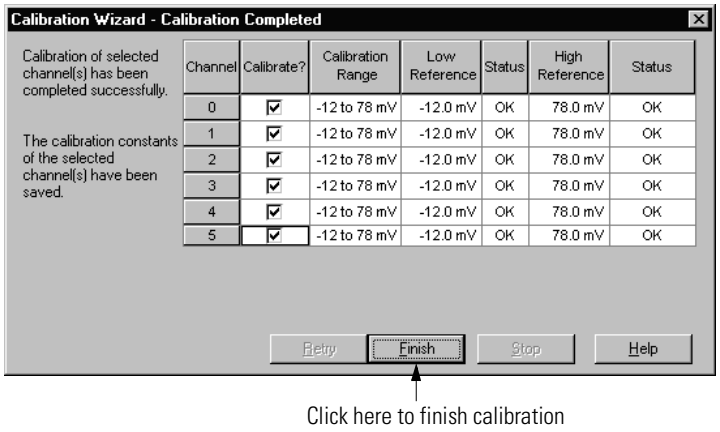
It also shows what reference signal is expected on the input.



This screen displays the status of each channel after calibrating for a high reference. If all channels are OK, continue, as shown below. If any channels report an Error, retry step 6 until the status is OK.



After you have completed both low and high reference calibration, this screen shows the status of both and allows you to finish the calibration process and return to normal operation.



Calibrating Output Modules

Output calibration is a multi-step process that involves measuring a signal from the module. This section has three parts.

Table 11.3 lists the catalog numbers covered in this section:

Table 11.3

For information about:	See page:
Calibrating the 1756-OF4 or 1756-OF8 Modules	11-22
Calibrating the 1756-OF6CI	11-27
Calibrating the 1756-OF6VI	11-31

Calibrating the 1756-OF4 or 1756-OF8 Modules

The 1756-OF4 and 1756-OF8 modules can be used for current or voltage applications.

Current applications

RSLogix 5000 commands the module to output specific levels of current. You must measure the actual level and record the results. This measurement allows the module to account for any inaccuracies.

Click here to start calibration

Voltage applications

RSLogix 5000 commands the module to output specific levels of voltage. You must measure the actual level and record the results. This measurement allows the module to account for any inaccuracies.

IMPORTANT This example shows a module calibrated for a current application. Use the same steps to calibrate for voltage.

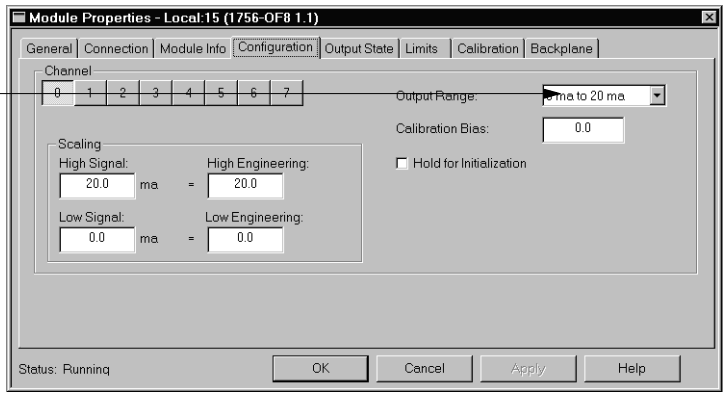
While you are online, you must access the modules' properties page. To see how to reach this page, see page 10-17.

Follow these steps:

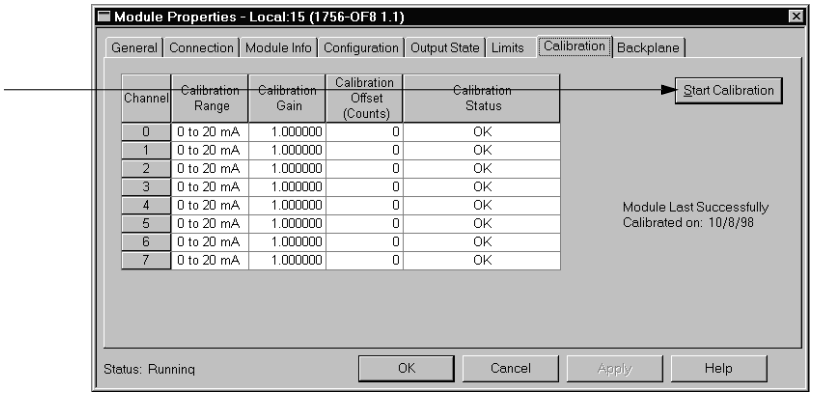
1. Connect your current meter to the module.

2. Go to the Configuration page. (Click on the tab for this page.)

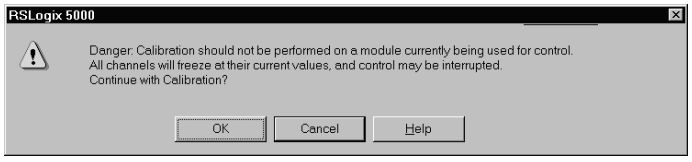
Use this pull-down menu to choose the Output Range to which you want to calibrate



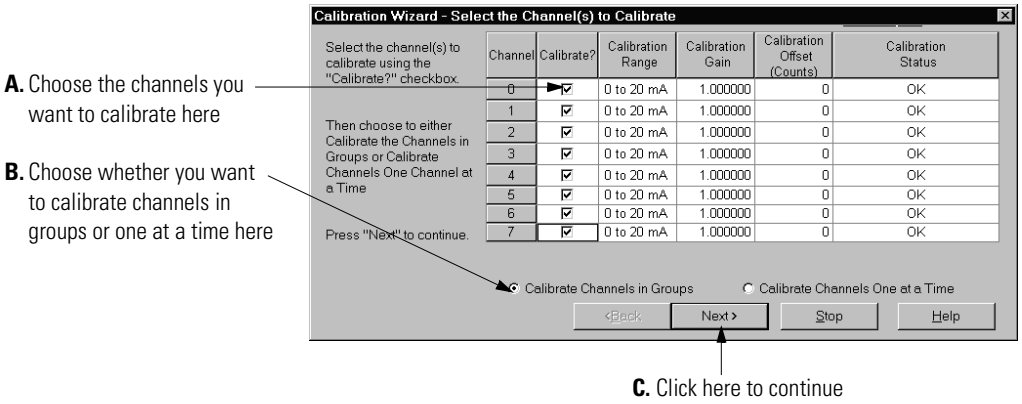
3. Go to the Calibration page. (Click on the tab for this page.)



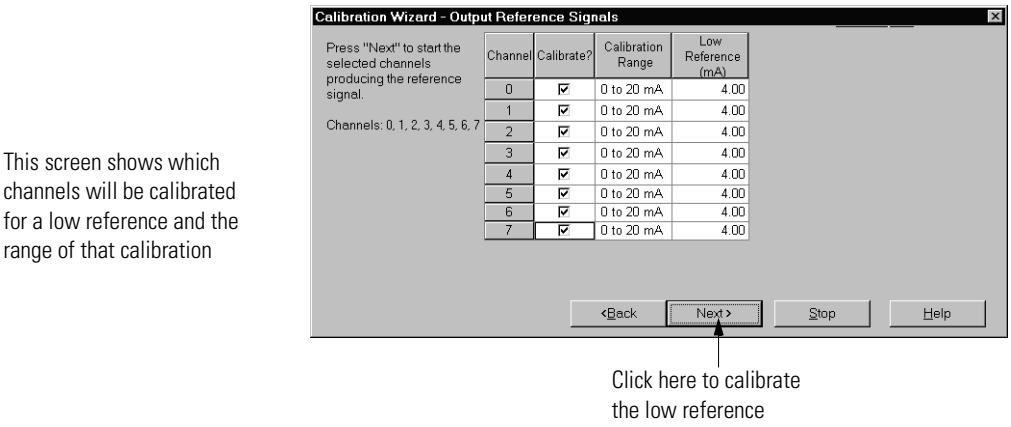
If your module is not in Program Mode, you see this warning. You must manually change the module to program mode before clicking on Yes.



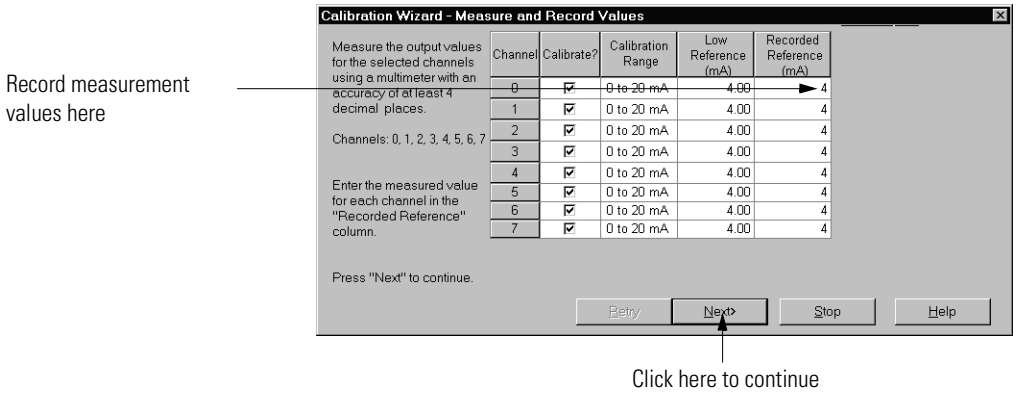
4. Set the channels to be calibrated.



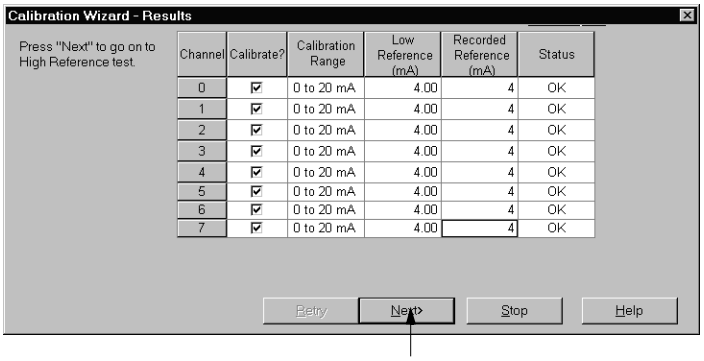
The low reference screen appears first.



5. Record the results of your measurement.



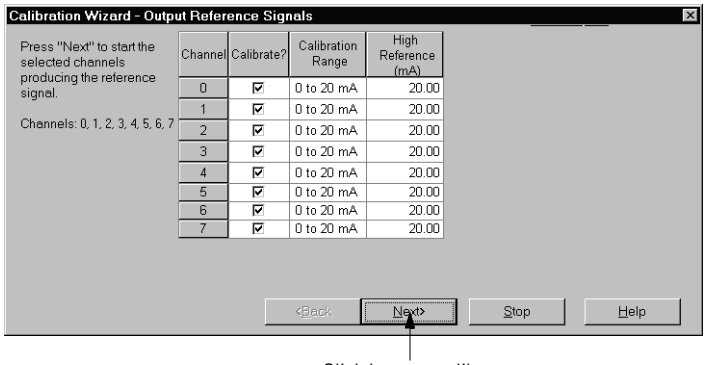
This screen displays the status of each channel after calibrating for a low reference. If all channels are OK, continue, as shown below. If any channels report an Error, return to step 4 until the status is OK.



Now you must calibrate each channel for a high reference voltage.

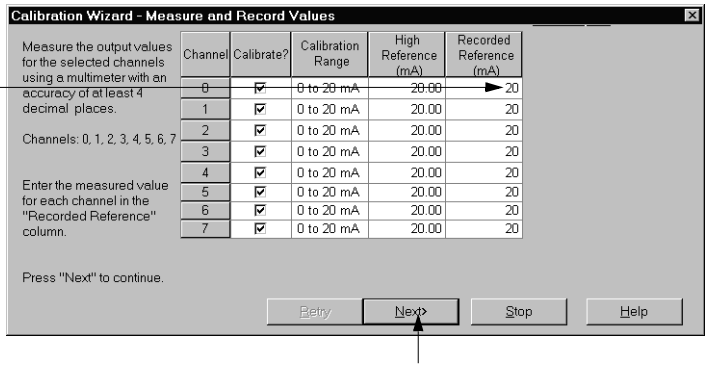
6. Set the channels to be calibrated.

This screen shows which channels will be calibrated for a high reference and the range of that calibration

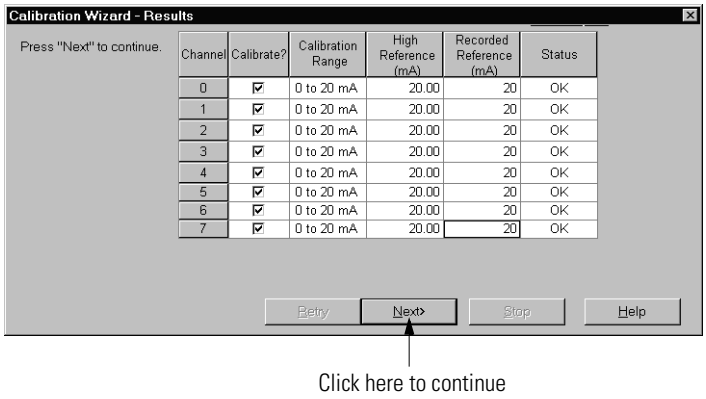


7. Record the measurement.

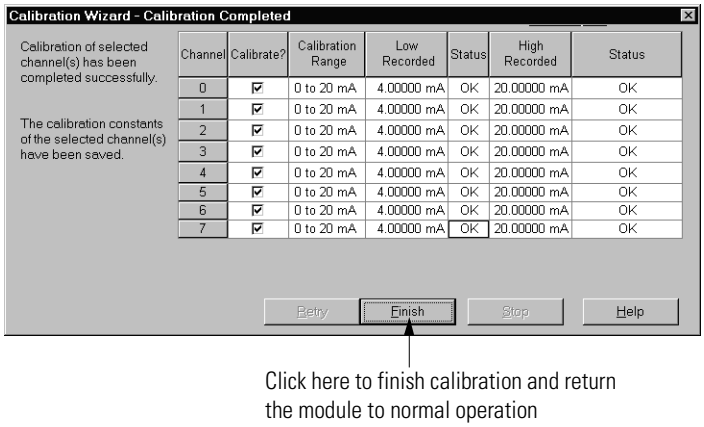
Record measurement values here



This screen displays the status of each channel after calibrating for a high reference. If all channels are OK, continue, as shown below. If any channels report an Error, return to step 6 until the status is OK.



After you have completed both low and high reference calibration, this screen shows the status of both and allows you to finish the calibration process and return to normal operation.



Calibrating the 1756-OF6CI

This module must be calibrated for current. RSLogix 5000 commands the module to output specific levels of current. You must measure the actual level and record the results. This measurement allows the module to account for any inaccuracies.

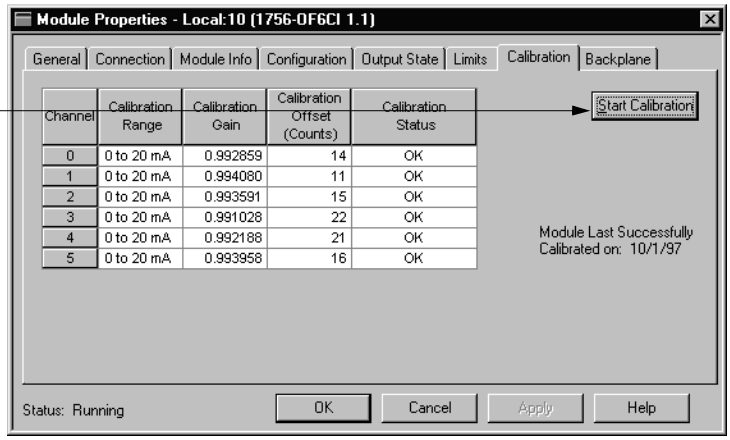
While you are online, you must access the modules' properties page. To see how to reach this page, see page 10-17.

Follow these steps:

1. Connect your current meter to the module.

2. Go to the Calibration page. (Click on the tab for this page.)

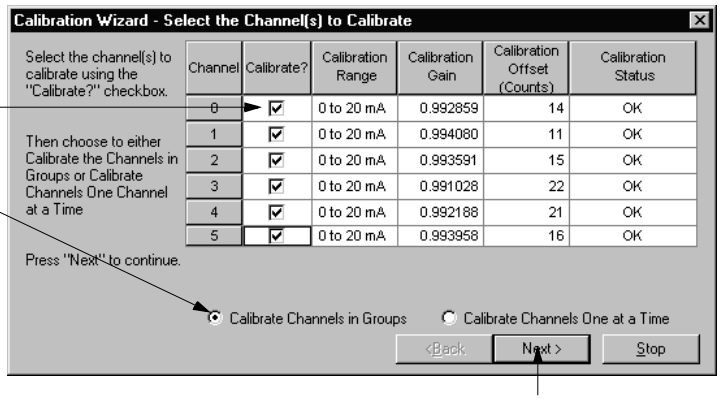
Click here to start calibration



3. Set the channels to be calibrated.

A. Choose the channels you want to calibrate here

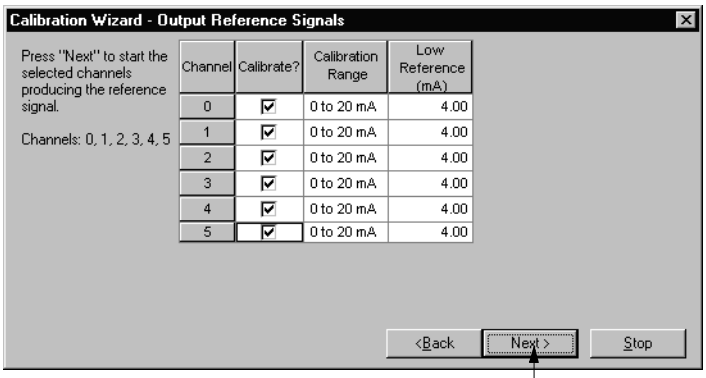
B. Choose whether you want to calibrate channels in groups or one at a time here



C. Click here to continue

The low reference screen appears first.

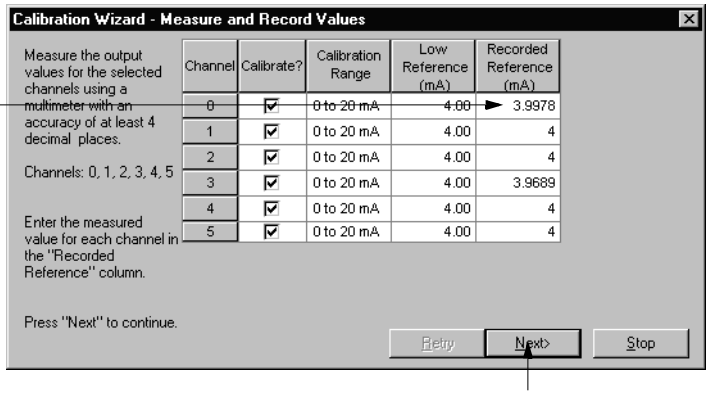
This screen shows which channels will be calibrated for a low reference and the range of that calibration



Click here to calibrate the low reference

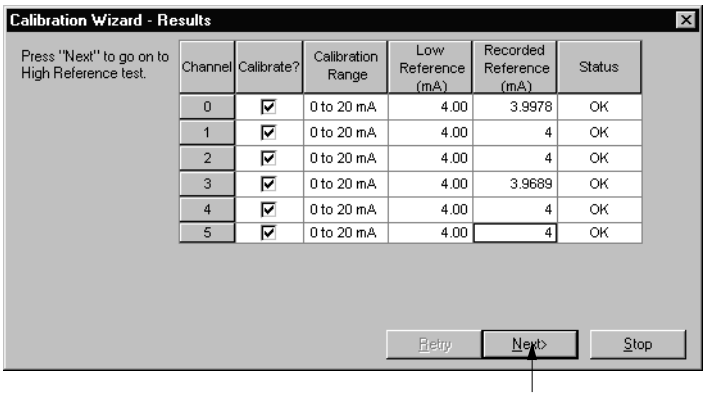
4. Record the results of your measurement.

Record measurement values here



Click here to continue

This screen displays the status of each channel after calibrating for a low reference. If all channels are OK, continue, as shown below. If any channels report an Error, return to step 3 until the status is OK.

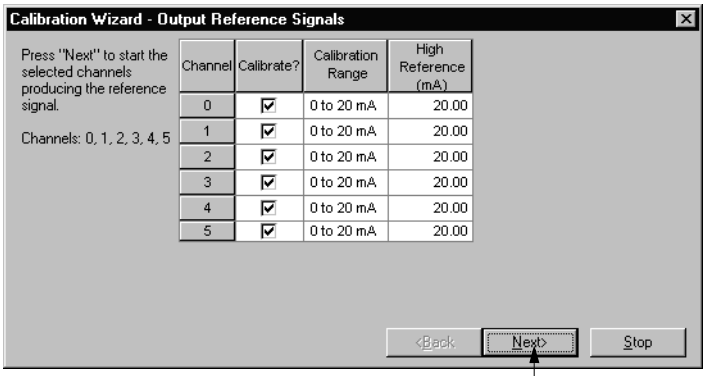


Click here to continue

Now you must calibrate each channel for a high reference voltage.

5. Set the channels to be calibrated.

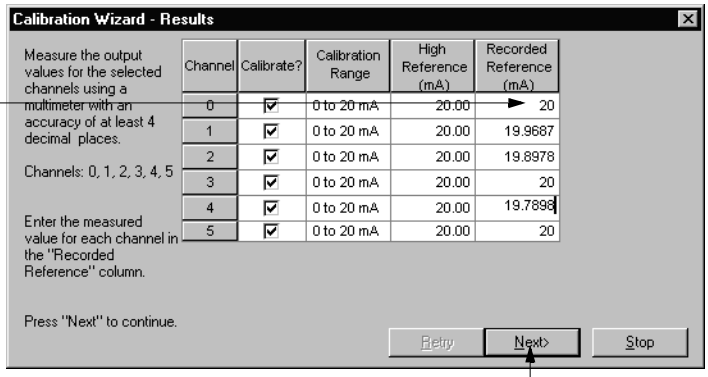
This screen shows which channels will be calibrated for a high reference and the range of that calibration



Click here to calibrate the high reference

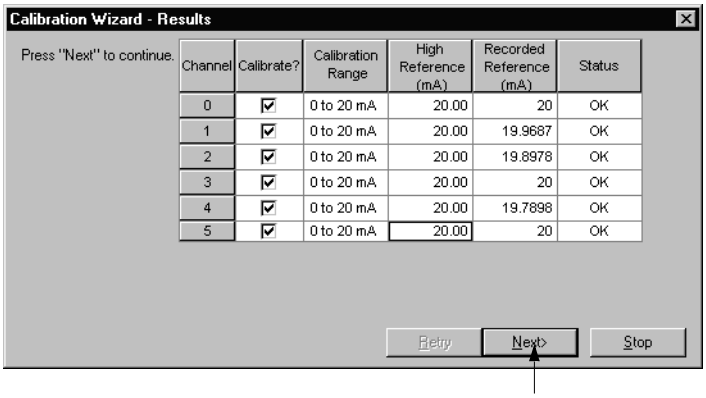
6. Record the measurement.

Record measurement values here

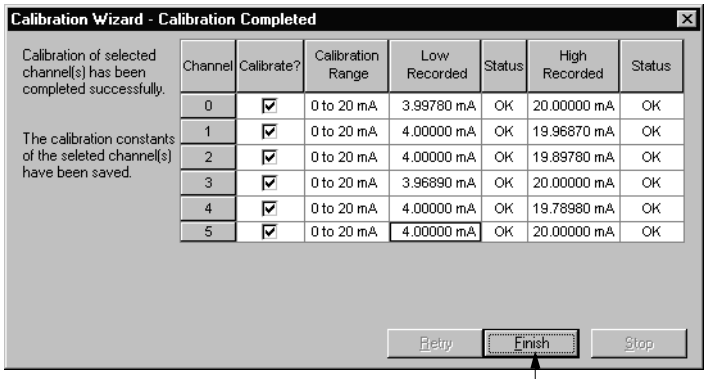


Click here to continue

This screen displays the status of each channel after calibrating for a high reference. If all channels are OK, continue, as shown below. If any channels report an Error, return to step 5 until the status is OK.



After you have completed both low and high reference calibration, this screen shows the status of both and allows you to finish the calibration process and return to normal operation.



Calibrating the 1756-OF6VI

This module must be calibrated for voltage. RSLogix 5000 commands the module to output specific levels of voltage. You must measure the actual level and record the results. This measurement allows the module to account for any inaccuracies.

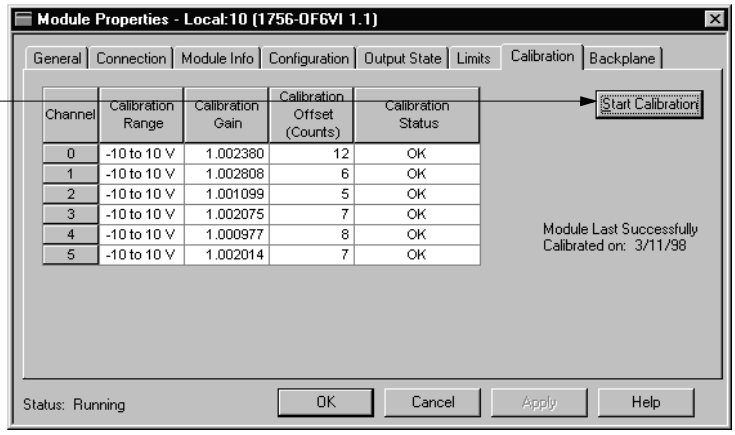
While you are online, you must access the modules' properties page. To see how to reach this page, see page 10-17.

Follow these steps:

1. Connect your voltage meter to the module.

2. Go to the Calibration page. (Click on the tab for this page.)

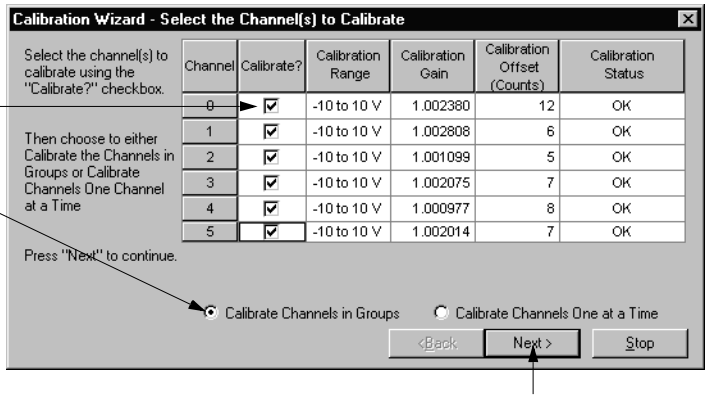
Click here to start calibration



3. Set the channels to be calibrated.

A. Choose the channels you want to calibrate here

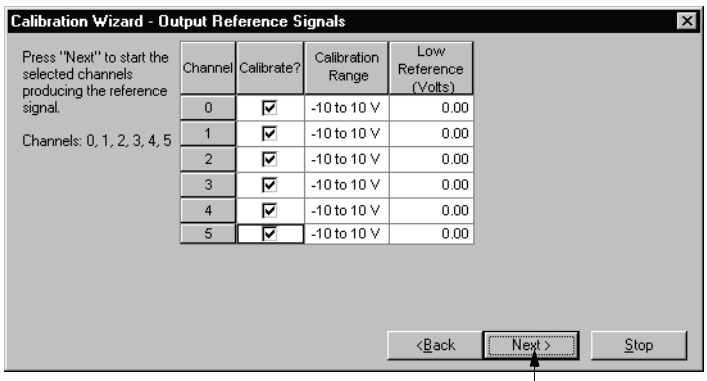
B. Choose whether you want to calibrate channels in groups or one at a time here



C. Click here to continue

The low reference screen appears first.

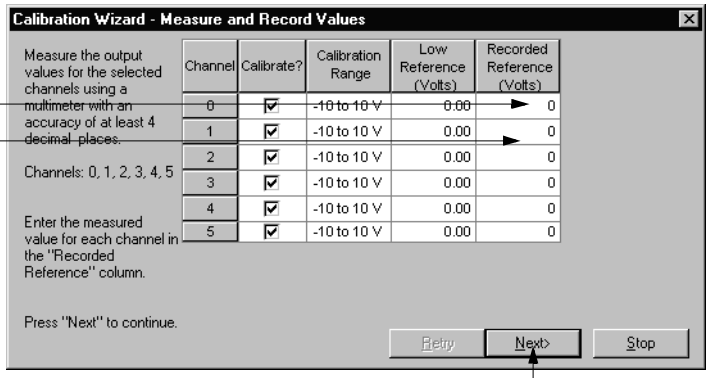
This screen shows which channels will be calibrated for a low reference and the range of that calibration



Click here to calibrate the low reference

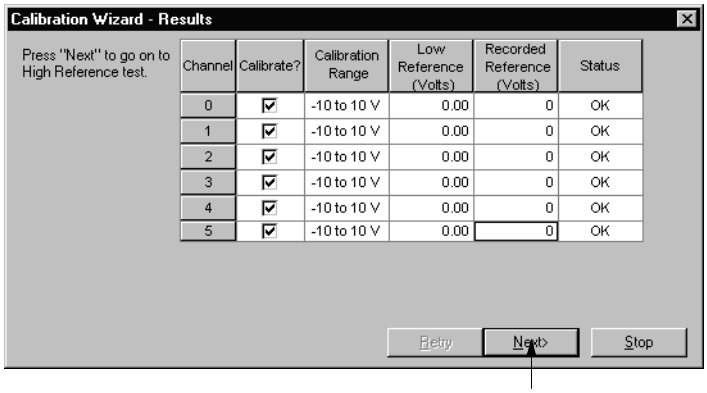
4. Record the results of your measurement.

Record measurement values here



Click here to continue

This screen displays the status of each channel after calibrating for a low reference. If all channels are OK, continue, as shown below. If any channels report an Error, return to step 3 until the status is OK.

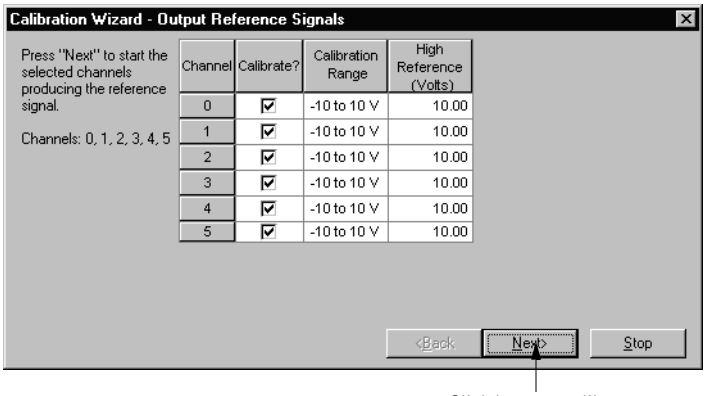


Click here to continue

Now you must calibrate each channel for a high reference voltage.

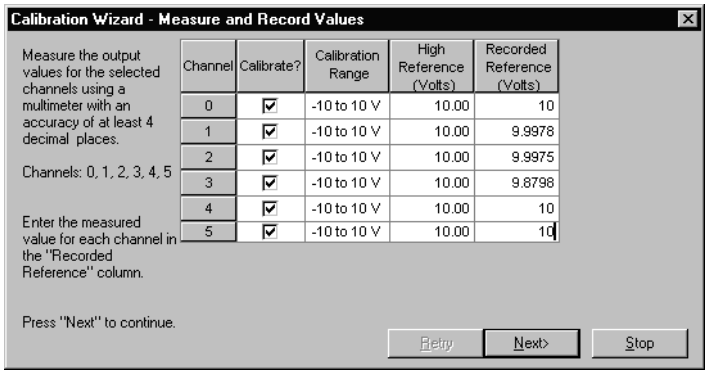
5. Set the channels to be calibrated.

This screen shows which channels will be calibrated for a high reference and the range of that calibration

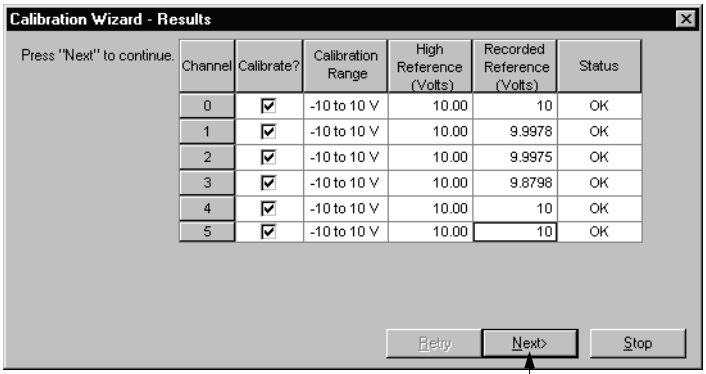


Click here to calibrate the high reference

6. Record the measurement.

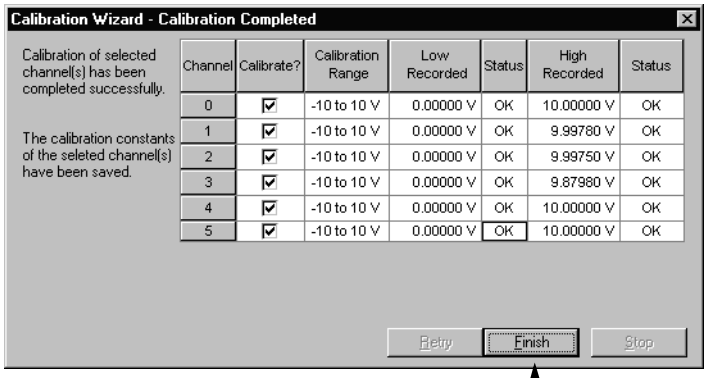


This screen displays the status of each channel after calibrating for a high reference. If all channels are OK, continue, as shown below. If any channels report an Error, return to step 5 until the status is OK.



Click here to continue

After you have completed both low and high reference calibration, this screen shows the status of both and allows you to finish the calibration process and return to normal operation.



Chapter Summary and What's Next

In this chapter, you read about Calibrating the ControlLogix Analog I/O Modules.

Chapter 12 describes Troubleshooting Your ControlLogix Analog I/O Module.

Troubleshooting Your ControlLogix Analog I/O Module

Chapter Objectives

This chapter describes the indicators on ControlLogix analog I/O modules, and how to use them in troubleshooting.

For information about:	See page:
Using Module Indicators to Troubleshoot Your Module	12-1
Using RSLogix 5000 to Troubleshoot Your Module	12-3

Using Module Indicators to Troubleshoot Your Module

Each ControlLogix analog I/O module has indicators that display module status. Table 12.1 lists the indicators used on ControlLogix analog input modules:

Table 12.1 LED Indicators for Input Modules

LED indicators:	This display:	Means:	Take this action:
OK	Steady green light	The inputs are being multicast and in normal operating state.	None
OK	Flashing green light	The module has passed internal diagnostics but is not currently performing connected communication.	None
OK	Flashing red light	Previously established communication has timed out.	Check controller and chassis communication
OK	Steady red light	The module must be replaced.	Replace the module.
CAL	Flashing green light	The module is in calibration mode.	Finish calibration

Figure 12.1 shows the LED display used with input modules.

Figure 12.1

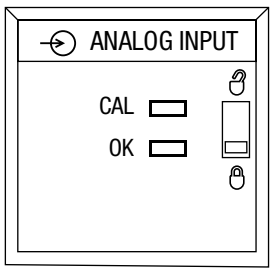


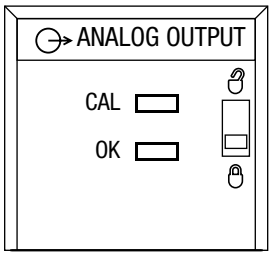
Table 12.2 lists the indicators used on ControlLogix analog output modules:

Table 12.2 LED Indicators for Output Modules

LED indicators:	This display:	Means:	Take this action:
OK	Steady green light	The outputs are in a normal operating state in Run Mode.	None
OK	Flashing green light	Either: • the module has passed internal diagnostics and is not actively controlled or • a connection is open and the controller is in program mode.	None
OK	Flashing red light	Previously established communication has timed out.	Check controller and chassis communication
OK	Steady red light	The module must be replaced.	Replace the module.
CAL	Flashing green light	The module is in calibration mode.	Finish calibration

Figure 12.2 shows the LED display used with analog output modules.

Figure 12.2

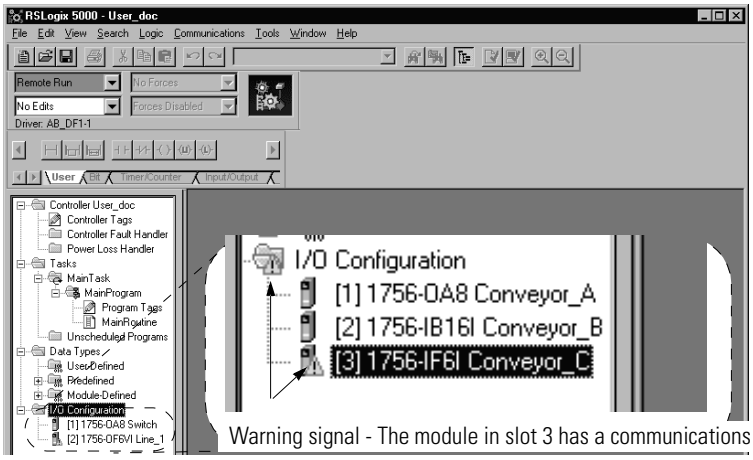


Using RSLogix 5000 to Troubleshoot Your Module

In addition to the LED display on the module, RSLogix 5000 alerts you to fault conditions. You will be alerted in one of three ways:

- Warning signal on the main screen next to the module-This occurs when the connection to the module is broken.

Warning icon when a communications fault occurs or if the module is inhibited

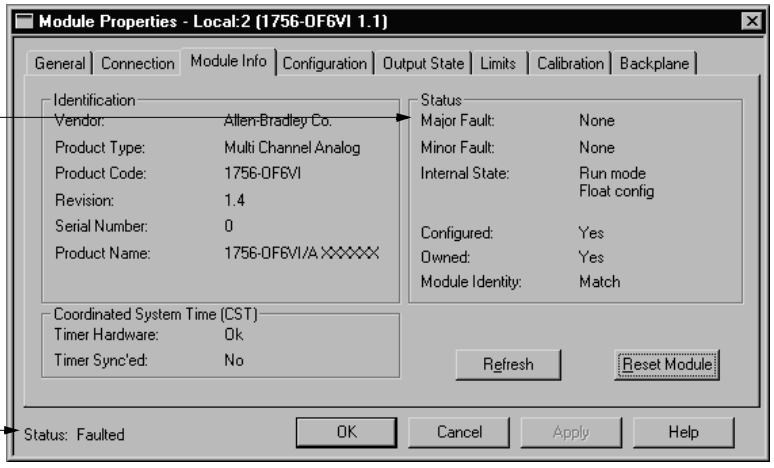


Warning signal - The module in slot 3 has a communications fault

- Fault message in a screen's status line

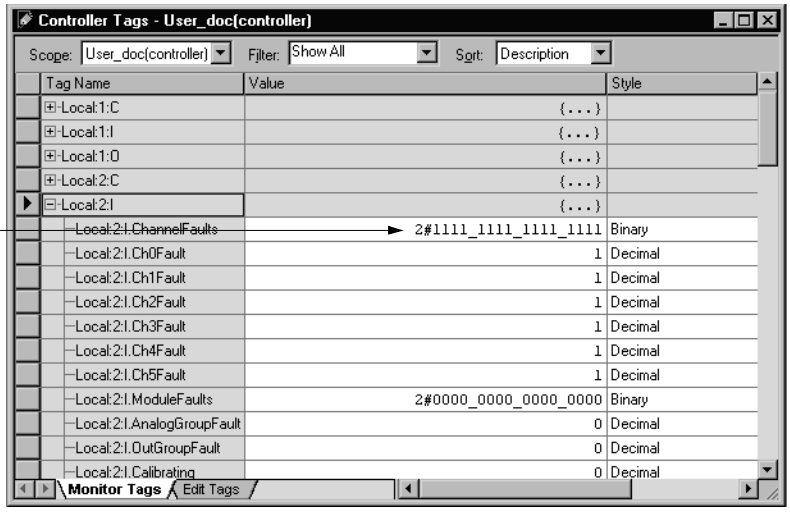
Status section lists Major and Minor Faults and the Internal State of the module

Status line provides information on the connection to the module



- Notification in the Tag Editor - General module faults are also reported in the Tag Editor. Diagnostic faults are only reported in the Tag Editor

A communication fault has occurred for any point that lists the number 1 in the Fault line

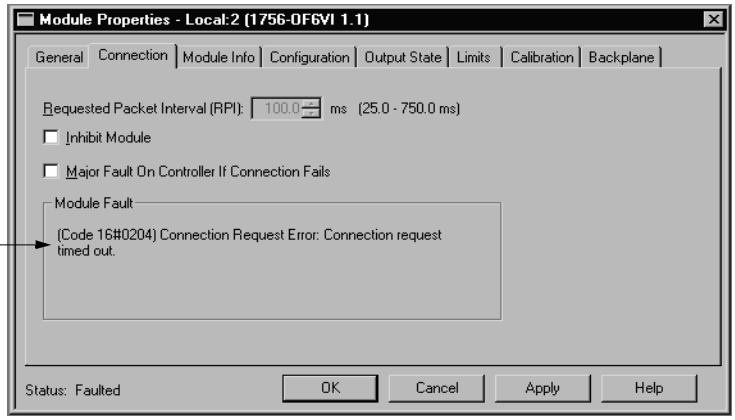


- Status on the Module Info Page

Determining Fault Type

When you are monitoring a module's configuration properties in RSLogix 5000 and receive a Communications fault message, the Connection page lists the type of fault.

The fault type is listed here



For a detailed listing of the possible faults, their causes and suggested solutions, see Module Faults in the online help.

Chapter Summary and What's Next

In this chapter you learned about troubleshooting the module.

Move on to Appendix A to see the Specifications for each module.

Specifications

Table A.1 lists where you can find specifications for the ControlLogix analog I/O modules.

Table A.1

For:	See page:
1756-IF16 Specifications	A-2
1756-IF6CIS Specifications	A-4
1756-IF6I Specifications	A-6
1756-IF8 Specifications	A-8
1756-IR6I Specifications	A-10
1756-IT6I Specifications	A-12
1756-IT6I2 Specifications	A-14
1756-OF4 Specifications	A-16
1756-OF6CI Specifications	A-18
1756-OF6VI Specifications	A-20
1756-OF8 Specifications	A-22

1756-IF16 Specifications

Number of Inputs	16 single ended, 8 differential or 4 differential (high speed)
Module Location	1756 ControlLogix Chassis
Backplane Current	150mA @ 5.1V dc & 65mA @ 24V dc
Backplane Power	2.33W
Power Dissipation within Module	2.3W – Voltage 3.9W – Current
Thermal Dissipation	7.84 BTU/hr. – Voltage 13.30 BTU/hr. – Current
Input Range and Resolution	+/-10.25V – 320μV/count (15 bits plus sign bipolar) 0-10.25V – 160μV/count (16 bits) 0-5.125V – 80μV/count (16 bits) 0-20.5mA – 0.32μA/count (16 bits)
Common Mode Voltage Range	+/- 10.25V (20.5V between any two input terminals)
Data Format	Left justified, 2s complement – Integer mode IEEE 32 bit – Floating point mode
Input Impedance	>1megΩ – Voltage 249Ω – Current
Open Circuit Detection Time	Positive full scale reading within 5s – Differential Voltage Negative full scale reading within 5s – Single-ended/Differential Current Even numbered channels go to positive full scale reading within 5s, odd numbered channels go to negative full scale reading within 5s – Single-ended voltage
Overvoltage Protection	30V dc – Voltage 8V dc – Current
Normal Mode Noise Rejection[1]	>80dB at 50/60Hz
Common Mode Noise Rejection	>100dB at 50/60Hz
Calibrated Accuracy	Better than 0.05% of range – Voltage Better than 0.15% of range – Current
Calibration Interval	12 months
Input Offset Drift with Temperature	90μV/°C
Gain Drift with Temperature	15 ppm/°C – Voltage 307.5μV/°C for +/-10.25V range; 153.8μV/°C for 0-10.25V range; 76.9μV/°C for 0-5.125V range 20 ppm/°C – Current +/-0.41μA/°C
Module Error over Full Temperature Range[2]	0.1% of range – Voltage 0.3% of range – Current
Module Conversion Method	Sigma-Delta
Isolation Voltage User to system	 250V 100% tested at 2550V dc for 1s
Module Scan Time for All Channels (Sample Rate Module Filter Dependent)	16-488ms – 16-point single ended 8-244ms – 8-point differential 5-122ms – 4-point differential -
RTB Screw Torque (Cage clamp)	4.4 inch-pounds (0.4Nm)
Module Keying (Backplane)	Electronic
RTB Keying	User defined
Field Wiring Arm and Housing	36 Position RTB (1756-TBCH or TBS6H)[3]

Environmental Conditions	
Operating Temperature	IEC 60068-2-1 (Test Ad, Operating Cold), IEC 60068-2-2 (Test Bd, Operating Dry Heat), IEC 60068-2-14 (Test Nb, Operating Thermal Shock): 0 to 60°C (32 to 140°F)
Storage Temperature	IEC 60068-2-1 (Test Ab, Un-packaged Non-operating Cold), IEC 60068-2-2 (Test Bb, Un-packaged Non-operating Dry Heat), IEC 60068-2-14 (Test Na, Un-packaged Non-operating Thermal Shock): –40 to 85°C (–40 to 185°F)
Relative Humidity	IEC 60068-2-30 (Test Db, Un-packaged Non-operating Damp Heat): 5 to 95% non-condensing
Vibration	IEC60068-2-6 (Test Fc, Operating): 2g @ 10-500Hz
Shock	IEC60068-2-27 (Test Ea, Unpackaged shock): Operating 30g Non-operating 50g
Emissions	CISPR 11: Group 1, Class A
ESD Immunity	IEC 61000-4-2: 6kV contact discharges 8kV air discharges
Radiated RF Immunity	IEC 61000-4-3: 10V/m with 1kHz sine-wave 80%AM from 30MHz to 1000MHz 10V/m with 200Hz 50% Pulse 100%AM at 900Mhz
EFT/B Immunity	IEC 61000-4-4: ±2kV at 5kHz on signal ports
Surge Transient Immunity	IEC 61000-4-5: ±2kV line-earth (CM) on shielded ports
Conducted RF Immunity	IEC 61000-4-6: 10Vrms with 1kHz sine-wave 80%AM from 150kHz to 80MHz
Enclosure Type Rating	None (open-style)
Conductors Wire Size Category	 #22 to #14 AWG (0.324 to 2.08 sq. mm) stranded [2] 3/64 inch (1.2mm) insulation maximum 2[4], [5]
Screwdriver Width for RTB	1/8 inch (3.2mm) maximum
Certifications (when product is marked)	UL — UL Listed Industrial Control Equipment CSA — CSA Certified Process Control Equipment CSA — CSA Certified Process Control Equipment for Class I, Division 2 Group A,B,C,D Hazardous Locations FM — FM Approved Equipment for use in Class I Division 2 Group A,B,C,D Hazardous Locations CE[6] — European Union 89/336/EEC EMC Directive, compliant with: EN 50082-2; Industrial Immunity EN 61326; Meas./Control/Lab., Industrial Requirements EN 61000-6-2; Industrial Immunity EN 61000-6-4; Industrial Emissions C-Tick[5] — Australian Radiocommunications Act, compliant with: AS/NZS 2064; Industrial Emissions EEx[5] — European Union 94/9/EEC ATEX Directive, compliant with: EN 50021; Potentially Explosive Atmospheres, Protection "n"

(1) This specification is module filter dependent.

(2) For more information on this specification, see Appendix E.

(3) Maximum wire size requires the extended housing - 1756-TBE.

(4) Use this conductor category information for planning conductor routing as described in the system level installation manual.

(5) Refer to publication 1770-4.1 *Industrial Automation Wiring and Grounding Guidelines*.

(6) See the Product Certification link at www.ab.com for Declarations of Conformity, Certificates, and other certification details.

1756-IF6CIS Specifications

Number of Inputs	6 points isolated
Module Location	ControlLogix Chassis
Backplane Current	250 mA @ 5.1V dc & 275 mA @ 24V dc
Backplane Power	7.9W
Module Power Dissipation	5.1W @ 60° C
Thermal Dissipation	17.4 BTU/hr.
Input Range	0-21mA (Over-range indication when exceeded)
Resolution 0-21mA	0.34μA/bit 16bit (15.9bits)
Data Format	Left justified, 2's complement – Integer Mode IEEE32 bit – Floating Point
Input Impedance	Approximately 215 ohm
Sourcing Voltage	20V dc minimum 30V dc maximum
Sourcing Current	Current limited to <30mA maximum
Open Circuit Detection Time	Zero reading within 5 seconds
Overvoltage Protection	30V AC/DC with PTC and Sense Resistor
Normal Mode Noise Rejection(1)	60dB at 60Hz
Common Mode Noise Rejection	120dB at 60Hz, 100 dB at 50Hz
Channel Bandwidth(1)	3-262Hz (-3dB)
Settling Time to % of Full Scale(1)	5% of FS: <80 milliseconds
Calibrated Accuracy(2) Typical Worst case	 Better than 0.025% of range Better than 0.1% of range
Calibration Interval	12 months
Input Offset Drift with Temperature	200nA/°C
Gain Drift with Temperature(2) Typical Worst Case	 17 ppm/°C 0.36μA/°C 35 ppm/°C 0.74μA/°C
Module Error over Full Temperature Range(2)	0.2% of range
Module Scan Time for all Channels (Sample Rate)	25 milliseconds minimum – Floating Point Mode 10 milliseconds minimum – Integer Mode
Isolation Voltage Channel to channel User to system	Optically Isolated, Transformer Coupled 250V 100% tested at 1900V dc for 2 s 250V 100% tested at 1900V dc for 2 s
Module Conversion Method	Sigma-Delta
RTB Screw Torque (NEMA clamp)	7-9 inch-lbs (.8 to 1Nm)
Module Keying (Backplane)	Electronic
RTB Keying	User defined
RTB and Housing	20 Position RTB (1756-TBNH or TBSH)(3)

Conductors Wire Size Category	 #22 to #14 AWG (0.324 to 2.08 sq. mm) stranded[2] 3/64 inch (1.2mm) insulation maximum 2[4], [5]
Screwdriver Blade Width for RTB	5/16 inch (8mm) maximum
Environmental Conditions	
Operating Temperature	IEC 60068-2-1 (Test Ad, Operating Cold), IEC 60068-2-2 (Test Bd, Operating Dry Heat), IEC 60068-2-14 (Test Nb, Operating Thermal Shock): 0 to 60°C (32 to 140°F)
Storage Temperature	IEC 60068-2-1 (Test Ab, Un-packaged Non-operating Cold), IEC 60068-2-2 (Test Bb, Un-packaged Non-operating Dry Heat), IEC 60068-2-14 (Test Na, Un-packaged Non-operating Thermal Shock): -40 to 85°C (-40 to 185°F)
Relative Humidity	IEC 60068-2-30 (Test Db, Un-packaged Non-operating Damp Heat): 5 to 95% non-condensing
Vibration	IEC 60068-2-6 (Test Fc, Operating): 2g @ 10-500Hz
Operating Shock	IEC 60068-2-27 (Test Ea, Unpackaged Shock): 30g
Non-operating Shock	IEC 60068-2-27 (Test Ea, Unpackaged Shock): 50g
Emissions	CISPR 11: Group 1, Class A
ESD Immunity	IEC 61000-4-2: 6kV contact discharges 8kV air discharges
Radiated RF Immunity	IEC 61000-4-3: 10V/m with 1kHz sine-wave 80%AM from 30MHz to 2000MHz 10V/m with 200Hz 50% Pulse 100%AM at 900Mhz
EFT/B Immunity	IEC 61000-4-4: ±2kV at 5kHz on signal ports
Surge Transient Immunity	IEC 61000-4-5: ±2kV line-earth(CM) on shielded ports
Conducted RF Immunity	IEC 61000-4-6: 10Vrms with 1kHz sine-wave 80%AM from 150kHz to 80MHz
Enclosure Type Rating	None (open-style)
Certifications: (when product is marked)	UL — UL Listed Industrial Control Equipment CSA — CSA Certified Process Control Equipment CSA — CSA Certified Process Control Equipment for Class I, Division 2 Group A,B,C,D Hazardous Locations CE[6] — European Union 89/336/EEC EMC Directive, compliant with: EN 50082-2; Industrial Immunity EN 61326; Meas./Control/Lab., Industrial Requirements EN 61000-6-2; Industrial Immunity EN 61000-6-4; Industrial Emissions C-Tick[5] — Australian Radiocommunications Act, compliant with: AS/NZS CISPR 11; Industrial Emissions

(1) These specifications are notch filter dependant.

(2) For more information on this specification, see Appendix E.

(3) Maximum wire size will require extended housing - 1756-TBE.

(4) Use this conductor category information for planning conductor routing as described in the system level installation manual.

(5) Refer to publication 1770-4.1 *Industrial Automation Wiring and Grounding Guidelines*.

(6) See the Product Certification link at www.ab.com for Declarations of Conformity, Certificates, and other certification details.

1756-IF6I Specifications

Number of Inputs	6 individually isolated channels
Module Location	1756 ControlLogix Chassis
Backplane Current (No module external power requirements)	250mA @5.1V dc & 100mA @ 24V dc
Backplane Power	3.7W
Power Dissipation within Module	3.7W - Voltage 4.3W - Current
Thermal Dissipation	12.62 BTU/hr. - Voltage 14.32 BTU/hr. - Current
Input Range	+/-10.5V, 0-10.5V, 0-5.25V, 0-21mA (overrange indication when exceeded)
Resolution +/-10.5V range 0 to 10.5V range 0 to 5.25V range 0-21mA range	Approximately 16 bits across each range shown below 343µV/count 171µV/count 86µV/count 0.34µA/count
Data Format	2s complement – Integer mode IEEE 32 bit – Floating point mode
Input Impedance	>10MΩ – Voltage 249Ω – Current
Open Circuit Detection Time	Positive full scale reading within 5s
Overvoltage Protection	120V ac/dc – Voltage 8V ac/dc with on-board current resistor – Current
Normal Mode Noise Rejection[1]	60dB at 60Hz
Common Mode Noise Rejection	120dB at 60Hz, 100dB at 50Hz
Channel Bandwidth[1]	15Hz (-3dB)
Settling Time to 5% of Full Scale[1]	<80ms
Calibrated Accuracy[2] Typical Worst case	 Better than 0.05% of range Better than 0.1% of range
Calibration Interval	12 months
Input Offset Drift with Temperature	2µV/°C
Gain Drift with Temperature[2] Typical Worst Case	 35 ppm/°C – Voltage 735µV/°C for +/-10.5V range; 367.5µV/°C for 0-10.5V range; 183.8µV/°C for 0-5.25V range 45 ppm/°C – Current +/-0.945µA/°C 80 ppm/°C – Voltage 1680µV/°C for +/-10.5V range; 840µV/°C for 0-10.5V range; 420µV/°C for 0-5.25V range 90 ppm/°C – Current +/-1.89µA/°C
Module Error over Full Temperature Range[2]	0.54% of range
Minimum Module Scan Time for all Channels (Sample Rate)[1]	25ms minimum – Floating Point Mode 10ms minimum – Integer Mode
Isolation Voltage Channel to channel User to system	Optoisolated, transformer isolated 100% tested at 1700V dc for 1s, based on 250V ac 100% tested at 1700V dc for 1s, based on 250V ac
Module Conversion Method	Sigma-Delta
Module Keying (Backplane)	Electronic
RTB Screw Torque (NEMA)	7-9 inch-pounds (0.8-1Nm)
RTB Keying	User defined
RTB and Housing	20 Position RTB (1756-TBNH or TBSH)[3]

Conductors Wire Size Category	 #22 to #14 AWG (0.324 to 2.08 sq. mm) stranded[3] 3/64 inch (1.2mm) insulation maximum 2[4], [5]
Screwdriver Blade Width for RTB	5/16 inch (8mm) maximum
Environmental Conditions	
Operating Temperature	IEC 60068-2-1 (Test Ad, Operating Cold), IEC 60068-2-2 (Test Bd, Operating Dry Heat), IEC 60068-2-14 (Test Nb, Operating Thermal Shock): 0 to 60°C (32 to 140°F)
Storage Temperature	IEC 60068-2-1 (Test Ab, Un-packaged Non-operating Cold), IEC 60068-2-2 (Test Bb, Un-packaged Non-operating Dry Heat), IEC 60068-2-14 (Test Na, Un-packaged Non-operating Thermal Shock): -40 to 85°C (-40 to 185°F)
Relative Humidity	IEC 60068-2-30 (Test Db, Un-packaged Non-operating Damp Heat): 5 to 95% non-condensing
Vibration	IEC 60068-2-6 (Test Fc, Operating): 2g @ 10-500Hz
Operating Shock	IEC 60068-2-27 (Test Ea, Unpackaged Shock): 30g
Non-operating Shock	IEC 60068-2-27 (Test Ea, Unpackaged Shock): 50g
Emissions	CISPR 11: Group 1, Class A
ESD Immunity	IEC 61000-4-2: 6kV contact discharges 8kV air discharges
Radiated RF Immunity	IEC 61000-4-3: 10V/m with 1kHz sine-wave 80%AM from 30MHz to 2000MHz 10V/m with 200Hz 50% Pulse 100%AM at 900Mhz
EFT/B Immunity	IEC 61000-4-4: ±2kV at 5kHz on signal ports
Surge Transient Immunity	IEC 61000-4-5: ±2kV line-earth(CM) on shielded ports
Conducted RF Immunity	IEC 61000-4-6: 10Vrms with 1kHz sine-wave 80%AM from 150kHz to 80MHz
Enclosure Type Rating	None (open-style)
Certifications: (when product is marked)	UL — UL Listed Industrial Control Equipment CSA — CSA Certified Process Control Equipment CSA — CSA Certified Process Control Equipment for Class I, Division 2 Group A,B,C,D Hazardous Locations CE[6] — European Union 89/336/EEC EMC Directive, compliant with: EN 50082-2; Industrial Immunity EN 61326; Meas./Control/Lab., Industrial Requirements EN 61000-6-2; Industrial Immunity EN 61000-6-4; Industrial Emissions C-Tick[5] — Australian Radiocommunications Act, compliant with: AS/NZS CISPR 11; Industrial Emissions

(1) These specifications are module filter dependent.

(2) For more information on this specification, see Appendix E.

(3) Maximum wire size will require extended housing - 1756-TBE.

(4) Use this conductor category information for planning conductor routing as described in the system level installation manual.

(5) Refer to publication 1770-4.1 *Industrial Automation Wiring and Grounding Guidelines*.

(6) See the Product Certification link at www.ab.com for Declarations of Conformity, Certificates, and other certification details.

1756-IF8 Specifications

Number of Inputs	8 single ended, 4 differential or 2 differential (high speed)
Module Location	1756 ControlLogix Chassis
Backplane Current	150mA @ 5.1V dc & 40mA @ 24V dc
Backplane Power	2.33W
Power Dissipation within Module	1.73W – Voltage 2.53W – Current
Thermal Dissipation	5.9 BTU/hr. – Voltage 8.6 BTU/hr. – Current
Input Range and Resolution	+/-10.25V – 320μV/count (15 bits plus sign bipolar) 0-10.25V – 160μV/count (16 bits) 0-5.125V – 80μV/count (16 bits) 0-20.5mA – 0.32μA/count (16 bits)
Common Mode Voltage Range	+/- 10.25V (20.5V between any two input terminals)
Data Format	Left justified, 2s complement – Integer mode IEEE 32 bit – Floating point mode
Input Impedance	>1megΩ – Voltage 249Ω – Current
Open Circuit Detection Time	Positive full scale reading within 5s – Differential Voltage Negative full scale reading within 5s – Single-ended/Differential Current Even numbered channels go to positive full scale reading within 5s, odd numbered channels go to negative full scale reading within 5s – Single-ended voltage
Overvoltage Protection	30V dc – Voltage 8V dc – Current
Normal Mode Noise Rejection[1]	>80dB at 50/60Hz
Common Mode Noise Rejection	>100dB at 50/60Hz
Calibrated Accuracy	Better than 0.05% of range – Voltage Better than 0.15% of range – Current
Calibration Interval	12 months
Input Offset Drift with Temperature	90μV/°C
Gain Drift with Temperature	15 ppm/°C – Voltage 307.5μV/°C for +/-10.25V range; 153.8μV/°C for 0-10.25V range; 76.9μV/°C for 0-5.125V range 20 ppm/°C – Current +/-0.41μA/°C
Module Error over Full Temperature Range[2]	0.1% of range – Voltage 0.3% of range – Current
Module Conversion Method	Sigma-Delta
Isolation Voltage User to system	 250V 100% tested at 2550 dc for 1s
Module Scan Time for All Channels (Sample Rate Module Filter Dependent)	16 to 488ms – 8-point single ended 8 to 244ms – 4-point differential 5 to 122ms – 2-point differential -
RTB Screw Torque (Cage clamp)	4.4 inch-pounds (0.4Nm)
Module Keying (Backplane)	Electronic
RTB Keying	User defined
Field Wiring Arm and Housing	36 Position RTB (1756-TBCH or TBS6H)[3]
Conductors Wire Size Category	 #22 to #14 AWG (0.324 to 2.08 sq. mm) stranded [2] 3/64 inch (1.2mm) insulation maximum 2[4], [5]
Screwdriver Width for RTB	1/8 inch (3.2mm) maximum

Environmental Conditions	
Operating Temperature	IEC 60068-2-1 (Test Ad, Operating Cold), IEC 60068-2-2 (Test Bd, Operating Dry Heat), IEC 60068-2-14 (Test Nb, Operating Thermal Shock): 0 to 60°C (32 to 140°F)
Storage Temperature	IEC 60068-2-1 (Test Ab, Un-packaged Non-operating Cold), IEC 60068-2-2 (Test Bb, Un-packaged Non-operating Dry Heat), IEC 60068-2-14 (Test Na, Un-packaged Non-operating Thermal Shock): -40 to 85°C (-40 to 185°F)
Relative Humidity	IEC 60068-2-30 (Test Db, Un-packaged Non-operating Damp Heat): 5 to 95% non-condensing
Vibration	IEC 60068-2-6 (Test Fc, Operating): 2g @ 10-500Hz
Operating Shock	IEC 60068-2-27 (Test Ea, Unpackaged Shock): 30g
Non-operating Shock	IEC 60068-2-27 (Test Ea, Unpackaged Shock): 50g
Emissions	CISPR 11: Group 1, Class A
ESD Immunity	IEC 61000-4-2: 6kV contact discharges 8kV air discharges
Radiated RF Immunity	IEC 61000-4-3: 10V/m with 1kHz sine-wave 80%AM from 30MHz to 1000MHz 10V/m with 200Hz 50% Pulse 100%AM at 900Mhz
Surge Transient Immunity	IEC 61000-4-5: ±2kV line-earth(CM) on shielded ports
Conducted RF Immunity	IEC 61000-4-6: 10Vrms with 1kHz sine-wave 80%AM from 150kHz to 80MHz
Enclosure Type Rating	None (open-style)
Certifications (when product is marked)	UL — UL Listed Industrial Control Equipment CSA — CSA Certified Process Control Equipment CSA — CSA Certified Process Control Equipment for Class I, Division 2 Group A,B,C,D Hazardous Locations FM — FM Approved Equipment for use in Class I Division 2 Group A,B,C,D Hazardous Locations CE[6] — European Union 89/336/EEC EMC Directive, compliant with: EN 50082-2; Industrial Immunity EN 61326; Meas./Control/Lab., Industrial Requirements EN 61000-6-2; Industrial Immunity EN 61000-6-4; Industrial Emissions C-Tick[6] — Australian Radiocommunications Act, compliant with: AS/NZS CISPR 11; Industrial Emissions EEx[6] — European Union 94/9/EEC ATEX Directive, compliant with: EN 50021; Potentially Explosive Atmospheres, Protection "n" (zone 2) TUV — TÜV Certified for Functional Safety 1oo2D (AK 1-6, SIL 1-3, according to DIN V 19250 and IEC 61508 respectively)

(1) This specification is module filter dependent.

(2) For more information on this specification, see Appendix E.

(3) Maximum wire size requires the extended housing - 1756-TBE.

(4) Use this conductor category information for planning conductor routing as described in the system level installation manual.

(5) Refer to publication 1770-4.1 *Industrial Automation Wiring and Grounding Guidelines*.

(6) See the Product Certification link at www.ab.com for Declarations of Conformity, Certificates, and other certification details.

1756-IR6I Specifications

Number of Inputs	6 individually isolated channels
Module Location	1756 ControlLogix Chassis
Backplane Current	250mA @ 5.1V dc & 125mA @ 24V dc
Backplane Power	4.25W
Power Dissipation within Module	4.3W
Thermal Dissipation	14.66 BTU/hr
Input Range	1-487Ω, 2-1000Ω, 4-2000Ω, 8-4020Ω
Resolution in Ranges 487Ω (Actual range 0.86 - 507.9Ω) 1000Ω (Actual range 2.0 - 1016.5Ω) 2000Ω (Actual range 4.0 - 2033.9Ω) 4020Ω (Actual range 8.0 - 4068.4Ω)	Approximately 16 bits across each input range 7.7mΩ/count 15mΩ/count 30mΩ/count 60mΩ/count
Sensors Supported	Resistance 4-4020Ω 100, 200, 500, 1000Ω Platinum, alpha=385 100, 200, 500, 1000Ω Platinum, alpha=3916 120Ω Nickel, alpha=672 100, 120, 200, 500Ω Nickel, alpha=618 10Ω Copper
RTD Excitation Current (All Ranges)	594μA
Data Format	Left justified, 2s complement – Integer mode IEEE 32 bit – Floating point mode
Open Circuit Detection Time	Negative full scale reading within 5s with any combination of lost wires, except input terminal A alone. If input terminal A is lost by itself, the module reads a positive full scale reading within 5s.
Overvoltage Protection	24V ac/dc maximum
Normal Mode Noise Rejection[1]	60dB at 60Hz
Common Mode Noise Rejection	120dB at 60Hz, 100db at 50Hz
Channel Bandwidth[1]	15Hz
Settling Time to 5% of Full Scale[1]	<80ms
Calibrated Accuracy[2] Typical Worst case	 Better than 0.05% of range Better than 0.1% of range
Calibration Interval	12 months
Input Offset Drift with Temperature	10mΩ/°C
Gain Drift with Temperature[2] Typical Worst Case	 50 ppm/°C 90 ppm/°C
Module Error over Full Temperature Range[2]	0.54% of range
Module Scan Time for all Channels[1] (Sample Rate)	25ms minimum – Floating point mode (ohms) 50ms minimum – Floating point mode (temperature) 10ms minimum – Integer mode (ohms)
Module Conversion Method	Sigma-Delta
Isolation Voltage Channel to channel User to system	Optoisolated, transformer isolated 100% tested at 1700V dc for 1s, based on 250V ac 100% tested at 1700V dc for 1s, based on 250V ac
Module Keying (Backplane)	Electronic
RTB Screw Torque (NEMA)	7-9 inch-pounds (0.8-1Nm)
RTB Keying	User defined mechanical keying
RTB and Housing	20 Position RTB (1756-TBNH or TBSH)[3]
Screwdriver Blade Width for RTB	5/16 inch (8mm) maximum
Conductors Wire Size Category	 #22 to #14 AWG (0.324 to 2.08 sq. mm) stranded[2] 3/64 inch (1.2mm) insulation maximum 2[4], [5]

Environmental Conditions	
Operating Temperature	IEC 60068-2-1 (Test Ad, Operating Cold), IEC 60068-2-2 (Test Bd, Operating Dry Heat), IEC 60068-2-14 (Test Nb, Operating Thermal Shock): 0 to 60°C (32 to 140°F)
Storage Temperature	IEC 60068-2-1 (Test Ab, Un-packaged Non-operating Cold), IEC 60068-2-2 (Test Bb, Un-packaged Non-operating Dry Heat), IEC 60068-2-14 (Test Na, Un-packaged Non-operating Thermal Shock): -40 to 85°C (-40 to 185°F)
Relative Humidity	IEC 60068-2-30 (Test Db, Un-packaged Non-operating Damp Heat): 5 to 95% non-condensing
Vibration	IEC 60068-2-6 (Test Fc, Operating): 2g @ 10-500Hz
Operating Shock	IEC 60068-2-27 (Test Ea, Unpackaged Shock): 30g
Non-Operating Shock	IEC 60068-2-27 (Test Ea, Unpackaged Shock): 50g
Emissions	CISPR 11: Group 1, Class A
ESD Immunity	IEC 61000-4-2: 6kV contact discharges 8kV air discharges
Radiated RF Immunity	IEC 61000-4-3: 10V/m with 1kHz sine-wave 80%AM from 30MHz to 1000MHz 10V/m with 200Hz 50% Pulse 100%AM at 900Mhz
EFT/B Immunity	IEC 61000-4-4: ±2kV at 5kHz on signal ports
Surge Transient Immunity	IEC 61000-4-5: ±2kV line-earth(CM) on shielded ports
Conducted RF Immunity	IEC 61000-4-6: 10Vrms with 1kHz sine-wave 80%AM from 150kHz to 80MHz
Enclosure Type Rating	None (open-style)
Certifications: (when product is marked)	UL UL Listed Industrial Control Equipment CSA CSA Certified Process Control Equipment CSA CSA Certified Process Control Equipment for Class I, Division 2 Group A,B,C,D Hazardous Locations FM FM Approved Equipment for use in Class I Division 2 Group A,B,C,D Hazardous Locations CE(6) European Union 89/336/EEC EMC Directive, compliant with: EN 50082-2; Industrial Immunity EN 61326; Meas./Control/Lab., Industrial Requirements EN 61000-6-2; Industrial Immunity EN 61000-6-4; Industrial Emissions C-Tick(6) Australian Radiocommunications Act, compliant with: AS/NZS CISPR 11; Industrial Emissions EEx(6) European Union 94/9/EC ATEX Directive, compliant with: EN 50021; Potentially Explosive Atmospheres, Protection "n" (Zone 2) TÜV(6) TÜV Certified for Functional Safety 1oo2D (AK 1-6, SIL 1-3, according to DIN V 19250 and IEC 61508 respectively)

(1) These specifications are notch filter dependent.

(2) For more information on this specification, see Appendix E.

(3) Maximum wire size will require extended housing - 1756-TBE.

(4) Use this conductor category information for planning conductor routing as described in the system level installation manual.

(5) Refer to publication 1770-4.1 *Industrial Automation Wiring and Grounding Guidelines*.

(6) See the Product Certification link at www.ab.com for Declarations of Conformity, Certificates, and other certification details.

1756-IT6I Specifications

Number of Inputs	6 individually isolated channels	
Module Location	1756 ControlLogix Chassis	
Backplane Current	250mA @ 5.1V dc & 125mA @ 24V dc	
Backplane Power	4.3W	
Power Dissipation within Module	4.3W	
Thermal Dissipation	14.66 BTU/hr.	
Input Ranges	-12mV to +78mV (1.4μV per bit) -12mV to +30mV (0.7μV per bit – high resolution range)	
Supported Thermocouple Types	B, E, J, K, R, S, T, N, C	
Thermocouple Linearization	ITS-90	
Resolution	16 bits 1.4μV/bit – Typical 0.7μV/bit – High resolution range	
Data Format	Left justified, 2s complement – Integer mode IEEE 32 bit – Floating point mode	
Input Impedance	>10MΩ	
Open Circuit Detection Time	Positive full scale reading within 2s	
Overvoltage Protection	120V ac/dc maximum	
Normal Mode Noise Rejection[1]	60dB at 60Hz	
Common Mode Noise Rejection	120dB at 60Hz 100dB at 50Hz	
Channel Bandwidth[1]	15Hz	
Settling Time to 5% of Full Scale[1]	<80ms	
Module Conversion Method	Sigma-Delta	
Isolation Voltage Channel to channel User to system	Optoisolated, transformer isolated 100% tested at 1700V dc for 1s, based on 250V ac 100% tested at 1700V dc for 1s, based on 250V ac	
Thermocouple Temp. and Millivolt Input Range	-12 to +78mV range	-12 to +30mV range
Thermocouple Type B	300 to 1820°C (572 to 3308°F)	full range
Thermocouple Type C	0 to 2315°C (32 to 4199°F)	0 to 1725°C (32 to 3137°F)
Thermocouple Type E	-270 to 1000°C (-454 to 1832°F)	-270 to 415°C (-454 to 779°F)
Thermocouple Type J	-210 to 1200°C (-346 to 2192°F)	-210 to 550°C (-346 to 1022°F)
Thermocouple Type K	-270 to 1372°C (-454 to 2502°F)	-270 to 725°C (-454 to 1337°F)
Thermocouple Type N	-270 to 1300°C (-454 to 2372°F)	-270 to 840°C (-454 to 1544°F)
Thermocouple Type R	-50 to 1768°C (-58 to 3215°F)	full range
Thermocouple Type S	-50 to 1768°C (-58 to 3215°F)	full range
Thermocouple Type T	-270 to 400°C (-454 to 752°F)	full range
Thermocouple Resolution Over Nominal Temperature Range	-12 to +78mV range	-12 to +30mV range
Type B, R, S, C	Approx. 0.15°C (Approx. 0.28°F)	Approx. 0.08°C (Approx. 0.15°F)
Type E, J, K, T, N	Approx. 0.05°C (Approx. 0.09°F)	Approx. 0.03°C (Approx. 0.05°F)
Calibrated Accuracy[2] Typical Worst case	 0.05% of full range at 25°C Better than 0.1% of full range at 25°C	
Calibration Interval	12 months	
Accuracy (Cold Junction Sensor) Local CJS (RTB) Remote CJS (IFM)	 +/-0.3°C up to +/-3.2°C +/-0.3°C	
Input Offset Drift with Temperature	0.5μV/°C	
Gain Drift with Temperature[2] Typical Worst case	 65 ppm/°C (5.9μV/°C for -12 to +78mV range; 2.7μV/°C for -12 to +30mV range) 80 ppm/°C (7.2μV/°C for -12 to +78mV range; 3.4μV/°C for -12 to +30mV range)	
Module Error over Full Temperature Range[2]	0.5% of temperature range	
Module Scan Time for all Channels (Sample Rate)[1]	25ms minimum – Floating point mode (millivolt) 50ms minimum – Floating point mode (temperature linearization) 10ms minimum – Integer (millivolt)	
RTB Screw Torque (NEMA)	7-9 inch-pounds (0.8-1Nm)	
Module Keying (Backplane)	Electronic	

RTB Keying	User defined
Field Wiring Arm and Housing	20 Position RTB (1756-TBNH or TBSH)[3]
Conductors	
Wire Size	#22 to #14 AWG (0.324 to 2.08 sq. mm) stranded[3] 3/64 inch (1.2mm) insulation maximum
Category	2[4], [5]
Screwdriver Width for RTB	5/16 inch (8mm) maximum
Environmental Conditions	
Operating Temperature	IEC 60068-2-1 (Test Ad, Operating Cold), IEC 60068-2-2 (Test Bd, Operating Dry Heat), IEC 60068-2-14 (Test Nb, Operating Thermal Shock): 0 to 60°C (32 to 140°F)
Storage Temperature	IEC 60068-2-1 (Test Ab, Un-packaged Non-operating Cold), IEC 60068-2-2 (Test Bb, Un-packaged Non-operating Dry Heat), IEC 60068-2-14 (Test Na, Un-packaged Non-operating Thermal Shock): -40 to 85°C (-40 to 185°F)
Relative Humidity	IEC 60068-2-30 (Test Db, Un-packaged Non-operating Damp Heat): 5 to 95% non-condensing
Vibration	IEC 60068-2-6 (Test Fc, Operating): 2g @ 10-500Hz
Operating Shock	IEC 60068-2-27 (Test Ea, Unpackaged Shock): 30g
Non-Operating Shock	IEC 60068-2-27 (Test Ea, Unpackaged Shock): 50g
Emissions	CISPR 11: Group 1, Class A
ESD Immunity	IEC 61000-4-2: 6kV contact discharges 8kV air discharges
Radiated RF Immunity	IEC 61000-4-3: 10V/m with 1kHz sine-wave 80%AM from 30MHz to 1000MHz 10V/m with 200Hz 50% Pulse 100%AM at 900Mhz
EFT/B Immunity	IEC 61000-4-4: ±2kV at 5kHz on signal ports
Surge Transient Immunity	IEC 61000-4-5: ±2kV line-earth(CM) on shielded ports
Conducted RF Immunity	IEC 61000-4-6: 10Vrms with 1kHz sine-wave 80%AM from 150kHz to 80MHz
Enclosure Type Rating	None (open-style)
Certifications: (when product is marked)	UL UL Listed Industrial Control Equipment CSA CSA Certified Process Control Equipment CSA CSA Certified Process Control Equipment for Class I, Division 2 Group A,B,C,D Hazardous Locations FM FM Approved Equipment for use in Class I Division 2 Group A,B,C,D Hazardous Locations CE[6] European Union 89/336/EEC EMC Directive, compliant with: EN 50082-2; Industrial Immunity EN 61326; Meas./Control/Lab., Industrial Requirements EN 61000-6-2; Industrial Immunity EN 61000-6-4; Industrial Emissions C-Tick[6] Australian Radiocommunications Act, compliant with: AS/NZS CISPR 11; Industrial Emissions EEx[6] European Union 94/9/EC ATEX Directive, compliant with: EN 50021; Potentially Explosive Atmospheres, Protection "n" (Zone 2) TÜV[6] TÜV Certified for Functional Safety 1oo2D (AK 1-6, SIL 1-3, according to DIN V 19250 and IEC 61508 respectively)

(1) These specifications are notch filter dependent. Values listed represent 60Hz setting.

(2) For more information on this specification, see Appendix E.

(3) Maximum wire size requires extended housing – 1756-TBE.

(4) Use this conductor category information for planning conductor routing as described in the system level installation manual.

(5) Refer to publication 1770-4.1 *Industrial Automation Wiring and Grounding Guidelines*.

(6) See the Product Certification link at www.ab.com for Declarations of Conformity, Certificates, and other certification details.

1756-IT6I2 Specifications

Number of Inputs	6 individually isolated channels	
Module Location	1756 ControlLogix Chassis	
Backplane Current	250mA @ 5.1V dc & 125mA @ 24V dc	
Backplane Power	4.3W	
Power Dissipation within Module	4.3W	
Thermal Dissipation	14.66 BTU/hr.	
Input Ranges	-12mV to +78mV (1.4μV per bit) -12mV to +30mV (0.7μV per bit – high resolution range)	
Supported Thermocouple Types	B, E, J, K, R, S, T, N, C, D, L	
Thermocouple Linearization	ITS-90	
Resolution	16 bits (1.4μV/bit – Typical; 0.7μV/bit – High resolution range)	
Data Format	Left justified, 2s complement – Integer mode IEEE 32 bit – Floating point mode	
Input Impedance	>10MΩ	
Open Circuit Detection Time	Positive full scale reading within 2s	
Overvoltage Protection	120V ac/dc maximum	
Normal Mode Noise Rejection[1]	60dB at 60Hz	
Common Mode Noise Rejection[2]	160dB minimum, tested at 600V ac 60Hz applied with 100 ohms differential resistance	
Channel Bandwidth[1]	15Hz	
Settling Time to 5% of Full Scale[1]	<80ms	
Module Conversion Method	Sigma-Delta	
Isolation Voltage Channel to channel and User to system	Optoisolated, transformer isolated 250 V 100% tested at 1900V dc for 2s	
Thermocouple Temp. and Millivolt Input Range	-12 to +78mV range	-12 to +30mV range
Thermocouple Type B	300 to 1820°C (572 to 3308°F)	full range
Thermocouple Type C	0 to 2315°C (32 to 4199°F)	0 to 1725°C (32 to 3137°F)
Thermocouple Type E	-270 to 1000°C (-454 to 1832°F)	-270 to 415°C (-454 to 779°F)
Thermocouple Type J	-210 to 1200°C (-346 to 2192°F)	-210 to 550°C (-346 to 1022°F)
Thermocouple Type K	-270 to 1372°C (-454 to 2502°F)	-270 to 725°C (-454 to 1337°F)
Thermocouple Type N	-270 to 1300°C (-454 to 2372°F)	-270 to 840°C (-454 to 1544°F)
Thermocouple Type R	-50 to 1768°C (-58 to 3215°F)	full range
Thermocouple Type S	-50 to 1768°C (-58 to 3215°F)	full range
Thermocouple Type T	-270 to 400°C (-454 to 752°F)	full range
Thermocouple Type D	0 to 2320°C (32 to 4208°F)	0 to 1718°C (32 to 3124°F)
Thermocouple Type TXK/XK (L)	-200 to 800°C (-328 to 1472°F)	200 to 399°C (392 to 750°F)
Thermocouple Resolution Over Nominal Temperature Range	-12 to +78mV range	-12 to +30mV range
Type B, R, S, C	Approx. 0.15°C (Approx. 0.28°F)	Approx. 0.08°C (Approx. 0.15°F)
Type E, J, K, T, N	Approx. 0.05°C (Approx. 0.09°F)	Approx. 0.03°C (Approx. 0.05°F)
Type D	Approx. 0.07°C (Approx. 0.13°F)	Approx. 0.03°C (Approx. 0.05°F)
Type TXK/XK (L)	Approx. 0.02°C (Approx. 0.04°F)	Approx. 0.01°C (Approx. 0.02°F)
Calibrated Accuracy[3]		
Typical	0.05% of full range at 25°C	
Worst case	Better than 0.1% of full range at 25°C	
Calibration Interval	12 months	
Accuracy (Cold Junction Sensor)		
Local or Remote CJC (RTB or IFM)	+/-0.3°C	
Input Offset Drift with Temperature	0.5μV/°C	
Gain Drift with Temperature	25 ppm/°C (2.3μV/°C for -12 to +78mV range; 1.1μV/°C for -12 to +30mV range)	
Module Error over Full Temperature Range[3]	0.15% of temperature range	
Module Scan Time for all Channels (Sample Rate)[1]	50ms minimum – Floating point mode (temperature linearization) 10ms minimum – Integer (millivolt)	
RTB Screw Torque (NEMA)	7-9 inch-pounds (0.8-1Nm)	

Module Keying (Backplane)	Electronic
RTB Keying	User defined
Field Wiring Arm and Housing	20 Position RTB (1756-TBNH or TBSH)[4]
Conductors	
Wire Size	#22 to #14 AWG (0.324 to 2.08 sq. mm) stranded[3] 3/64 inch (1.2mm) insulation maximum
Category	2[5], [6]
Screwdriver Width for RTB	5/16 inch (8mm) maximum
Environmental Conditions	
Operating Temperature	IEC 60068-2-1 (Test Ad, Operating Cold), IEC 60068-2-2 (Test Bd, Operating Dry Heat), IEC 60068-2-14 (Test Nb, Operating Thermal Shock): 0 to 60°C (32 to 140°F)
Storage Temperature	IEC 60068-2-1 (Test Ab, Un-packaged Non-operating Cold), IEC 60068-2-2 (Test Bb, Un-packaged Non-operating Dry Heat), IEC 60068-2-14 (Test Na, Un-packaged Non-operating Thermal Shock): -40 to 85°C (-40 to 185°F)
Relative Humidity	IEC 60068-2-30 (Test Db, Un-packaged Non-operating Damp Heat): 5 to 95% non-condensing
Vibration	IEC 60068-2-6 (Test Fc, Operating): 2g @ 10-500Hz
Operating Shock	IEC 60068-2-27 (Test Ea, Unpackaged Shock): 30g
Non-Operating Shock	IEC 60068-2-27 (Test Ea, Unpackaged Shock): 50g
Emissions	CISPR 11: Group 1, Class A
ESD Immunity	IEC 61000-4-2: 6kV contact discharges 8kV air discharges
Radiated RF Immunity	IEC 61000-4-3: 10V/m with 1kHz sine-wave 80%AM from 80MHz to 2000MHz 10V/m with 200Hz 50% Pulse 100%AM at 900Mhz 10V/m with 200Hz 50% Pulse 100%AM at 1890Mhz
EFT/B Immunity	IEC 61000-4-4: +/-2kV at 5kHz on signal ports
Surge Transient Immunity	IEC 61000-4-5: ±2kV line-earth(CM) on shielded ports
Conducted RF Immunity	IEC 61000-4-6: 10Vrms with 1kHz sine-wave 80%AM from 150kHz to 80MHz
Certifications: (when product is marked)	UL UL Listed Industrial Control Equipment CSA CSA Certified Process Control Equipment CSA CSA Certified Process Control Equipment for Class I, Division 2 Group A,B,C,D Hazardous Locations FM FM Approved Equipment for use in Class I Division 2 Group A,B,C,D Hazardous Locations CE[7] European Union 89/336/EEC EMC Directive, compliant with: EN 50082-2; Industrial Immunity EN 61326; Meas./Control/Lab., Industrial Requirements EN 61000-6-2; Industrial Immunity EN 61000-6-4; Industrial Emissions C-Tick[7] Australian Radiocommunications Act, compliant with: AS/NZS CISPR 11; Industrial Emissions

(1) These specifications are notch filter dependent. Values listed represent 60Hz setting.

(2) 140dB minimum, tested at 600V ac 60Hz applied with 1000 ohms differential resistance.

(3) For more information on this specification, see Appendix E.

(4) Maximum wire size requires extended housing – 1756-TBE.

(5) Use this conductor category information for planning conductor routing as described in the system level installation manual.

(6) Refer to publication 1770-4.1 *Industrial Automation Wiring and Grounding Guidelines*.

(7) See the Product Certification link at www.ab.com for Declarations of Conformity, Certificates, and other certification details.

1756-OF4 Specifications

Number of Outputs	4 voltage or current outputs
Module Location	1756 ControlLogix Chassis
Backplane Current	150mA @ 5.1V dc & 120mA @ 24V dc
Backplane Power	5.8W
Power Dissipation within Module	3.2W – 4 channel current
Thermal Dissipation	10.91 BTU/hr.
Output Range	+/- 10.4V 0 to 21mA
Resolution	15 bits across 10.4V - 320μV/bit – Voltage 15 bits across 21mA - 650nA/bit – Current
Data Format	Left justified, 2s complement – Integer mode IEEE 32 bit – Floating point mode
Open Circuit Detection	Current output only (Output must be set to >0.1mA)
Output Overvoltage Protection	24V dc
Output Short Circuit Protection	Electronically current limited to 21mA or less
Drive Capability	>2000Ω – Voltage 0-750Ω – Current
Output Settling Time	<2ms to 95% of final value with resistive loads
Calibrated Accuracy	Better than 0.05% of range from 4mA to 21mA, -10.4V to 10.4V
Calibration Interval	Twelve months
Output Offset Drift with Temperature	50μV/°C 100nA/°C
Gain Drift with Temperature	25 ppm/°C – Voltage 520μV/°C 50 ppm/°C – Current 1.05μA/°C
Module Error over Full Temperature Range[1]	0.15% of range – Voltage 0.3% of range – Current
Module Scan Time for all Channels	12ms minimum – Floating point mode 8ms minimum – Integer
Isolation Voltage User to system	 250V 100% tested at 2550V dc for 1 second
Module Conversion Method	R-Ladder DAC, monotonicity with no missing codes
RTB Screw Torque (NEMA)	7-9 inch-pounds (0.8-1Nm)
Module Keying (Backplane)	Electronic
RTB Keying	User defined
RTB and Housing	20 Position RTB (1756-TBNH or TBSH)[2]
Conductors Wire Size Category	 #22 to #14 AWG (0.324 to 2.08 sq. mm) stranded[1] 3/64 inch (1.2mm) insulation maximum 2[3], [4]
Screwdriver Width for RTB	5/16 inch (8mm) maximum

Environmental Conditions	
Operating Temperature	IEC 60068-2-1 (Test Ad, Operating Cold), IEC 60068-2-2 (Test Bd, Operating Dry Heat), IEC 60068-2-14 (Test Nb, Operating Thermal Shock): 0 to 60°C (32 to 140°F)
Storage Temperature	IEC 60068-2-1 (Test Ab, Un-packaged Non-operating Cold), IEC 60068-2-2 (Test Bb, Un-packaged Non-operating Dry Heat), IEC 60068-2-14 (Test Na, Un-packaged Non-operating Thermal Shock): -40 to 85°C (-40 to 185°F)
Relative Humidity	IEC 60068-2-30 (Test Db, Un-packaged Non-operating Damp Heat): 5 to 95% non-condensing
Vibration	IEC60068-2-6 (Test Fc, Operating): 2g @ 10-500Hz
Operating Shock	IEC60068-2-27 (Test Ea, Unpackaged shock): 30g
Non-operating Shock	IEC60068-2-27 (Test Ea, Unpackaged shock): 50g
Emissions	CISPR 11: Group 1, Class A
ESD Immunity	IEC 61000-4-2: 6kV contact discharges 8kV air discharges
Radiated RF Immunity	IEC 61000-4-3: 10V/m with 1kHz sine-wave 80%AM from 30MHz to 1000MHz 10V/m with 200Hz 50% Pulse 100%AM at 900Mhz
EFT/B Immunity	IEC 61000-4-4: ±2kV at 5kHz on signal ports
Surge Transient Immunity	IEC 61000-4-5: ±2kV line-earth (CM) on shielded ports
Conducted RF Immunity	IEC 61000-4-6: 10Vrms with 1kHz sine-wave 80%AM from 150kHz to 80MHz
Enclosure Type Rating	None (open-style)
Certifications (when product is marked)	UL — UL Listed Industrial Control Equipment CSA — CSA Certified Process Control Equipment CSA — CSA Certified Process Control Equipment for Class I, Division 2 Group A,B,C,D Hazardous Locations FM — FM Approved Equipment for use in Class I Division 2 Group A,B,C,D Hazardous Locations CE(5) — European Union 89/336/EEC EMC Directive, compliant with: EN 50082-2; Industrial Immunity EN 61326; Meas./Control/Lab., Industrial Requirements EN 61000-6-2; Industrial Immunity EN 61000-6-4; Industrial Emissions C-Tick(5) — Australian Radiocommunications Act, compliant with: AS/NZS CISPR 11; Industrial Emissions EEx(5) — European Union 94/9/EEC ATEX Directive, compliant with: EN 50021; Potentially Explosive Atmospheres, Protection "n" (zone 2)

(1) For more information on this specification, see Appendix E.

(2) Maximum wire size requires extended housing - 1756-TBE.

(3) Use this conductor category information for planning conductor routing as described in the system level installation manual.

(4) Refer to publication 1770-4.1 *Industrial Automation Wiring and Grounding Guidelines*.

(5) See the Product Certification link at www.ab.com for Declarations of Conformity, Certificates, and other certification details.

1756-OF6CI Specifications

Number of Outputs	6 individually isolated channels
Module Location	1756 ControlLogix Chassis
Backplane Current 0-550Ω loads 551-1000Ω loads	 250mA @ 5.1V dc & 225mA @ 24V dc (load terminated on OUTs and RTNs) 250mA @ 5.1V dc & 300mA @ 24V dc (load terminated on OUTs and ALTs)
Backplane Power 0-550Ω loads 551-1000Ω loads	 6.7W 8.5W
Power Dissipation within Module 0-550Ω loads 551-1000Ω loads	 5.5W 6.1W
Thermal Dissipation 0-550Ω loads 551-1000Ω loads	 18.76 BTU/hr. 20.80 BTU/hr.
Output Current Range	0 to 21mA
Current Resolution	13 bits across 21mA (2.7µA)
Data Format	Left justified, 2s complement – Integer mode IEEE 32 bit – Floating point mode
Open Circuit Detection	None
Output Overvoltage Protection	24V ac/dc maximum
Output Short Circuit Protection	Electronically current limited to 21mA or less
Drive Capability	0-1000Ω Separate field terminations for ranges 0-550Ω or 551-1000Ω
Output Settling Time	<2ms to 95% of final value with resistive loads
Calibrated Accuracy	Better than 0.1% of range from 4mA to 21mA
Calibration Interval	12 months
Output Offset Drift with Temperature	1 µA/°C
Gain Drift with Temperature[1] Typical Worst case	 60 ppm/°C 1.26µA/°C 100 ppm/°C 2.10µA/°C
Module Error over Full Temperature Range[1]	0.6% of range
Minimum Module Scan Time for All Channels	25ms minimum – Floating point mode 10ms minimum – Integer mode
Isolation Voltage Channel to channel User to system	Optoisolated, transformer isolated 100% tested at 1700V dc for 1s, based on 250V ac 100% tested at 1700V dc for 1s, based on 250V ac
Module Conversion Method	R-Ladder DAC, monotonicity with no missing codes
Inductive Load	<1 mH
Module Keying (Backplane)	Electronic
RTB Screw Torque (NEMA)	7-9 inch-pounds (0.8-1Nm)
RTB Keying	User defined
RTB and Housing	20 Position RTB (1756-TBNH or TBSH)[2]
Conductors Wire Size Category	 #22 to #14 AWG (0.324 to 2.08 sq. mm) stranded[1] 3/64 inch (1.2mm) insulation maximum 2[3], [4]
Screwdriver Width for RTB	5/16 inch (8mm) maximum

Environmental Conditions	
Operating Temperature	IEC 60068-2-1 (Test Ad, Operating Cold), IEC 60068-2-2 (Test Bd, Operating Dry Heat), IEC 60068-2-14 (Test Nb, Operating Thermal Shock): 0 to 60°C (32 to 140°F)
Storage Temperature	IEC 60068-2-1 (Test Ab, Un-packaged Non-operating Cold), IEC 60068-2-2 (Test Bb, Un-packaged Non-operating Dry Heat), IEC 60068-2-14 (Test Na, Un-packaged Non-operating Thermal Shock): –40 to 85°C (–40 to 185°F)
Relative Humidity	IEC 60068-2-30 (Test Db, Un-packaged Non-operating Damp Heat): 5 to 95% non-condensing
Vibration	IEC60068-2-6 (Test Fc, Operating): 2g @ 10-500Hz
Operating Shock	IEC60068-2-27 (Test Ea, Unpackaged shock): 30g
Non-Operating Shock	IEC60068-2-27 (Test Ea, Unpackaged shock): 50g
Emissions	CISPR 11: Group 1, Class A
ESD Immunity	IEC 61000-4-2: 6kV contact discharges 8kV air discharges
Radiated RF Immunity	IEC 61000-4-3: 10V/m with 1kHz sine-wave 80%AM from 30MHz to 1000MHz 10V/m with 200Hz 50% Pulse 100%AM at 900Mhz
EFT/B Immunity	IEC 61000-4-4: ±2kV at 5kHz on signal ports
Surge Transient Immunity	IEC 61000-4-5: ±2kV line-earth (CM) on shielded ports
Conducted RF Immunity	IEC 61000-4-6: 10Vrms with 1kHz sine-wave 80%AM from 150kHz to 80MHz
Enclosure Type Rating	None (open-style)
Certifications (when product is marked)	UL — UL Listed Industrial Control Equipment CSA — CSA Certified Process Control Equipment CSA — CSA Certified Process Control Equipment for Class I, Division 2 Group A,B,C,D Hazardous Locations FM — FM Approved Equipment for use in Class I Division 2 Group A,B,C,D Hazardous Locations CE[5] — European Union 89/336/EEC EMC Directive, compliant with: EN 50082-2; Industrial Immunity EN 61326; Meas./Control/Lab., Industrial Requirements EN 61000-6-2; Industrial Immunity EN 61000-6-4; Industrial Emissions C-Tick[5] — Australian Radiocommunications Act, compliant with: AS/NZS CISPR 11; Industrial Emissions EEx[5] — European Union 94/9/EEC ATEX Directive, compliant with: EN 50021; Potentially Explosive Atmospheres, Protection "n" (zone 2)

(1) For more information on this specification, see Appendix E.

(2) Maximum wire size will require extended housing - 1756-TBE.

(3) Use this conductor category information for planning conductor routing as described in the system level installation manual.

(4) Refer to publication 1770-4.1 *Industrial Automation Wiring and Grounding Guidelines.*

(5) See the Product Certification link at www.ab.com for Declarations of Conformity, Certificates, and other certification details.

1756-OF6VI Specifications

Number of Outputs	6 individually isolated channels
Module Location	1756 ControlLogix Chassis
Backplane Current	250mA @ 5.1V dc & 175mA @ 24V dc
Backplane Power	5.5W
Power Dissipation within Module	4.85W
Thermal Dissipation	16.54 BTU/hr
Output Voltage Range	+/- 10.5V maximum
Voltage Resolution	14 bits across 21V (1.3mV) (13 bits across 10.5V +sign bit)
Data Format	Left justified, 2s complement – Integer mode IEEE 32 bit – Floating point mode
Output Impedance	<1Ω
Open Circuit Detection	None
Output Overvoltage Protection	24V ac/dc maximum
Output Short Circuit Protection	Electronically current limited
Drive Capability	≥1000Ω loads, 10mA maximum
Output Settling Time	<2ms to 95% of final value with resistive loads
Calibrated Accuracy[1]	Better than 0.1% of range
Calibration Interval	12 months
Output Offset Drift with Temperature	60 µV/°C
Gain Drift with Temperature[1] Typical Worst case	 50 ppm/°C 1.05mV/°C 80 ppm/°C 1.68mV/°C
Module Error over Full Temperature Range[1]	0.5% of range
Minimum Module Scan Time for all Channels	25ms minimum – Floating point mode 10ms minimum – Integer mode
Isolation Voltage Channel to channel User to system	Optoisolated, transformer isolated 100% tested at 1700V dc for 1s, based on 250V ac 100% tested at 1700V dc for 1s, based on 250V ac
Module Conversion Method	R-Ladder DAC, monotonicity with no missing codes
Capacitive Load	<1 µF
Module Keying (Backplane)	Electronic
RTB Screw Torque (NEMA)	7-9 inch-pounds (0.8-1Nm)
RTB Keying	User defined
RTB and Housing	20 Position RTB (1756-TBNH or TBSH)[2]
Conductors Wire Size Category	 #22 to #14 AWG (0.324 to 2.08 sq. mm) stranded[1] 3/64 inch (1.2mm) insulation maximum 2[3], [4]
Screwdriver Width for RTB	5/16 inch (8mm) maximum

Environmental Conditions	
Operating Temperature	IEC 60068-2-1 (Test Ad, Operating Cold), IEC 60068-2-2 (Test Bd, Operating Dry Heat), IEC 60068-2-14 (Test Nb, Operating Thermal Shock): 0 to 60°C (32 to 140°F)
Storage Temperature	IEC 60068-2-1 (Test Ab, Un-packaged Non-operating Cold), IEC 60068-2-2 (Test Bb, Un-packaged Non-operating Dry Heat), IEC 60068-2-14 (Test Na, Un-packaged Non-operating Thermal Shock): –40 to 85°C (–40 to 185°F)
Relative Humidity	IEC 60068-2-30 (Test Db, Un-packaged Non-operating Damp Heat): 5 to 95% non-condensing
Vibration	IEC 60068-2-6 (Test Fc, Operating): 2g @ 10-500Hz
Shock	IEC 60068-2-27 (Test Ea, Unpackaged shock): 30g
Non-Operating Shock	IEC 60068-2-27 (Test Ea, Unpackaged shock): 50g
Emissions	CISPR 11: Group 1, Class A
ESD Immunity	IEC 61000-4-2: 6kV contact discharges 8kV air discharges
Radiated RF Immunity	IEC 61000-4-3: 10V/m with 1kHz sine-wave 80%AM from 30MHz to 1000MHz 10V/m with 200Hz 50% Pulse 100%AM at 900Mhz
EFT/B Immunity	IEC 61000-4-4: ±2kV at 5kHz on signal ports
Surge Transient Immunity	IEC 61000-4-5: ±2kV line-earth (CM) on shielded ports
Conducted RF Immunity	IEC 61000-4-6: 10Vrms with 1kHz sine-wave 80%AM from 150kHz to 80MHz
Enclosure Type Rating	None (open-style)
Certifications (when product is marked)	UL — UL Listed Industrial Control Equipment CSA — CSA Certified Process Control Equipment CSA — CSA Certified Process Control Equipment for Class I, Division 2 Group A,B,C,D Hazardous Locations FM — FM Approved Equipment for use in Class I Division 2 Group A,B,C,D Hazardous Locations CE[5] — European Union 89/336/EEC EMC Directive, compliant with: EN 50082-2; Industrial Immunity EN 61326; Meas./Control/Lab., Industrial Requirements EN 61000-6-2; Industrial Immunity EN 61000-6-4; Industrial Emissions C-Tick[5] — Australian Radiocommunications Act, compliant with: AS/NZS CISPR 11; Industrial Emissions EEx[5] — European Union 94/9/EEC ATEX Directive, compliant with: EN 50021; Potentially Explosive Atmospheres, Protection "n" (zone 2)

(1) For more information on this specification, see Appendix E.

(2) Maximum wire size will require extended housing - 1756-TBE.

(3) Use this conductor category information for planning conductor routing as described in the system level installation manual.

(4) Refer to publication 1770-4.1 *Industrial Automation Wiring and Grounding Guidelines*.

(5) See the Product Certification link at www.ab.com for Declarations of Conformity, Certificates, and other certification details.

1756-OF8 Specifications

Number of Outputs	8 voltage or current outputs
Module Location	1756 ControlLogix Chassis
Backplane Current	150mA @ 5.1V dc & 210mA @ 24V dc
Backplane Power	5.8W
Power Dissipation within Module	4.92W - 8 channel current
Thermal Dissipation	16.78 BTU/hr.
Output Range	+/- 10.4V 0 to 21mA
Resolution	15 bits across 10.4V - 320μV/bit – Voltage 15 bits across 21mA - 650nA/bit – Current
Data Format	Left justified, 2s complement – Integer mode IEEE 32 bit – Floating point mode
Open Circuit Detection	Current output only (Output must be set to >0.1mA)
Output Overvoltage Protection	24V dc
Output Short Circuit Protection	Electronically current limited to 21mA or less
Drive Capability	>2000Ω – Voltage 0-750Ω – Current
Output Settling Time	<2ms to 95% of final value with resistive loads
Calibrated Accuracy[1]	Better than 0.05% of range from 4mA to 21mA, -10.4V to 10.4V
Calibration Interval	Twelve months – Typical
Output Offset Drift with Temperature	50 μV/°C – Voltage 100nA/°C – Current
Gain Drift with Temperature	25 ppm/°C – Voltage 520μV/°C 50 ppm/°C – Current 1.05μA/°C
Module Error over Full Temperature Range[1]	0.15% of range – Voltage 0.3% of range – Current
Module Scan Time for all Channels	12ms minimum – Floating point mode 8ms minimum – Integer
Isolation Voltage User to system	 250V 100% tested at 2550V dc for 1 second
Module Conversion Method	R-Ladder DAC, monotonicity with no missing codes
RTB Screw Torque (NEMA)	7-9 inch-pounds (0.8-1Nm)
Module Keying (Backplane)	Electronic
RTB Keying	User defined
RTB and Housing	20 Position RTB (1756-TBNH or TBSH)[2]

Environmental Conditions	
Operating Temperature	IEC 60068-2-1 (Test Ad, Operating Cold), IEC 60068-2-2 (Test Bd, Operating Dry Heat), IEC 60068-2-14 (Test Nb, Operating Thermal Shock): 0 to 60°C (32 to 140°F)
Storage Temperature	IEC 60068-2-1 (Test Ab, Un-packaged Non-operating Cold), IEC 60068-2-2 (Test Bb, Un-packaged Non-operating Dry Heat), IEC 60068-2-14 (Test Na, Un-packaged Non-operating Thermal Shock): –40 to 85°C (–40 to 185°F)
Relative Humidity	IEC 60068-2-30 (Test Db, Un-packaged Non-operating Damp Heat): 5 to 95% non-condensing
Vibration	IEC60068-2-6 (Test Fc, Operating): 2g @ 10-500Hz
Shock	IEC60068-2-27 (Test Ea, Unpackaged shock): Operating 30g Non-operating 50g
Emissions	CISPR 11: Group 1, Class A
ESD Immunity	IEC 61000-4-2: 6kV contact discharges 8kV air discharges
Radiated RF Immunity	IEC 61000-4-3: 10V/m with 1kHz sine-wave 80%AM from 30MHz to 1000MHz 10V/m with 200Hz 50% Pulse 100%AM at 900Mhz
EFT/B Immunity	IEC 61000-4-4: ±2kV at 5kHz on signal ports
Surge Transient Immunity	IEC 61000-4-5: ±2kV line-earth (CM) on shielded ports
Conducted RF Immunity	IEC 61000-4-6: 10Vrms with 1kHz sine-wave 80%AM from 150kHz to 80MHz
Enclosure Type Rating	None (open-style)
Conductors Wire Size Category	 #22 to #14 AWG (0.324 to 2.08 sq. mm) stranded(1) 3/64 inch (1.2mm) insulation maximum 2(3), (4)
Screwdriver Width for RTB	5/16 inch (8mm) maximum
Certifications (when product is marked)	UL — UL Listed Industrial Control Equipment CSA — CSA Certified Process Control Equipment CSA — CSA Certified Process Control Equipment for Class I, Division 2 Group A,B,C,D Hazardous Locations FM — FM Approved Equipment for use in Class I Division 2 Group A,B,C,D Hazardous Locations CE(5) — European Union 89/336/EEC EMC Directive, compliant with: EN 50082-2; Industrial Immunity EN 61326; Meas./Control/Lab., Industrial Requirements EN 61000-6-2; Industrial Immunity EN 61000-6-4; Industrial Emissions C-Tick(4) — Australian Radiocommunications Act, compliant with: AS/NZS 2064; Industrial Emissions EEx(4) — European Union 94/9/EEC ATEX Directive, compliant with: EN 50021; Potentially Explosive Atmospheres, Protection “n”

(1) For more information on this specification, see Appendix E.

(2) Maximum wire size requires extended housing - 1756-TBE.

(3) Use this conductor category information for planning conductor routing as described in the system level installation manual.

(4) Refer to publication 1770-4.1 *Industrial Automation Wiring and Grounding Guidelines*.

(5) See the Product Certification link at www.ab.com for Declarations of Conformity, Certificates, and other certification details.

Notes:

Tag Definitions

Communications Mode Tag Names and Definitions

The set of tags associated with any module depends on the module type and the communications format. For each operational mode, integer or floating point, there are three sets of tags:

- input
- output
- configuration.

Integer Mode Tags

Table B.1, Table B.2 and Table B.3 list the tags that are available on ControlLogix analog modules operating in integer mode.

IMPORTANT Each application's series of tags varies but no input module application contains any tags that are not listed here.

Integer Input Tags

Table B.1 Integer Input Tags

Tag Name	Data Type	Applicable Modules	Definition:
ChannelFaults	INT	All	Collection of individual channel fault bits in one word. Can address individual channel fault via bit notation: ex. ChannelFaults 3 for channel 3
Ch0Fault	BOOL	All	Individual channel fault status bit. Indicates a "hard" fault has occurred on the channel which means: calibration is ongoing; or if an input, an overrange or underrange condition is present; or if an output, a low or high clamp condition is occurring. These bits are also set by the controller if communications are lost with the I/O module.
ModuleFaults	INT	All	Collection of all module level fault bits
AnalogGroupFault	BOOL	All	Indicates if a channel fault has occurred on any channel
InGroupFault	BOOL	All inputs	Indicates if a channel fault has occurred on any input channel
Calibrating	BOOL	All	Indicates if a calibration is currently in progress on any channel
CalFault	BOOL	All	Status bit indicating if any channel has a "bad" calibration. "Bad" calibration means the last attempt to calibrate the channel failed with an error
CJUnderrange	BOOL	1756-IT6I and 1756-IT6I2	Status bit to indicate if the Cold Junction reading is currently beneath the lowest detectable temperature of 0.0 degrees Celsius

Table B.1 Integer Input Tags

Tag Name	Data Type	Applicable Modules	Definition:
CJOverrange	BOOL	1756-IT6I and 1756-IT6I2	Status bit to indicate if the Cold Junction reading is currently above the highest detectable temperature of 86.0 degrees Celsius
ChannelStatus	INT	All	Collection of individual channel status bits
Ch0Underrange	BOOL	All inputs	Alarm bits indicating the channel's input is less than the minimum detectable input signal
Ch0Overrange	BOOL	All inputs	Alarms bit indicating the channel's input is greater than the maximum detectable input signal
Ch0Data	INT	All inputs	The channel input signal represented in counts where -32,768 counts is the minimum detectable input signal and 32,767 counts is the maximum detectable
CJData	INT	1756-IT6I and 1756-IT6I2	The cold junction sensor temperature in counts where -32,768 counts is 0 degree Celsius and 32,767 counts is 86 degrees Celsius
CSTTimestamp	Array of DINT	All (if the CST connection is selected)	Timestamp taken at time the input data was sampled, or if an output when the output was applied, and placed in terms of Coordinated System Time which is a 64 bit quantity in microseconds coordinated across the rack. Must be addressed in 32 bit chunks as an array
RollingTimestamp	INT	All	Timestamp taken at time the input data was sampled, or if an output when the output was applied, which is in terms of milliseconds relative solely to the individual module

Integer Output Tags.

Table B.2 Integer Output Tags

Tag Name	Data Type	Applicable Modules	Definition:
Ch0Data	INT	All outputs	The value the channel is to output in counts where the minimum producible output is -32,768 counts and 32,767 counts is the maximum producible
Ch0DataEcho	INT	All outputs	The value the channel is currently outputting in counts where -32,768 counts is the minimum producible output signal and 32, 767 counts is the maximum producible
OutGroupFault	BOOL	All outputs	Indicates if a channel fault has occurred on any output channel
Ch0InHold	BOOL	All outputs	Bit which indicates if the output channel is currently holding until the Output value sent to the module (O tag Ch0Data) matches the current output value (I tag Ch0Data) within 0.1% of the channel's full scale

Integer Configuration Tags

Table B.3 Integer Configuration Tags

Tag Name	Data Type	Applicable Modules	Definition
CJDisable	BOOL	All inputs (only used for the 1756-IT6I and 1756-IT6I2)	Disables the cold junction sensor which turns off cold junction compensation when linearizing thermocouple inputs
RealTimeSample	INT	All input	Determines how often the input signal is to be sampled in terms of milliseconds
Ch0RangeNotch	SINT	1756-IF6CIS, 1756-IF6I, 1756-IR6I, 1756-IT6I and 1756-IT6I2	Configures the channel's input range and notch filter settings. The input range is the upper nibble (bits 4-7) and determines the signal range the input channel can detect. Input range values are as follows: 0 = -10 to 10V (1756-IF6I) 1 = 0 to 5V (1756-IF6I) 2 = 0 to 10V (1756-IF6I) 3 = 0 to 20mA (1756-IF6CIS and 1756-IF6I) 4 = -12 to 78mV (1756-IT6I and 1756-IT6I2) 5 = -12 to 30mV (1756-IT6I and 1756-IT6I2) 6 = 1 to 487Ω (1756-IR6I) 7 = 2 to 1,000Ω (1756-IR6I) 8 = 4 to 2,000Ω (1756-IR6I) 9 = 8 to 4,020Ω (1756-IR6I) The notch filter provides superior frequency filtering at the selected value and its harmonics. The notch filter is the lowest nibble (bits 0-3) 0 = 10Hz 1 = 50Hz 2 = 60Hz 3 = 100Hz 4 = 250Hz 5 = 1,000Hz
ProgToFaultEn	BOOL	All outputs	The program to fault enable bit determines how the outputs should behave if a communications fault were to occur while the output module is in the program mode. When set the bit will cause the outputs to transition to their programmed fault state if a communications fault occurs while in the program state. If not set, outputs will remain in their configured program state despite a communications fault occurring
Ch0Config	SINT	All outputs	Contains all individual configuration bits for channel

Table B.3 Integer Configuration Tags

Tag Name	Data Type	Applicable Modules	Definition
Ch0HoldForInit	BOOL	All outputs	When set configures the channel to hold, or not change, until initialized with a value within 0.1% of full scale of its current value when one of the following conditions occurs: 1 = Module initial connection (power up) 2 = Module transition from Program mode back to Run mode 3 = Module reestablishes communications after fault
Ch0Fault Mode	BOOL	All outputs	Selects the behavior the output channel should take if a communications fault were to occur. Either hold last state (0) or go to a user defined value (1). Ch0FaultValue defines the value to go to on fault if the bit is set
Ch0ProgMode	BOOL	All outputs	Selects the behavior the output channel when transitioned into Program mode. Either hold last state (0) or go to a user defined value (1). Ch0ProgValue defines the value to go to on fault if the bit is set
Ch0RampToProg	BOOL	All outputs	Enables ramping of the output value to a user defined program value, Ch0ProgValue, when set. Ramping defines the maximum rate the output is allowed to transition at based upon the configured Ch0RampRate
Ch0RampToFault	BOOL	All outputs	Enables ramping of the output value to a user defined fault value, Ch0FaultValue, when set. Ramping defines the maximum rate the output is allowed to transition at based upon the configured Ch0RampRate
Ch0FaultValue	INT	All outputs	Defines the value, in counts, the output should take on if a communications fault occurs when the Ch0FaultMode bit it set
Ch0ProgValue	INT	All outputs	Defines the value, in counts, the output should take on when the connection transitions to Program mode if the Ch0ProgMode bit is set
Ch0RampRate	INT	All outputs	Configures the maximum rate at which the output value may change when transitioning to either the Ch0FaultValue or Ch0ProgValue if either the Ch0RampToFault or Ch0RampToProg bits are set respectively. In terms of percent full-scale per second

Floating Point Mode Tags

Table B.4, Table B.5 and Table B.3 list the tags that are available on ControlLogix analog modules operating in floating point mode.

IMPORTANT Each application's series of tags varies but no input module application contains any tags that are not listed here.

Floating Point Input Tags

Table B.4 Floating Point Input Tags

Tag Name	Data Type	Applicable Modules	Definition:
ChannelFaults	INT	All	Collection of individual channel fault bits in one word. Can address individual channel fault via bit notation: ex. ChannelFaults 3 for channel 3
Ch0Fault	BOOL	All	Individual channel fault status bit. Indicates a "hard" fault has occurred on the channel which means: calibration is ongoing; or if an input, an overrange or underrange condition is present; or if an output, a low or high clamp condition is occurring. These bits are also set by the controller if communications are lost with the I/O module.
ModuleFaults	INT	All	Collection of all module level fault bits
AnalogGroupFault	BOOL	All	Indicates if a channel fault has occurred on any channel
InGroupFault	BOOL	All inputs	Indicates if a channel fault has occurred on any input channel
Calibrating	BOOL	All	Indicates if a calibration is currently in progress on any channel
CalFault	BOOL	All	Status bit indicating if any channel has a "bad" calibration. "Bad" calibration means the last attempt to calibrate the channel failed with an error and was aborted
CJUnderrange	BOOL	1756-IT6I and 1756-IT6I2	Status bit to indicate if the Cold Junction reading is currently beneath the lowest detectable temperature of 0.0 degrees Celsius
CJOverrange	BOOL	1756-IT6I and 1756-IT6I2	Status bit to indicate if the Cold Junction reading is currently above the highest detectable temperature of 86.0 degrees Celsius
Ch0Status	INT	All	Collection of individual channel status bits
Ch0CalFault	BOOL	All inputs	Status bit indicating if the channel has a "bad" calibration. "Bad" calibration means the last attempt to calibrate the channel failed with an error and was aborted
Ch0Underrange	BOOL	All inputs	Alarm bits indicating the channel's input is less than the minimum detectable input signal

Table B.4 Floating Point Input Tags

Tag Name	Data Type	Applicable Modules	Definition:
Ch0Overrange	BOOL	All inputs	Alarms bit indicating the channel's input is greater than the maximum detectable input signal
Ch0RateAlarm	BOOL	All inputs	Alarm bit which sets when the input channel's rate of change exceeds the configured Ch0ConfigRateAlarmLimit. Remains set until the rate change drops below the configured limit unless latched via Ch0ConfigRateAlarmLatch in the configuration
Ch0LAlarm	BOOL	All inputs	Low alarm bits which sets when the input signal moves beneath the configured low alarm trigger point, Ch0ConfigLAlarmLimit. Remains set until the input signal moves above the trigger point, unless latched via Ch0ConfigProcAlarmLatch or the input is still within the configured alarm deadband, Ch0ConfigAlmDeadband, of the low alarm trigger point
Ch0HAlarm	BOOL	All inputs	High alarm bit which sets when the input signal moves above the configured high alarm trigger point, Ch0ConfigHAlarmLimit. Remains set until the input signal moves below the trigger point, unless latched viaCh0ConfigProcAlarmLatch or the input is still within the configured alarm deadband, Ch0ConfigAlmDeadband, of the high alarm trigger point
Ch0LLAlarm	BOOL	All inputs	Low low alarm bit which sets when the input signal moves beneath the configured low low alarm trigger point, Ch0ConfigLLAlarmLimit. Remains set until the input signal moves above the trigger point, unless latched via Ch0ConfigProcAlarmLatch or the input is still within the configured alarm deadband, Ch0ConfigAlmDeadband, of the low low alarm trigger point
CH0HHAlarm	BOOL	All inputs	High high alarm bit which sets when the input signal moves above the configured high high alarm trigger point, Ch0ConfigProcAlarmLimit. Remains set until the input signal moves below the trigger point, unless latched via Ch0ConfigAlmDeadband, of the high high alarm trigger point
Ch0Data	REAL	All inputs	The channel input signal represented in engineering units. The input signal is measured and then scaled based on the user configuration
CJData	REAL	1756-IT6I and 1756-IT6I2	The cold junction sensor temperature in degrees Celsius or Fahrenheit
CSTTimestamp	Array of DINT	All (if the CST connection is selected)	Timestamp taken at time the input data was sampled, or if an output when the output was applied, and placed in terms of Coordinated System Time which is a 64 bit quantity in microseconds coordinated across the rack. Must be addressed in 32 bit chunks as an array
RollingTimestamp	INT	All inputs	Timestamp taken at time the input data was sampled, or if an output when the output was applied, which is in terms of milliseconds relative solely to the individual module

Floating Point Output Tags

Table B.5 Floating Point Output Tags

Tag Name	Data Type	Applicable Modules	Definition:
Ch0Data	REAL	All outputs	The value the channel is set to output in engineering units based upon the configured scaling for the channel
Ch0DataEcho	REAL	All outputs	The value the channel is currently outputting in engineering units based upon the configured user scaling. Will match the requested output value, O tag Ch0Data, unless: in Program mode, calibrating, beneath Low Limit, above High Limit, currently ramping or In Hold
OutGroupFault	BOOL	All outputs	Indicates if a channel fault has occurred on any output channel
Ch0NotANumber	BOOL	All outputs	Bit indicating the received output value from the controller, O tag Ch0Data, was an invalid IEEE floating point value. When an invalid value is received, the output value holds its last known valid state
Ch0InHold	BOOL	All outputs	Bit which indicates if the output channel is currently holding until the Output value sent to the module (O tag Ch0Data) matches the current output value (I tag Ch0Data) within 0.1% of the channel's full scale
CH0RampAlarm	BOOL	All outputs	Alarm bit which sets when the requested output value, Ch0ConfigRampToRun set, and the difference between the new output value requested and the current output exceeds the configured ramp limit, Ch0ConfigMaxRampRate. The bit will remain set until ramping ceases unless the alarm is latched via Ch0ConfigRampAlarmLatch
Ch0LLimitAlarm	BOOL	All outputs	Alarm bit which sets when the requested output value, Ch0Data, is below the configured low limit, Ch0ConfigLowLimit, in which case the output will stop at the configured low limit which the echo will reflect. Remains set until the requested output moves above the low limit unless latched by Ch0ConfigLimitAlarmLatch
Ch0HLimitAlarm	BOOL	All outputs	Alarm bit which sets when the requested output value, Ch0Data, is above the configured high limit, Ch0ConfigHighLimit, in which case the output will stop at the configured high limit which the echo will reflect. Remains set until the requested output moves below the high limit unless latched by Ch0ConfigLimitAlarmLatch

Floating Point Configuration Tags

Table B.6 Floating Point Configuration Tags

Tag Name	Data Type	Applicable Modules	Definition
RemoteTermination	BOOL	1756-IT6I and 1756-IT6I2	Indicates if the cold junction sensor is mounted on a remote termination block when set, rather than on the local terminal block. Needed for proper cold junction compensation when linearizing thermocouples
CJDisable	BOOL	1756-IT6I and 1756-IT6I2	Disables the cold junction sensor which turns off cold junction compensation when linearizing thermocouple inputs
TempMode	BOOL	1756-IR6I, 1756-IT6I and 1756-IT6I2	Controls the temperature scale to use on the module: 0 = Celsius 1 = Fahrenheit
ProgToFaultEn	BOOL	All outputs	The program to fault enable bit determines how the outputs should behave if a communications fault were to occur while the output module is in the program mode. When set, the bit will cause the outputs to transition to their programmed fault state if a communications fault occurs while in the program state. If not set, outputs will remain in their configured program state despite a communications fault occurring
RealTimeSample	INT	All input	Determines how often the input signal is to be sampled in terms of milliseconds
CJOffset	REAL	1756-IT6I and 1756-IT6I2	Provides a user selected offset to add into the read cold junction sensor value. Allows a sensor with a built in bias to be compensated for
Ch0Config	Struct	All	Master structure beneath which the channel's configuration parameters are set.

Table B.6 Floating Point Configuration Tags

Tag Name	Data Type	Applicable Modules	Definition
Ch0Config RangeTypeNotch	INT	1756-IF6CIS, 1756-IF6I, 1756-IR6I, 1756-IT6I and 1756-IT6I2	Configures the channel's input range, sensor type and notch filter settings. The input range is bits 8-11 and determines the signal range the input channel can detect. Input range values are as follows: 0 = -10 to 10V (1756-IF6I) 1 = 0 to 5V (1756-IF6I) 2 = 0 to 10V (1756-IF6I) 3 = 0 to 20mA (1756-IF6CIS and 1756-IF6I) 4 = -12 to 78mV (1756-IT6I and 1756-IT6I2) 5 = -12 to 30mV (1756-IT6I and 1756-IT6I2) 6 = 1 to 487Ω (1756-IR6I) 7 = 2 to 1,000Ω (1756-IR6I) 8 = 4 to 2,000Ω (1756-IR6I) 9 = 8 to 4,020Ω (1756-IR6I) Sensor type is bits 4-7 and selects the sensor type to use for linearization on the 1756-IR6I, IT6I. Sensor types values are as follows: 0 =no linearization, Ω (1756-IR6I), mV (1756-IT6I and 1756-IT6I2) 1 = 100Ω Platinum 385 (1756-IR6I) B (1756-IT6I and 1756-IT6I2) 2 = 200Ω Platinum 385 (1756-IR6I), C (1756-IT6I and 1756-IT6I2) 3 = 500Ω Platinum 385 (1756-IR6I), E (1756-IT6I and 1756-IT6I2) 4 = 1000Ω Platinum 385 (1756-IR6I), J (1756-IT6I and 1756-IT6I2) 5 = 100Ω Platinum 3916 (1756-IR6I), K (1756-IT6I and 1756-IT6I2) 6 = 200Ω Platinum 3916 (1756-IR6I), N (1756-IT6I and 1756-IT6I2) 7 = 500Ω Platinum 3916 (1756-IR6I), R (1756-IT6I and 1756-IT6I2) 8 = 1000Ω Platinum 3916 (1756-IR6I), S (1756-IT6I and 1756-IT6I2) 9 = 10Ω Copper 427 (1756-IR6I), T (1756-IT6I and 1756-IT6I2) 10 = 120Ω Nickel 672 (1756-IR6I), TXK/XK (L) (1756-IT6I2) 11 = 100Ω Nickel 618 (1756-IR6I), D (1756-IT6I2) 12 = 120Ω Nickel 618 (1756-IR6I) 13 = 200Ω Nickel 618 (1756-IR6I) 14 = 500Ω Nickel 618 (1756-IR6I) The notch filter provides superior frequency filtering at the selected value and its harmonics. The notch filter is the lower nibble (bits 0-3) 0 = 10Hz 1 = 50Hz 2 = 60Hz 3 = 100Hz 4 = 250Hz 5 = 1,000Hz
Ch0ConfigAlarm Disable	BOOL	All	Disables all alarms for the channel
Ch0ConfigProcess AlarmLatch	BOOL	All inputs	Enables latching for all four process alarms: low, low low, high and high high. Latching causes the process alarm to remain set until an unlatch service is explicitly sent to the channel or alarm
Ch0ConfigRate AlarmLatch	BOOL	All inputs	Enables latching for the rate alarm. Latching causes the rate alarm to remain set until an unlatch service is explicitly sent to the channel or alarm
Ch0ConfigDigital Filter	INT	All inputs	A non-zero value enables the filter, providing a time constant in milliseconds used in a first order lag filter to smooth the input signal

Table B.6 Floating Point Configuration Tags

Tag Name	Data Type	Applicable Modules	Definition
Ch0ConfigTenOhm Offset	INT	1756-IR6I	A value from -100 to 100 which represents -1.00 to 1.00Ω and is an offset used when linearizing a 10Ω copper sensor type's input
Ch0ConfigRate AlarmLimit	INT	All inputs	The trigger point for the rate alarm status bit which will set if the input signal changes at a rate faster than the configured rate alarm. Configured in percent full scale per second
Ch0ConfigLow Signal	REAL	All	One of four points used in scaling. The low signal is in terms of the inputs signal units and corresponds to the low engineering term when scaled. The scaling equation is as follows: $Data = \frac{(Signal - Low\ Signal) \times (High\ Engineering - Low\ Engineering)}{(High\ Signal - Low\ Signal)} + LowEngineering$
Ch0ConfigHigh Signal	REAL	All	One of four points used in scaling. The high signal is in terms of the inputs signal units and corresponds to the high engineering term when scaled. The scaling equation is as follows: $Data = \frac{(Signal - Low\ Signal) \times (High\ Engineering - Low\ Engineering)}{(High\ Signal - Low\ Signal)} + LowEngineering$
Ch0ConfigLow Engineering	REAL	All	One of four points used in scaling. The low engineering helps determine the engineering units the signal values scale into. The low engineering term corresponds to the low signal value. The scaling equation used is: $Data = \frac{(Signal - Low\ Signal) \times (High\ Engineering - Low\ Engineering)}{(High\ Signal - Low\ Signal)} + LowEngineering$
C0ConfigHigh Engineering	REAL	All	One of four points used in scaling. The high engineering helps determine the engineering units the signal values scale into. The high engineering term corresponds to the high signal value. The scaling equation used is: $Data = \frac{(Signal - Low\ Signal) \times (High\ Engineering - Low\ Engineering)}{(High\ Signal - Low\ Signal)} + LowEngineering$
Ch0ConfigLAlarm Limit	REAL	All inputs	The low alarm trigger point. Causes the Ch0LAlarm to trigger when the input signal moves beneath the configured trigger point. In terms of engineering units
Ch0ConfigHAlarm Limit	REAL	All inputs	The high alarm trigger point. Causes the Ch0HAlarm to trigger when the input signal moves above the configured trigger point. In terms of engineering units
Ch0ConfigLLAlarm Limit	REAL	All inputs	The low low alarm trigger point. Causes the Ch0LLAlarm to trigger when the input signal moves beneath the configured trigger point. In terms of engineering units
Ch0ConfigHH AlarmLimit	REAL	All inputs	The high high alarm trigger point. Causes the Ch0HHAlarm to trigger when the input signal moves above the configured trigger point. In terms of engineering units
Ch0ConfigAlarm Deadband	REAL	All inputs	Forms a deadband around the process alarms which causes the corresponding process alarm status bit to remain set until the input moves beyond the trigger point by greater than the amount of the alarm deadband
Ch0ConfigCalBias	REAL	All inputs	A user configurable offset added directly into the data, Ch0Data. used to compensate for inherent sensor offset
Ch0ConfigConfig Bits	INT	All outputs	Collection of channel's individual configuration bits

Table B.6 Floating Point Configuration Tags

Tag Name	Data Type	Applicable Modules	Definition
Ch0ConfigHoldForInit	BOOL	All outputs	When set configures the channel to hold, or not change, until initialized with a value within 0.1% of full scale of its current value when one of the following conditions occurs: 1 = Module initial connection (power up) 2 = Module transition from Program mode back to Run mode 3 = Module reestablishes communications after fault
Ch0ConfigRamp AlarmLatch	BOOL	All outputs	Enables latching for the rate alarm. Latching causes the rate alarm to remain set until an unlatch service is explicitly sent to the channel or alarm
Ch0ConfigLimit AlarmLatch	BOOL	All outputs	Enables latching for the clamp limit alarms. Latching causes the limit alarms to remain set until an unlatch service is explicitly sent to the channel or alarm
Ch0ConfigFault Mode	BOOL	All outputs	Selects the behavior the output channel should take if a communications fault were to occur. Either hold last state (0) or go to a user defined value (1). Ch0ConfigFaultValue defines the value to go to on fault if the bit is set
Ch0ConfigProg Mode	BOOL	All outputs	Selects the behavior the output channel when transitioned into Program mode. Either hold last state (0) or go to a user defined value (1). Ch0ConfigProgValue defines the value to go to on program if the bit is set
Ch0ConfigRampTo Run	BOOL	All outputs	Enables ramping of the output value during Run mode between the current output level and a newly requested output. Ramping defines the maximum rate the output is allowed to transition at based upon the configured Ch0ConfigRampRate
Ch0ConfigRampToProg	BOOL	All outputs	Enables ramping of the output value to a user defined program value, Ch0ConfigProgValue, when set. Ramping defines the maximum rate the output is allowed to transition at based upon the configured Ch0ConfigRampRate
Ch0ConfigRampToFaul t	BOOL	All outputs	Enables ramping of the output value to a user defined fault value, Ch0FaultValue, when set. Ramping defines the maximum rate the output is allowed to transition at based upon the configured Ch0ConfigRampRate
Ch0ConfigMax RampRate	INT	All outputs	Configures the maximum rate at which the output value may change when transitioning to either the Ch0ConfigFaultValue or Ch0ConfigProgValue if either the Ch0ConfigRampToFault or Ch0ConfigRampToProg bits are set respectively, or in Run mode if Ch0ConfigRampToRun is set. In terms of percent full-scale per second
Ch0ConfigFault Value	REAL	All outputs	Defines the value, in engineering terms, the output should take on if a communications fault occurs when the Ch0ConfigFaultMode bit it set
Ch0ConfigProg Value	REAL	All outputs	Defines the value, in engineering units, the output should take on when the connection transitions to Program mode if the Ch0ConfigProgMode bit is set
Ch0ConfigLow Limit	REAL	All outputs	Defines the minimum value the output is allowed to take on within the process. If an output beneath the low limit is requested, the Ch0LLimit alarm is set and the output signal will remain at the configured low limit
Ch0ConfigHigh Limit	REAL	All outputs	Defines the maximum value the output is allowed to take on within the process. If an output above the high limit is requested, the Ch0HLimit alarm is set and the output signal will remain at the configured high limit

Notes:

Using Ladder Logic To Perform Run Time Services and Reconfiguration

You can use ladder logic to perform run time services on your module. For example, page 10-10 shows how to unlatch alarms on the 1756-IF6I module using RSLogix 5000. This appendix provides an example of how to unlatch those same alarms **without using RSLogix 5000.**

In addition to performing run time services, you can use ladder logic to change configuration. Chapter 10 explained how to use the RSLogix 5000 software to set configuration parameters in your ControlLogix analog I/O module. Some of those parameters may also be changed through ladder logic.

Using Message Instructions

In ladder logic, you can use message instructions to send occasional services to any ControlLogix I/O module. Message instructions send an explicit service to the module, causing specific behavior to occur, for example, unlatching a high alarm.

Message instructions maintain the following characteristics:

- messages use unscheduled portions of system communications bandwidth
- one service is performed per instruction
- performing module services does not impede module functionality, such as sampling inputs or applying new outputs

Processing Real-Time Control and Module Services

Services sent via message instructions are not as time critical as the module behavior defined during configuration and maintained by a real-time connection. Therefore, the module processes messaging services only after the needs of the I/O connection have been met.

For example, you may want to unlatch all process alarms on the module, but real-time control of your process is still occurring using the input value from that same channel. Because the input value is critical to your application, the module prioritizes the sampling of inputs ahead of the unlatch service request.

This prioritization allows input channels to be sampled at the same frequency and the process alarms to be unlatched in the time between sampling and producing the real-time input data.

One Service Performed Per Instruction

Message instructions will only cause a module service to be performed once per execution. For example, if a message instruction sends a service to the module to unlatch the high high alarm on a particular channel, that channel's high high alarm will unlatch, but may be set on a subsequent channel sample. The message instruction must then be reexecuted to unlatch the alarm a second time.

Creating a New Tag

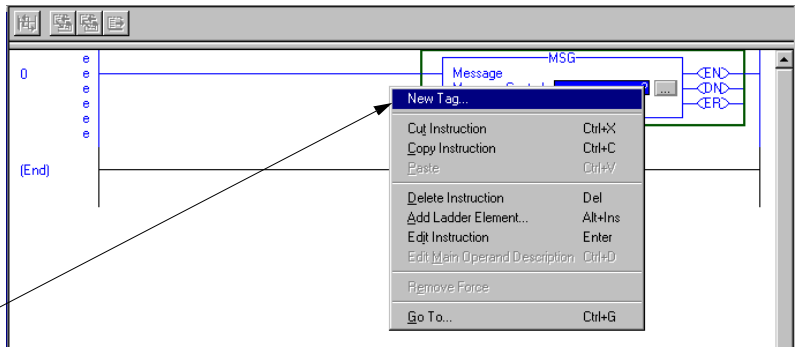
This ladder logic is written in the Main Routine.

Double-click here to enter the Main Routine

After adding a message instruction to a rung, you must create a tag for the message instruction

A. Right-click on the question mark (?) to see this pull-down menu.

B. Click on New Tag.



You must fill in the following information on the New Tag pop-up:

IMPORTANT We suggest you name the tag to indicate what module service is sent by the message instruction. For example, the message instruction below is used to unlatch a high alarm, and the tag is named to reflect this.

.

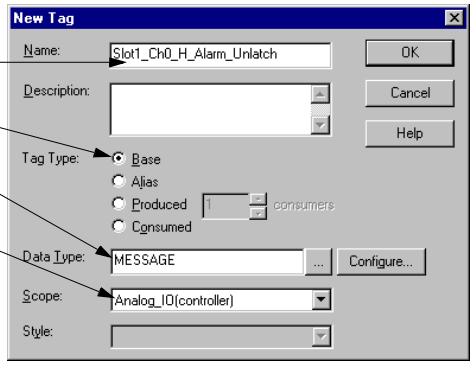
A. Name the tag.

B. Choose the Base tag type.

C. Choose the Message data type.

D. Choose the Controller scope.

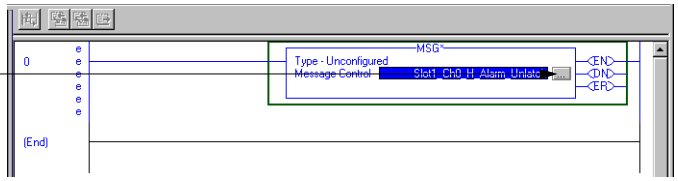
IMPORTANT: Message tags can only be created with the Controller Scope.



Enter Message Configuration

After creating a new tag, you must enter message configuration.

Click here to see the message configuration pop-up screens



Enter message configuration on the following screens:

- Configuration pop-up screen
- Communications pop-up screen

A description of the purpose and set-up of each screen follows.

IMPORTANT

In RSLogix 5000, version 10 and greater, the message configuration screens changed significantly to make it easier for you to configure you messages.

For example, **in version 9 and earlier**, depending on the Message Type, you are required to configure some combination of the following:

- Service Code
- Object Type
- Object ID
- Object Attribute
- Source
- Number of Elements
- Destination

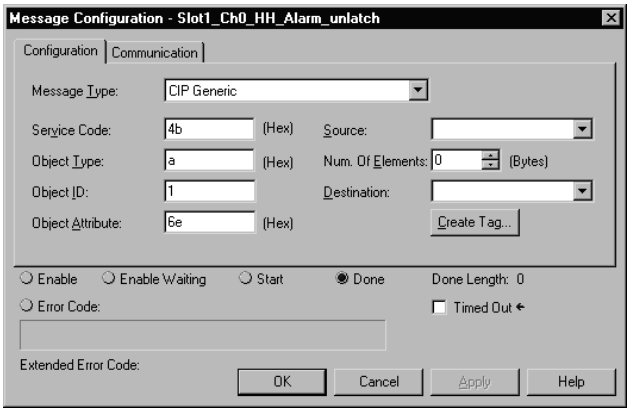
In **version 10 and greater**, however, you are only required to choose a Service Type. RSLogix 5000 fills in most of the fields listed above. You are only required to configure the Instance field; Instance represents the module channel on which the service is performed, if appropriate

The following sections show how to configure messages with RSLogix 5000, versions 9 and earlier and RSLogix 5000, versions 10 and greater.

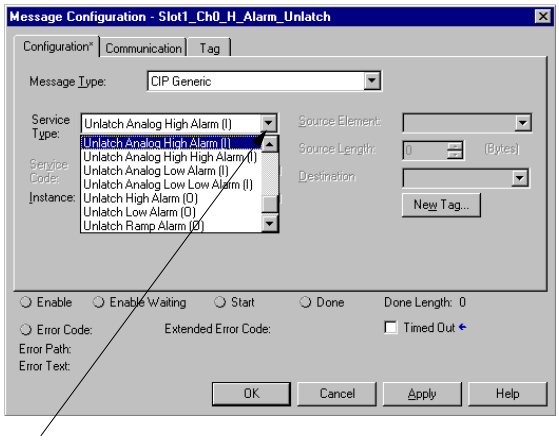
Configuration Pop-Up Screen

This pop-up screen provides information on what module service to perform and where to perform it. For example, you must use this screen to unlatch high high alarms (module service) on channel 0 of a 1756-IF6I module (where to perform service).

RSLogix 5000, version 9 and earlier



RSLogix 5000, version 10 and greater



In the newer versions of RSLogix 5000, you can use a pull-down menu to choose the Service Type. The list of available services includes multiple services to unlatch high high, high, low low, low, ramp and rate alarms.

Table C.1 contains required configuration pop-up screen information to perform input module services. This information is only necessary if you are configuring the message with **RSLogix 5000, versions 9 or earlier**:

Table C.1 Analog Input Modules Configuration Pop-Up Screen Information

Enter the following:	To unlatch the high high alarm:	To unlatch the high alarm:	To unlatch the low alarm:	To unlatch the low low alarm:	To unlatch the rate alarm:
Service Code	4B	4B	4B	4B	4B
Object Type	0A	0A	0A	0A	0A
Object ID[1] (Channel Number)	1-6 or 1-8	1-6 or 1-8	1-6 or 1-8	1-6 or 1-8	1-6 or 1-8
Object Attribute	6E	6C	6B	6D	6F
Number of Elements	0 bytes	0 bytes	0 bytes	0 bytes	0 bytes

(1) The 1756-IF16 module does not have any unlatchable features in the 16 channel mode.

IMPORTANT

For input or output modules, the Object Attribute determines which alarm feature for the selected channel to unlatch. If this field is left blank, **all alarms for the selected channel** will be unlatched.

You must send separate message instructions to control specific alarms on each channel of the module.

Also, Object ID represents channel number. For the 1756-IF6I, 1756-IR6I and 1756-IT6I modules, channels 0-5 are represented by Object ID 1-6. For the 1756-IF16 (in differential mode only) and 1756-IF8 modules, channels 0-7 are represented by Object ID 1-8.

Table C.2 contains required configuration pop-up screen information to perform output module services. This information is only necessary if you are configuring the message with **RSLogix 5000, versions 9 or earlier**:

Table C.2 Analog Output Modules Configuration Pop-Up Screen Information

Enter the following:	To unlatch the high alarm:	To unlatch the low alarm:	To unlatch the ramp alarm:
Service Code	4B	4B	4B
Object Type	0B	0B	0B
Object ID (Channel Number)	1-6 or 1-8	1-6 or 1-8	1-6 or 1-8
Object Attribute	6F	6E	70
Number of Elements	0 bytes	0 bytes	0 bytes

Communications Pop-Up Screen

This pop-up screen provides information on the path of the message instruction. For example, the slot number of a 1756-IF6I distinguishes exactly which module a message is designated for.

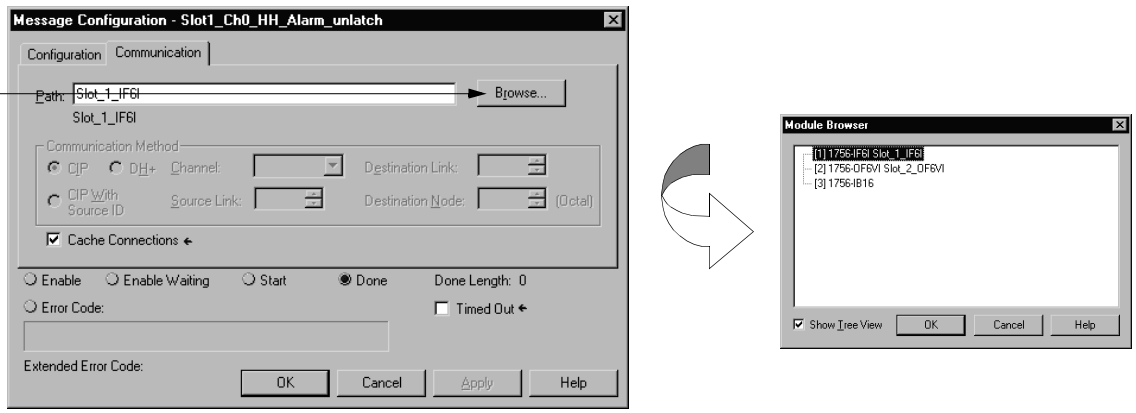
IMPORTANT

Use the Browse button to see a list of the I/O modules in the system. You choose a path when you choose a module from the list.

You must name an I/O module during initial module configuration to choose a path for your message instruction.

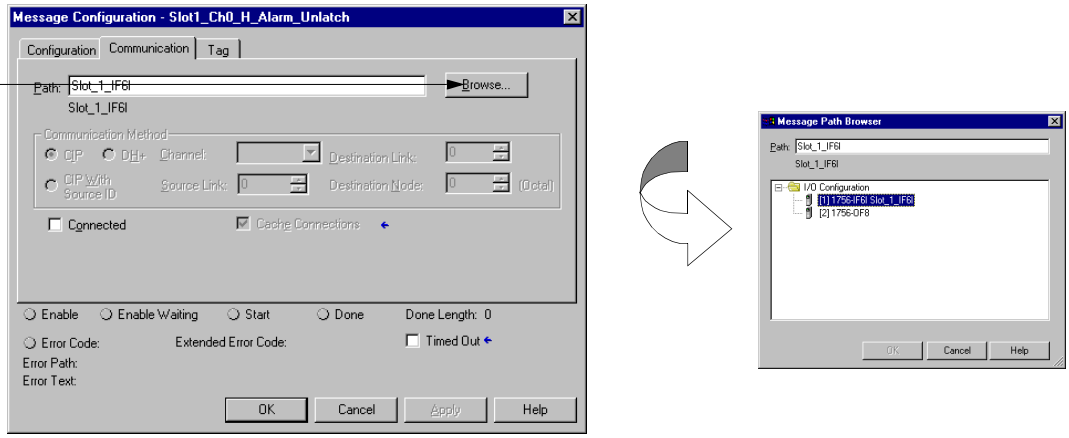
RSLogix 5000, version 9 and earlier

Use this Browse button to see a list.



RSLogix 5000, version 10 and greater

Use this Browse button to see a list.



Unlatch Alarms in the 1756-IF6I

Example Rungs 0-4 show how to unlatch the following alarms in a 1756-IF6I module, named *Slot_1_IF6I*:

- Channel 0 High high alarm - Rung 0
- Channel 0 High alarm - Rung 1
- Channel 0 Low alarm - Rung 2
- Channel 0 Low low alarm - Rung 3
- Channel 0 Rate alarm - Rung 4

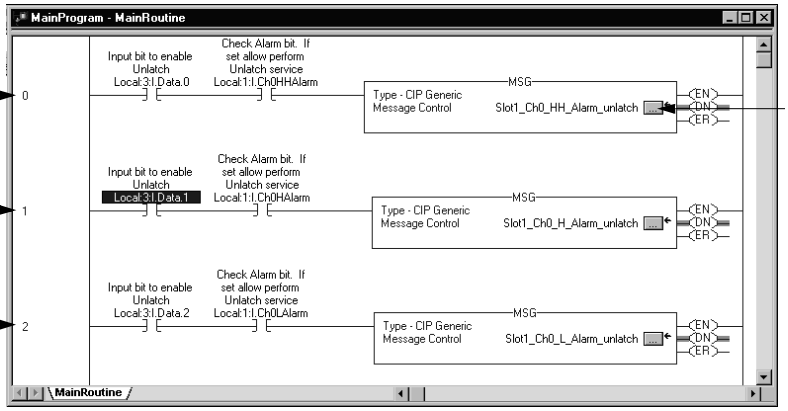
IMPORTANT An I/O module must be configured to latch alarms, see pages 10-9 & 10-13, before you can perform unlatch services using ladder logic. If an unlatch service is received by a module not configured to latch alarms, the message instruction will error.

Also, all alarms for channel 0 can be unlatched simultaneously with a single message instruction by leaving the object attribute field blank.

Rung 0 unlatches the high high alarm.

Rung 1 unlatches the high alarm.

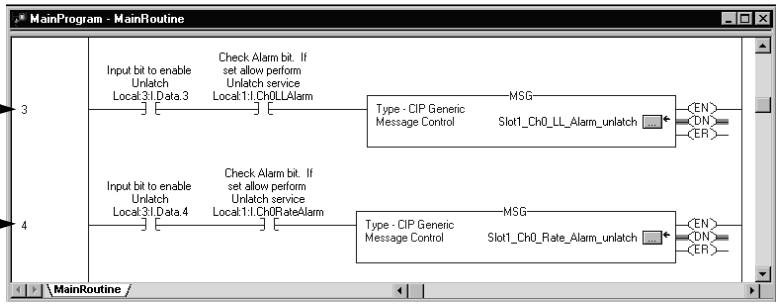
Rung 2 unlatches the low alarm.



Click on the box in each rung to see the configuration and communication information pop-up associated with it. This information is explained on the next page.

Rung 3 unlatches the low low alarm.

Rung 4 unlatches the rate alarm.



Configuration Pop-Up Screens

The screen below shows the Configuration pop-up for Rung 0.

RSLogix 5000, version 9 and earlier

This pop-up screen contains the same information for each rung, except for the Object Attribute field. The information in this field is as follows:

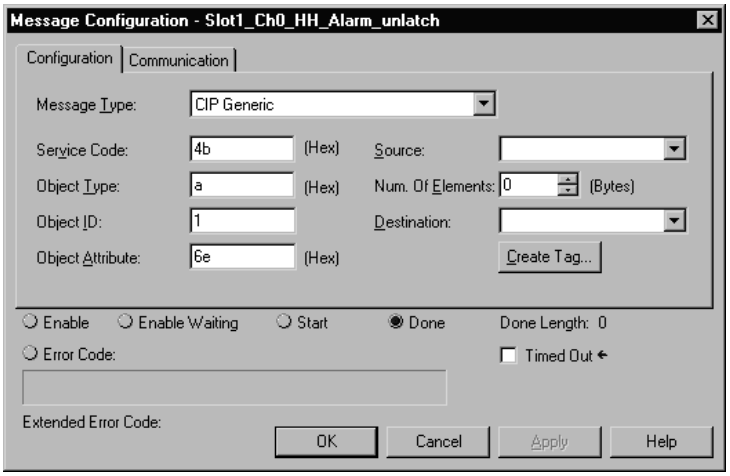
Rung 0 - 6e

Rung 1 - 6c

Rung 2 - 6b

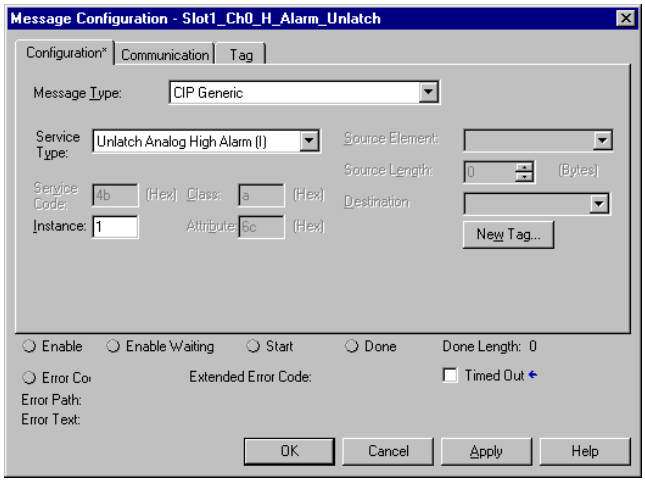
Rung 3 - 6d

Rung 4 - 6f



RSLogix 5000, version 10 and greater

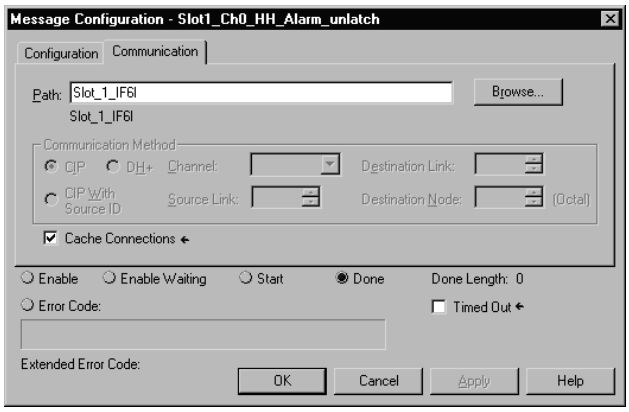
With the newer RSLogix 5000 versions, you are only required to choose a service type and configure the instance.



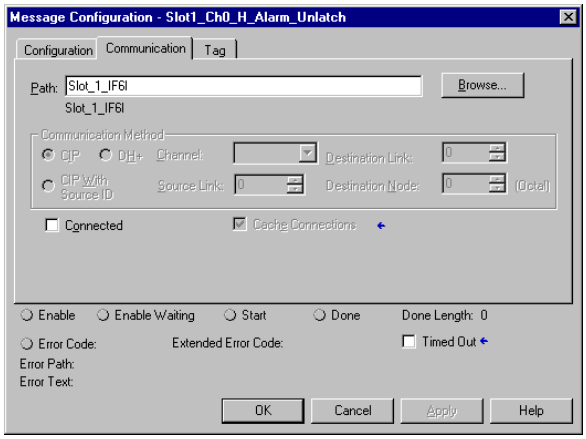
Communications Pop-Up Screens

The screen below shows the Communications pop-up for Rung 0. This pop-up screen is the same for each rung of this example.

RSLogix 5000, version 9 and earlier



RSLogix 5000, version 10 and greater



IMPORTANT You must name an I/O module to set the message path under that module's communication tab.

Unlatch Alarms in the 1756-OF6VI

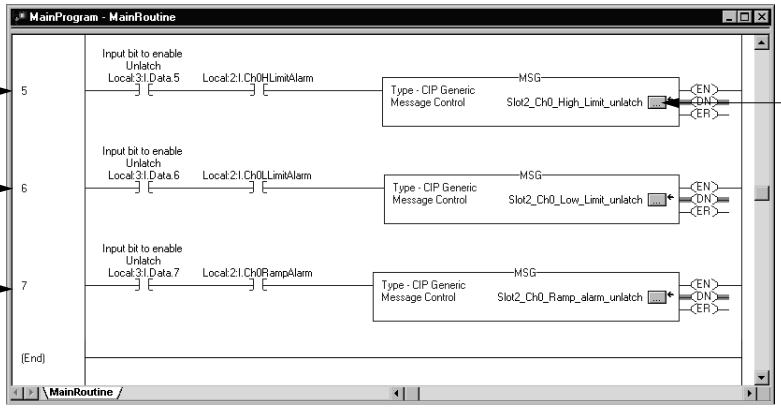
Example Rungs 5-7 show how to unlatch the following alarms in a 1756-OF6VI module:

- High limit alarm - Rung 5
- Low limit alarm - Rung 6
- Ramp alarm - Rung 7

Rung 5 unlatches the high limit alarm.

Rung 6 unlatches the low limit alarm.

Rung 7 unlatches the ramp alarm.

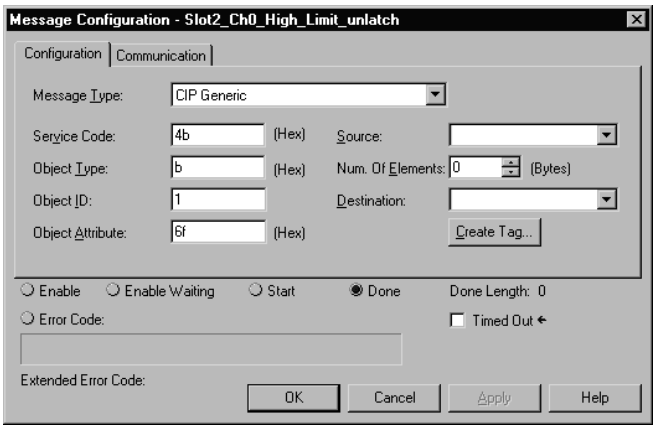


Click on the box in each rung to see the configuration and communication information pop-up associated with it. This information is explained below.

Configuration Pop-Up Screens

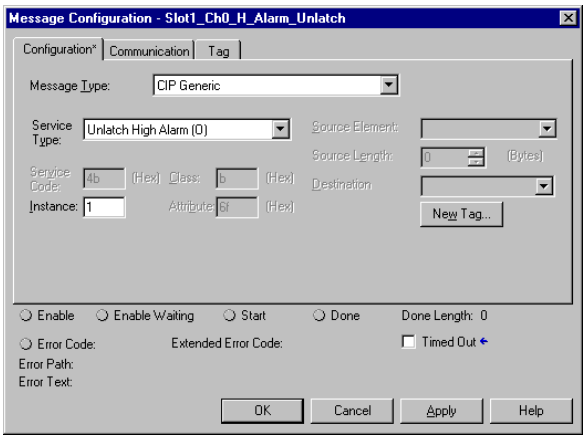
The screen below shows the Configuration pop-up for Rung 5.

RSLogix 5000, version 9 and earlier



This pop-up screen contains the same information for each rung, except for the Object Attribute field. The information in this field is as follows:
Rung 5 - 6f
Rung 6 - 6e
Rung 7 - 70

RSLogix 5000, version 10 and greater

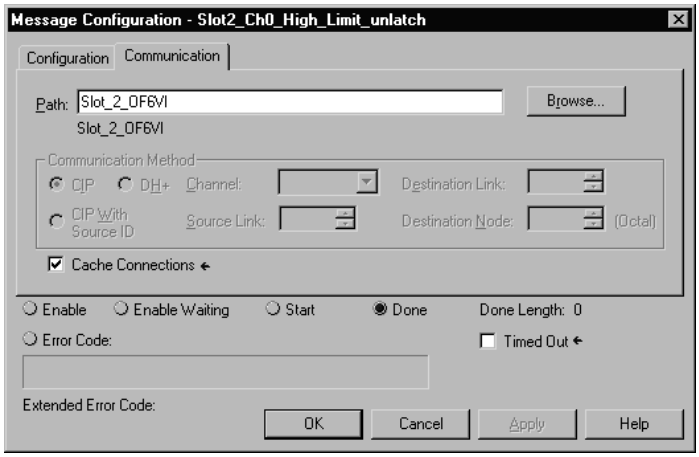


With the newer RSLogix 5000 versions, you are only required to choose a service type and configure the instance.

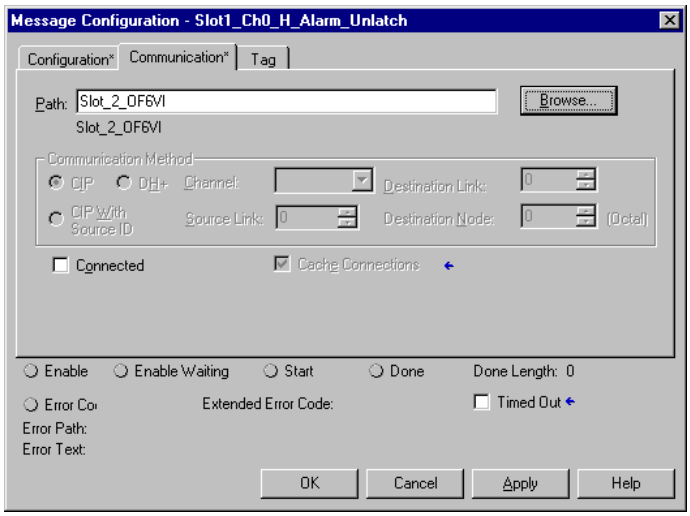
Communications Pop-Up Screens

The screen below shows the Communications pop-up for Rung 5. This pop-up is the same for each rung in this example.

RSLogix 5000, version 9 and earlier



RSLogix 5000, version 10 and greater



IMPORTANT You must name an I/O module to set the message path under that module's communication tab.

Reconfiguring a 1756-IR6I Module

It is sometimes advantageous to change the functional operation of a module in the ControlLogix system automatically via the user program rather than using RSLogix5000 software to reconfigure it. This way, changes in the process can dictate when the reconfiguration should take place rather than the user performing that function manually.

The following steps are used in this example when reconfiguring a module via ladder are:

1. Move new configuration parameters to the Configuration portion of the Tag Structure associated with the module.

2. If you are using RSLogix 5000, **version 10 or greater**, use a message instruction to send a Reconfigure Module service to the same module.

   If you are using RSLogix 5000, **version 9 or earlier**, use a message instruction to send a Reset Module service to the same module to trigger sending the configuration data.

Before the new configuration parameters are sent to the module, the user must make sure that their relationship to each other is in a format the module will accept (see tables below).

IMPORTANT Reconfiguring analog modules via ladder should be limited to functions that involve **the changing of values only**. We do not recommend that enabling or disabling features be done via ladder. Use RSLogix 5000 to enable or disable these features.

Table C.3 and Table C.4 list module parameters that may be changed via ladder logic:

Table C.3 Permissible Analog Input Module Parameters to Change Via Ladder Logic

Feature:	Restriction:
High Engineering Value	Must not be equal to low engineering value
Low Engineering Value	Must not be equal to high engineering value
High-High Alarm Value	Must be greater than or equal to high alarm value
High Alarm Value	Must be greater than low alarm value
Low Alarm Value	Must be less than high alarm value
Low-Low Alarm Value	Must be less than or equal to low alarm value
Deadband	Must be less than half of high alarm minus low alarm

Table C.4 Permissible Analog Output Module Parameters to Change Via Ladder Logic

Feature:	Restriction:
High Clamp Value(1)	Must be greater than low clamp value
Low Clamp Value(1)	Must be less than high clamp value

(1) The values for user-defined state at Fault or Program (set during initial configuration) must fall within the range of the High and Low Clamp values.

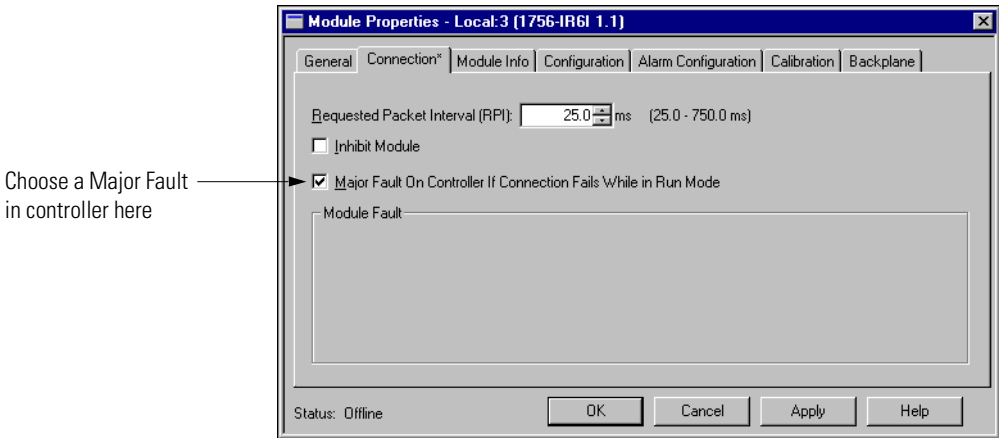
Considerations With This Ladder Logic Example

IMPORTANT The considerations listed in this section only apply if you are using RSLogix 5000, version 9 or earlier.

If you are using RSLogix 5000, **version 10 or greater, none of these considerations apply.**

Remember the following when using this method of module reconfiguration using the reset service:

- When this method of reconfiguration is used on Output modules, ALL module outputs will be reset to Zero for at least three seconds
- This method of reconfiguration will cause a Major Fault in the controller if the module was initially configured to do so on the following screen:



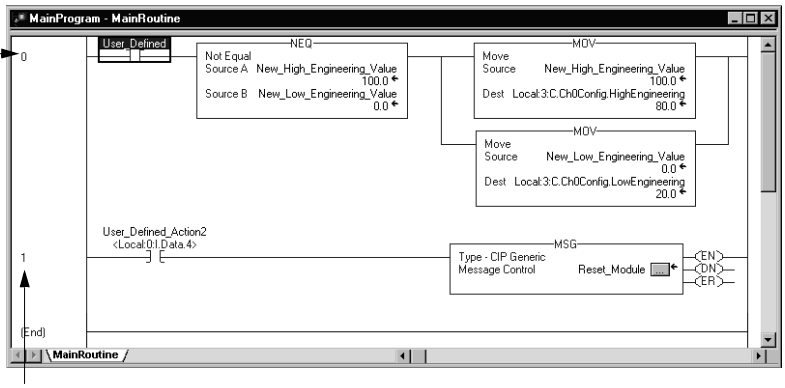
- All Listen-Only controllers will lose their connections to the module for a minimum of three seconds after the Reset is performed.
- If the Reconfiguration is performed on an Input module with multiple owners, then all owners will lose their connections simultaneously after the Reset is performed. In order to re-establish all their connections, all owners must change their configuration to the same values BEFORE the Reset is performed.

The following ladder example shows how to change the High and Low Engineering Values (Scaling Parameters) for an Analog Output module in Slot 3 of the Local Chassis:

Rung 0

This rung moves new Channel 0 scaling parameters to the configuration portion of the structure associated with an analog output module in Slot 3 of the local chassis.

The new values move at the user's discretion (represented by the user defined XIC instruction) after making sure the desired new high value is not equal to the desired new low value. This rung only moves the data to the configuration portion of the structure but does not send it to the module.



Rung 1

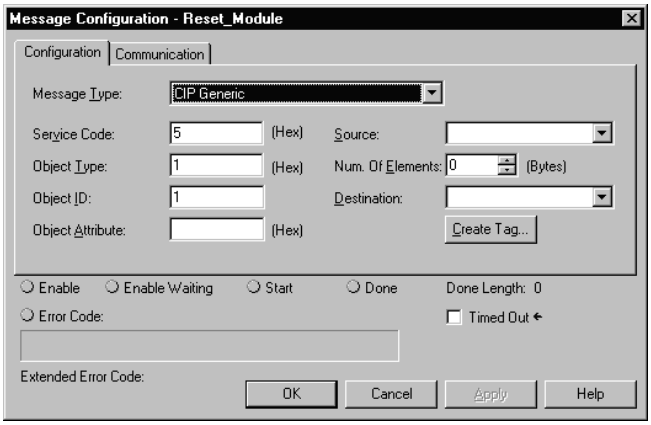
This rung sends the Reset Module service to the analog output module. Upon receipt, the module will initiate a hardware reset on itself, behaving as though it has just been inserted into the system. A connection is established and the new configuration parameters are sent.

Perform Module Reset Service

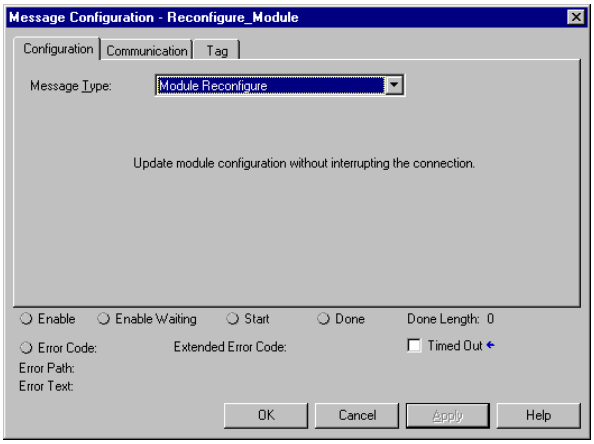
The following configuration and communication pop-up screens show the **message instruction to perform the Reset service** and its path:

The screen below shows the Configuration pop-up.

RSLogix 5000, version 9 and earlier

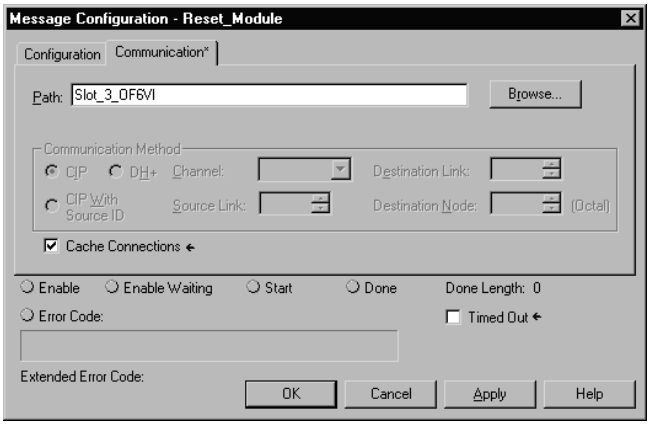


RSLogix 5000, version 10 and greater

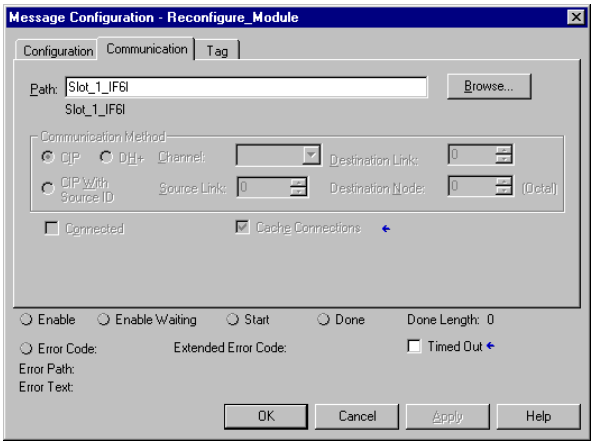


The screen below shows the Configuration pop-up.

RSLogix 5000, version 9 and earlier



RSLogix 5000, version 10 and greater



Notes:

Power Supply Sizing Chart

Use Table D.1 to check the power your ControlLogix chassis is using.

Table D.1

Slot number	Module Catalog Number	Current @ 5.1 VDC (mA)		Power @ 5.1 VDC (Watts)	Current @ 24 VDC (mA)		Power @ 24 VDC (Watts)	Current @ 3.3 VDC (mA)		Power @ 3.3 VDC (Watts)
0			x 5.1V =			x 24V =			x 3.3V =	
1			x 5.1V =			x 24V =			x 3.3V =	
2			x 5.1V =			x 24V =			x 3.3V =	
3			x 5.1V =			x 24V =			x 3.3V =	
4			x 5.1V =			x 24V =			x 3.3V =	
5			x 5.1V =			x 24V =			x 3.3V =	
6			x 5.1V =			x 24V =			x 3.3V =	
7			x 5.1V =			x 24V =			x 3.3V =	
8			x 5.1V =			x 24V =			x 3.3V =	
9			x 5.1V =			x 24V =			x 3.3V =	
10			x 5.1V =			x 24V =			x 3.3V =	
11			x 5.1V =			x 24V =			x 3.3V =	
12			x 5.1V =			x 24V =			x 3.3V =	
13			x 5.1V =			x 24V =			x 3.3V =	
14			x 5.1V =			x 24V =			x 3.3V =	
15			x 5.1V =			x 24V =			x 3.3V =	
16			x 5.1V =			x 24V =			x 3.3V =	
	TOTALS	**mA**		**W**	**mA**		**W**	**mA**		**W**
		This number cannot exceed 10000mA			This number cannot exceed 2800mA			This number cannot exceed 4000mA		
				These three numbers added together cannot exceed: **70W @40°C** **55W @ 60°C**						

IMPORTANT We recommend that you copy this worksheet for use in checking the power supply of each ControlLogix chassis used.

Notes:

Additional Specification Information

This appendix offers additional calibration information that may assist you in using the ControlLogix analog I/O module.

For more information on:	See page:
Analog to Digital (A/D) Converter Accuracy	E-1
Calibrated Accuracy	E-2
Error Calculated Over Hardware Range	E-3
How Operating Temperature Changes Affect Module Accuracy	E-3
RTD Error	E-5
Thermocouple Error	E-6
Thermocouple Resolution	E-14

Analog to Digital (A/D) Converter Accuracy

There are two types of calibration that occur on a ControlLogix analog I/O module.

- The user-directed and user-performed calibration process described in Chapter 11. This type of calibration occurs only when you determine it is necessary and involves an external calibration instrument like those listed in Table 11.1 on page 11-2.

- A self-calibration process that takes place internally on ControlLogix analog I/O modules when either of the following events occurs:
  - Module power is cycled
  - You begin the user calibration described in Chapter 11.

  The "A/D self-calibration" feature maintains the accuracy of the A/D convertor found on all 1756 isolated analog modules. This feature executes each time the module cycles power or when a self-calibration cycle is initiated.

  The self-calibration compensates for inaccuracies of the on-board reference signal and the A/D convertor only. In other words, the self-calibration feature makes sure that the A/D convertor itself is accurate with respect to its on-board voltage reference that is used for a conversion of the input signal. Together with user calibration, the module's total accuracy is maintained.

Calibrated Accuracy

The *Calibrated Accuracy* specification represents the module's accuracy when its ambient (i.e. operating) temperature is the same as the temperature at which the module was calibrated.

Immediately following a calibration, a ControlLogix analog I/O module is most accurate. Because the module was calibrated at its zero and span, the inaccuracy is largely non-linearity between zero and span. Assuming the module is operating at the exact temperature when it was calibrated and uses the same voltage source to check the post-calibration accuracy, a module may be as accurate as 0.01% to 0.05% of range.

Once the module begins operation, its accuracy lessens as components change over time. However, this change (in components or accuracy) is different from the Gain Drift With Temperature specification described on page E-3.

Other than non-linearity, the *Calibrated Accuracy @ 25°C* specification represents a time drift/aging specification between calibrations. A module with a calibration accuracy of 0.01% of range immediately following calibration is estimated to be better than 0.1% of range @ 25°C for one year (i.e. the calibration cycle).

The reason for the difference between 0.01% and 0.1% of range is that the *Calibrated Accuracy @ 25°C* specification must capture the effect of component aging until the next time the module is calibrated. Primarily, the module's operating conditions, such as temperature, humidity, and power cycling, affect component aging.

Because ControlLogix analog I/O modules operate in different conditions, the specific accuracy deviation from 0.01% of range cannot be measured. Typically, however, a module's *Calibrated Accuracy @ 25°C* is closer to 0.05% of range than 0.1% of range as the 0.1% of range is determined by the worst case scenario operating conditions.

Error Calculated Over Hardware Range

A ControlLogix analog I/O module's calibration accuracy at 25°C is calculated over the full hardware range of the module and is not dependent on the application's use of the range. The error is the same if you are measuring it across a 10% or 100% portion of a given range.

However, a module's accuracy at 25°C is dependent on the hardware range in which the module operates.

EXAMPLE

The 1756-IT6I module offers two input ranges, -12 to 30mV and -12 to 78mV. Because module error at 25°C depends on the input range used, the module error is as follows when using 0.1% of range accuracy:

- +/- 42µV for the -12 to 30mV range
- +/- 90µV for the -12 to 78mV range

These error values are the same whether you use 10% or 100% of the chosen range.

How Operating Temperature Changes Affect Module Accuracy

The following specifications take into account how the module's operating temperature changes can affect a module's accuracy:

- Gain Drift With Temperature
- Module Error Over Full Temperature Range

Gain Drift With Temperature

The *Gain Drift with Temperature* specification represents the calibration inaccuracy that occurs as a module's ambient (i.e. operating) temperature drifts from the temperature at which it was calibrated.

You can use the *Gain Drift with Temperature* specification (varies for each catalog number) to determine the module's calibration inaccuracy for each degree between calibration and operating temperature. The *Gain Drift with Temperature* specification represents a percentage of the full operating range that the module's calibration is inaccurate to for each degree difference. The specification is determined with the following formula:

Gain Drift with Temperature = (PPM/°C) x Module's Full Range

Because the specifications listed in Appendix A include a typical and worst case PPM/°C for each module, you can determine multiple Gain Drift with Temperature values for each module.

EXAMPLE

For example, the 1756-IT6I module has a maximum *Gain Drift with Temperature* specification of 80ppm/°C. The 80ppm represents 0.008% of the module's full operating temperature.

If the module was calibrated to operate in the -12mV to 78mV input range, then following formula is used:

(0.008/°C) x 90mV = +/-7.2µV/°C

For every degree C that the module's operating temperature moves from the calibration temperature, the maximum calibration accuracy deviation is +/-7.2µV.

Module Error Over Full Temperature Range

The *Module Error Over Full Temperature Range* specification represents the error that occurs if the module's ambient temperature changes a total of 60°C (i.e. from 0 to 60°C or 60 to 0°C). While this temperature change is extremely unlikely, it represents the worst case scenario.

This specification is determined by multiplying the temperature change by the maximum *Gain Drift with Temperature* for the given module. In other words, we determine Module Error Over Full Temperature Range with the following formula:

Module Error Over Full Temperature = Full Temperature Range x Gain Drift with Temperature

EXAMPLE

The 1756-IT6I module has a maximum *Gain Drift with Temperature* specification = 80 ppm/°C.

Module Error over Full Temperature Range = 60°C (full temperature range) X 80 ppm/°C (gain drift). The result is 4800 ppm or 0.48%.

RTD and Thermocouple Error Calculations

When you using the temperature-measuring modules (1756-IR6I, 1756-IT6I and 1756-IT6I2), error calculations are achieved in the following two-step process:

1. Calculate the module's error in ohms or volts
2. Convert the ohm/volt error to temperature for the specific sensor and at the correct application temperature

RTD Error

Module error on the 1756-IR6I module is defined in ohms and is calculated across the entire input range selected, not the available range of a sensor used with the module. For example, if the 1 ohm to 487 ohm input range is used, the module error is calculated across 507 ohms (actual range = 0.86 ohms to 507.86 ohms).

The error in ohms translates to temperature, but that translation varies because the relationship is non-linear. The most effective way to check 1756-IR6I module error is to calculate the error in ohms and use that value in a linearization table to check the temperature error.

If the module is calibrated at operating temperature and the operating temperature remains relatively stable, calibration accuracy is better than 0.1% of the full range for the first year after calibration. This 0.1% value is a worst case value. In other words, with the 1 ohm to 487 ohms input range selected, the worst case module error is 0.507 ohms.

Finally, you must check an RTD linearization table to determine the temperature error to which an error of 0.507 ohms translates. For example, if the 1756-IR6I has a 0.1% (or 0.507 ohms) error and is operating at 0°C, the temperature error is -1.25°C to +1.2°C–when the Platinum 385 sensor type is used. However, this same ohms error calculated in an operating temperature of 200°C translates to a temperature error of -1.4°C to +1.4°C.

Thermocouple Error

Thermocouple error at 25°C indicates the module's accuracy in measuring temperature. This accuracy varies depending on the following factors:

- Input range used, either:
  - -12 to 30mV
  - -12 to 78mV
- Thermocouple type, any of the following:
  - B, R, S, E, J, K, N, T, L or D (L and D types can be used with the 1756-IT6I2 only)
- Application temperature (i.e. the temperature of the physical location where the thermocouple is being used)

EXAMPLE

For example, when the 1756-IT6I module is operating in the following conditions:

- -12 to 30mV input range
- connected to a type S thermocouple
- application temperature of 1200°C

the module error at 25°C is +/-1.75 degrees.

In other words, the difference between the temperature the module reports and the actual application temperature can be +/- 1.75 degrees.

The module may report an application temperature of 1200° celsius in this case when the actual temperature can be in the range from 1196.26 to 1203.74° celsius.

IMPORTANT

When determining the thermocouple error, we used a typical error of 0.05% of temperature range. The error calculations are listed for each range (i.e. -12 to 30mv and -12 to 78mV) in the rest of this section.

However, keep in mind that if cold junction compensation is performed on the thermocouple modules, the cold junction sensor error values must be added to the +/-1.75 degrees value in the example above and the numbers listed in the rest of this section.

Module Error at 25°C (-12 to 30mV Range)

Table E.1 lists the ControlLogix thermocouple modules' error at 25°C when used in the -12 to 30mV input range.

Table E.1

Application Temperature	Module Error (in degrees) at 25°C When Connected to This Thermocouple Type:							
	B	R	S	E[1]	J[2]	K[3]	N[4]	T
-200°C				0.836	0.96	1.376	2.115	1.334
0°C				0.358	0.42	0.532	0.803	0.542
200°C		2.37	2.48	0.284	0.38	0.525	0.637	0.395
400°C		2.02	2.19	0.262	0.38	0.497	0.566	0.340
600°C	3.53	1.85	2.06			0.494	0.539	
800°C	2.75	1.71	1.93				0.535	
1000°C	2.30	1.59	1.82					
1200°C	2.03	1.51	1.75					
1400°C	1.86	1.49	1.73					
1600°C	1.80	1.51	1.77					
1800°C	1.83	1.71	2.04					

(1) Type E thermocouples can only be used in applications up to 400°C.

(2) Type J thermocouples can only be used in applications up to 550°C.

(3) Type K thermocouples can only be used in applications up to 700°C.

(4) Type N thermocouples can only be used in applications up to 800°C.

The information represented in Table E.1 is shown graphically in Figure E.1 through Figure E.8.

Figure E.1 Thermocouple Module Error at 25° - Type B Thermocouple Connection in a -12 to 30mV Input Range

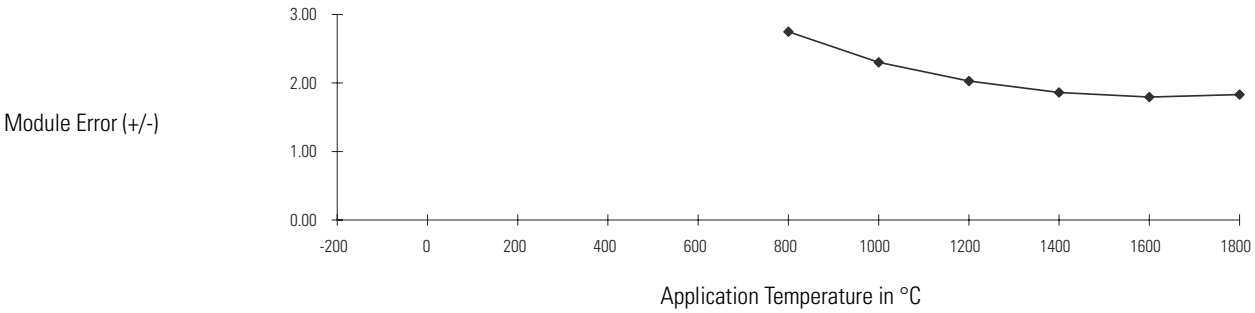


Figure E.2 Thermocouple Module Error at 25° - Type R Thermocouple Connection in a -12 to 30mV Input Range

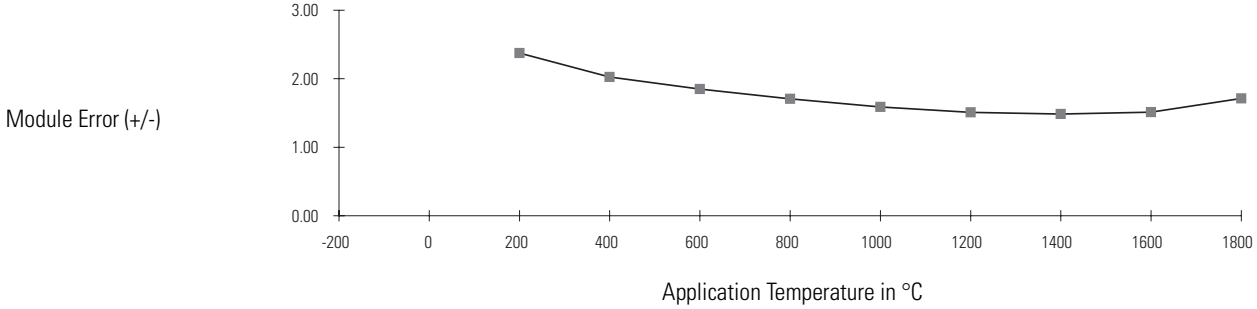


Figure E.3 Thermocouple Module Error at 25° - Type S Thermocouple Connection in a -12 to 30mV Input Range

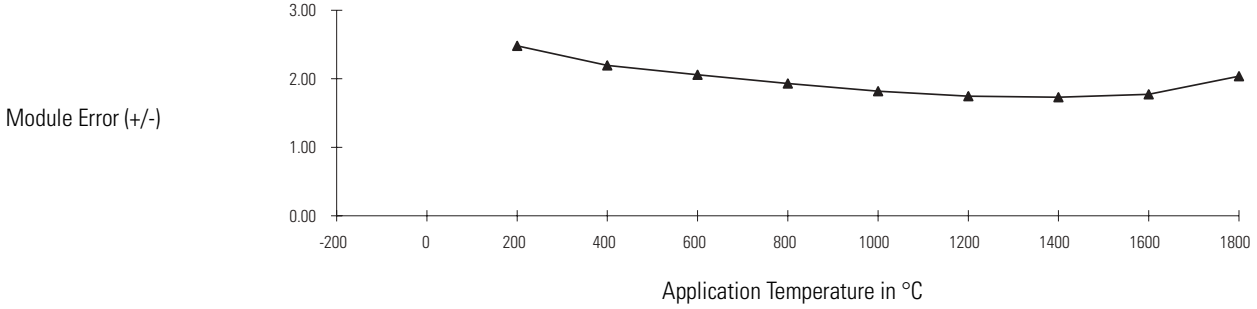


Figure E.4 Thermocouple Module Error at 25° - Type E Thermocouple Connection in a -12 to 30mV Input Range

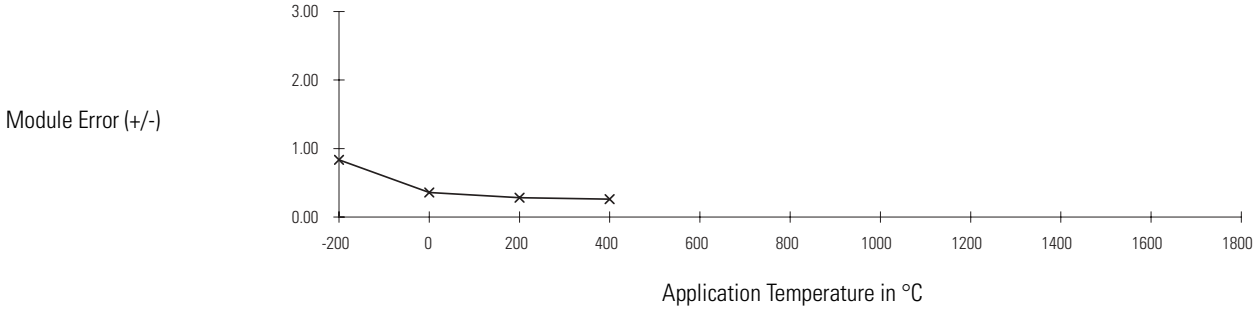


Figure E.5 Thermocouple Module Error at 25° - Type J Thermocouple Connection in a -12 to 30mV Input Range

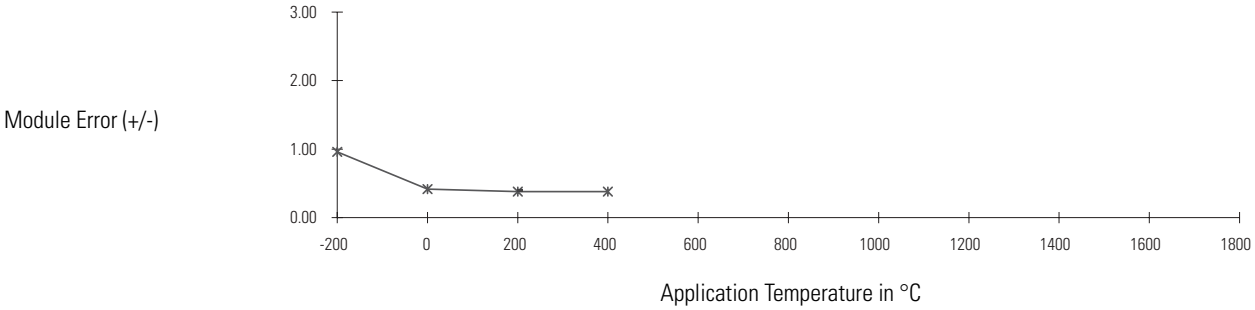


Figure E.6 Thermocouple Module Error at 25° - Type K Thermocouple Connection in a -12 to 30mV Input Range

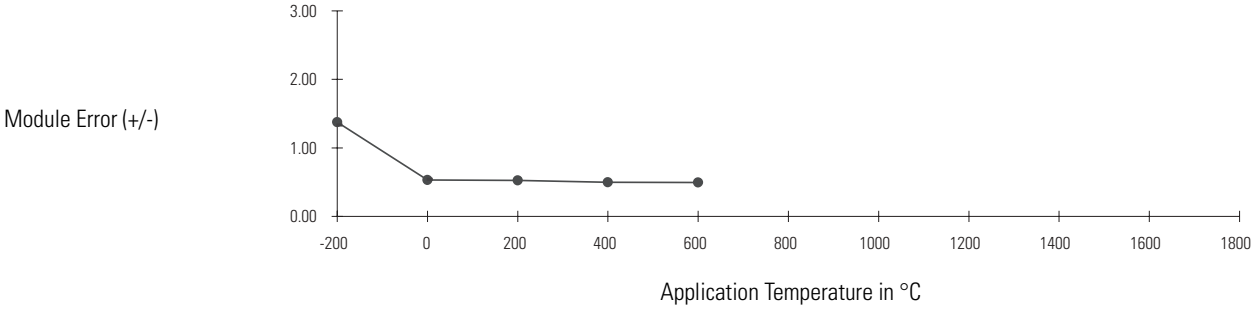


Figure E.7 Thermocouple Module Error at 25° - Type N Thermocouple Connection in a -12 to 30mV Input Range

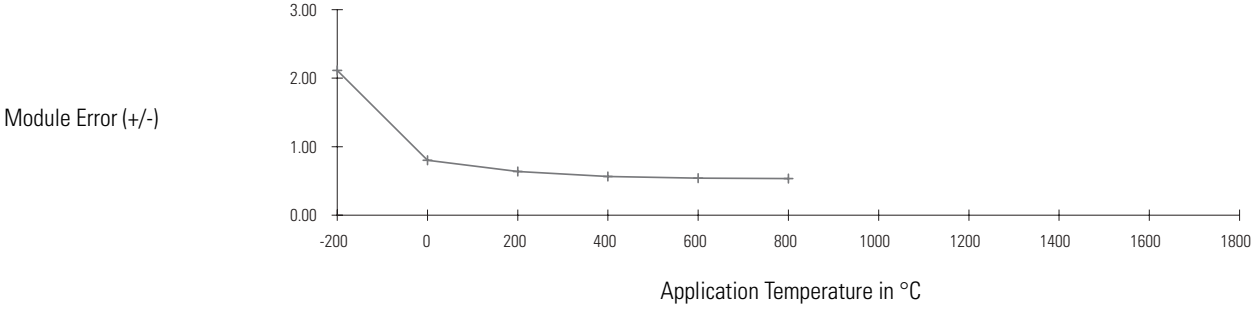
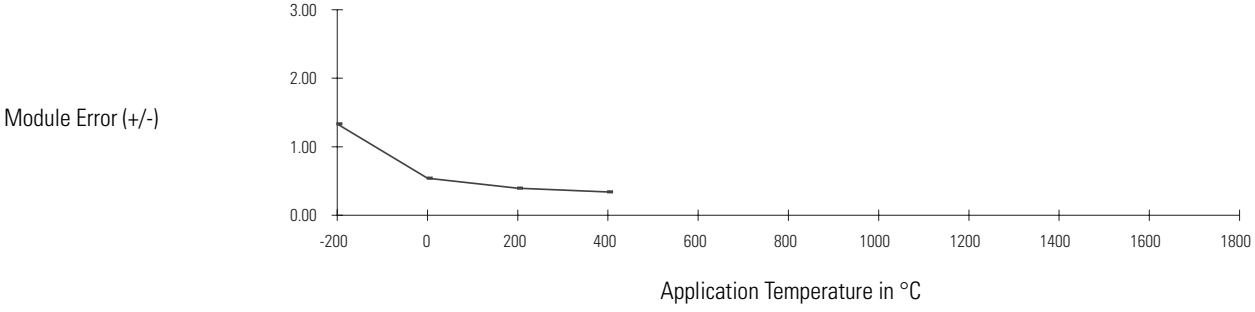


Figure E.8 Thermocouple Module Error at 25° - Type T Thermocouple Connection in a -12 to 30mV Input Range



Module Error at 25°C (-12 to 78mV Range)

Table E.2 lists the ControlLogix thermocouple modules' error at 25°C when used in the -12 to 78mV input range.

Table E.2

Application Temperature in °C:	Module Error (in degrees) at 25°C When Connected to This Thermocouple Type:							
	B	**R**	**S**	**E**	**J**	**K**	**N**	**T**
-200°C				1.791	2.06	2.949	4.532	2.859
0°C				0.767	0.89	1.141	1.720	1.161
200°C		5.09	5.32	0.608	0.81	1.126	1.364	0.847
400°C		4.34	4.70	0.562	0.82	1.065	1.212	0.728
600°C	7.56	3.96	4.41	0.558	0.77	1.059	1.155	
800°C	5.89	3.65	4.14	0.574	0.70	1.098	1.146	
1000°C	4.93	3.40	3.90	0.599	0.76	1.154	1.165	
1200°C	4.35	3.23	3.74		0.79	1.233	1.210	
1400°C	3.99	3.18	3.71			1.328		
1600°C	3.85	3.24	3.80					
1800°C	3.92	3.67	4.36					

The information represented in Table E.2 is shown graphically in Figure E.9 through Figure E.16.

Figure E.9 Thermocouple Module Error at 25° - Type B Thermocouple Connection in a -12 to 78mV Input Range

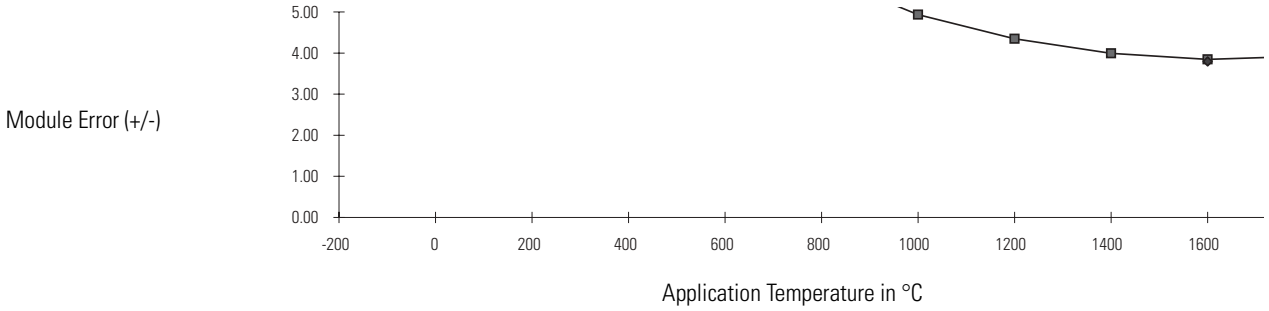


Figure E.10 Thermocouple Module Error at 25° - Type R Thermocouple Connection in a -12 to 78mV Input Range

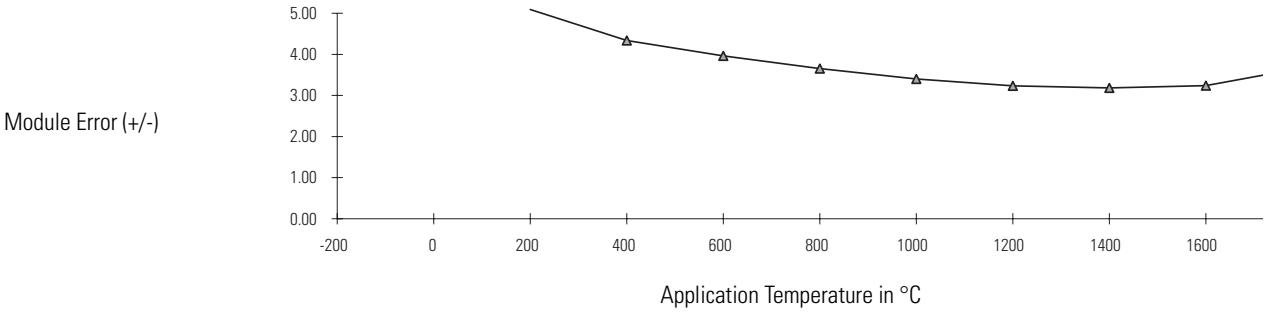


Figure E.11 Thermocouple Module Error at 25° - Type S Thermocouple Connection in a -12 to 78mV Input Range

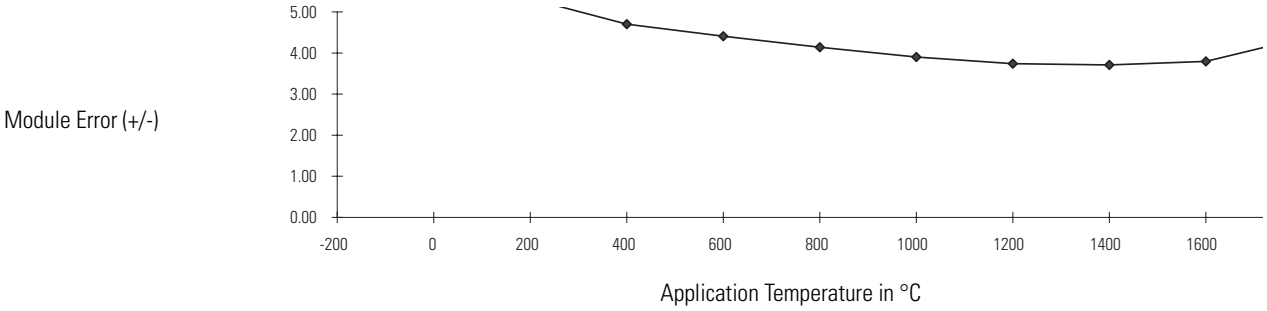


Figure E.12 Thermocouple Module Error at 25° - Type E Thermocouple Connection in a -12 to 78mV Input Range

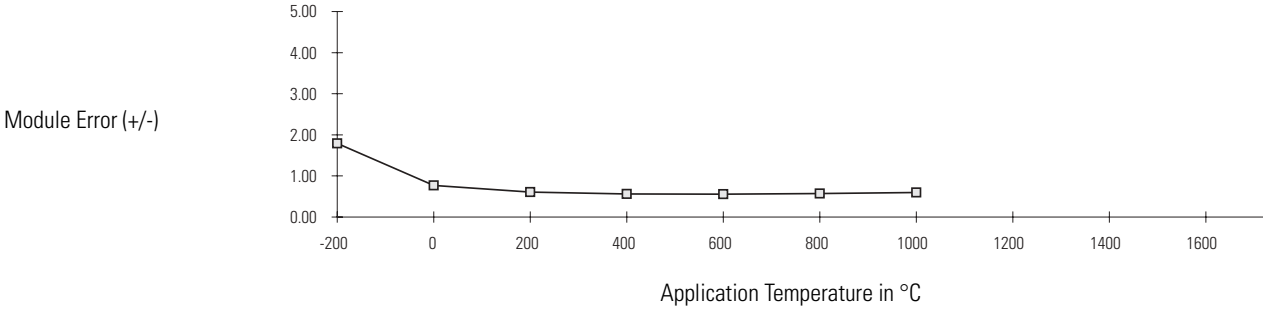


Figure E.13 Thermocouple Module Error at 25° - Type J Thermocouple Connection in a -12 to 78mV Input Range

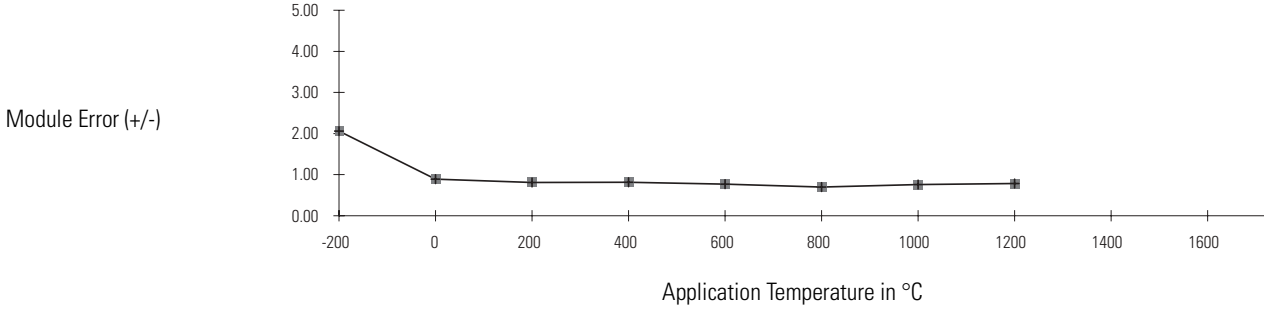


Figure E.14 Thermocouple Module Error at 25° - Type K Thermocouple Connection in a -12 to 78mV Input Range

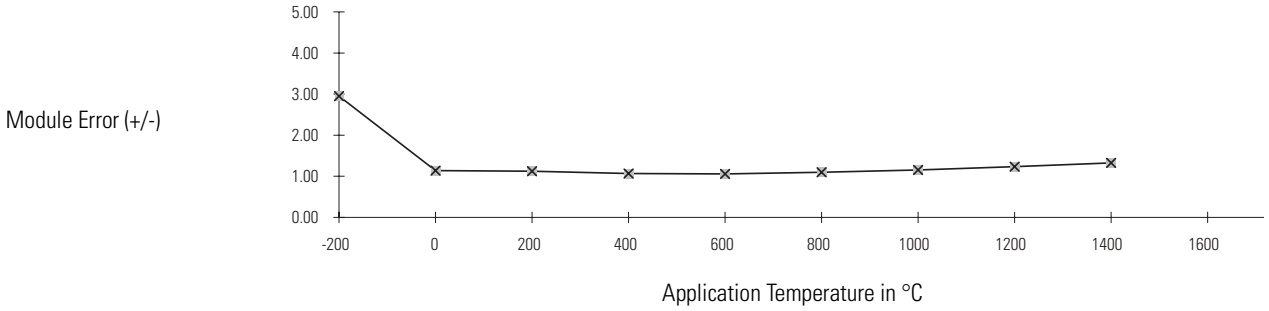


Figure E.15 Thermocouple Module Error at 25° - Type N Thermocouple Connection in a -12 to 78mV Input Range

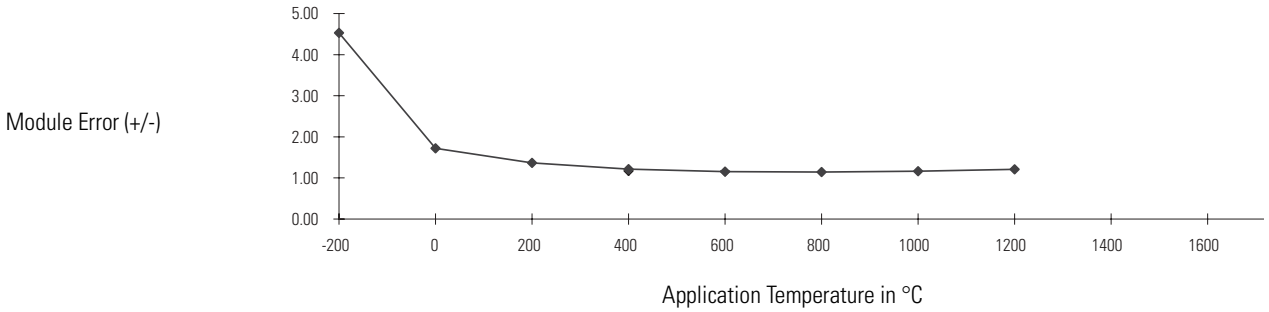
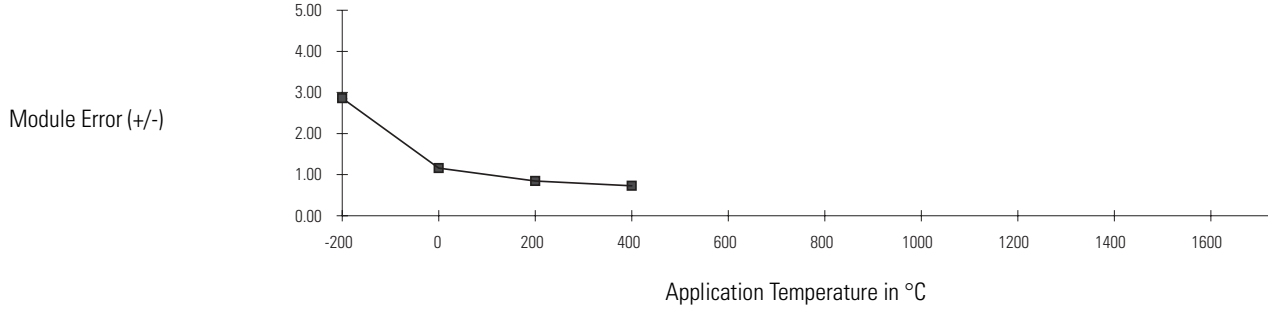


Figure E.16 Thermocouple Module Error at 25° - Type T Thermocouple Connection in a -12 to 78mV Input Range



Thermocouple Resolution

Thermocouple resolution indicates the degrees that an application temperature must change before the ControlLogix thermocouple module reports a change. Resolution varies depending on the following factors:

- Input range used, either:
  - -12 to 30mV
  - -12 to 78mV
- Thermocouple type, any of the following:
  - B, R, S, E, J, K, N, T, L and D (L and D are used on the 1756-IT6I2 module only)
- Application temperature (i.e. the temperature of the physical location where the thermocouple is being used)

EXAMPLE

For example, when the 1756-IT6I module is operating in the following conditions:

- -12 to 30mV input range
- connected to a type K thermocouple
- application temperature of 400°C

the resolution is 0.017 degrees.

In other words, the application temperature must change by 0.017 degrees or greater for the 1756-IT6I module to record a change. If the temperature stays in a range from 399.984 to 400.0169°C, the module will continue to report an application temperature of 400°C.

Module Resolution (-12 to 30mV Range)

Table E.3 lists the resolution of ControlLogix thermocouple modules when used in the -12 to 30mV input range.

Table E.3

Application Temperature in °C:	Module Resolution (in degrees) When Connected to This Thermocouple Type:							
	B	R	S	E(1)	J(2)	K(3)	N(4)	T
-200°C				0.028	0.032	0.046	0.071	0.044
0°C		0.13	0.13	0.012	0.014	0.018	0.027	0.018
200°C		0.08	0.08	0.009	0.013	0.018	0.021	0.013
400°C	0.17	0.07	0.07	0.009	0.013	0.017	0.019	0.011
600°C	0.12	0.06	0.07			0.016	0.02	
800°C	0.09	0.06	0.06				0.02	
1000°C	0.08	0.05	0.06					
1200°C	0.07	0.05	0.06					
1400°C	0.06	0.05	0.06					
1600°C	0.06	0.05	0.06					
1800°C	0.06	0.06	0.07					

(1) Type E thermocouples can only be used in applications up to 400°C.

(2) Type J thermocouples can only be used in applications up to 550°C.

(3) Type K thermocouples can only be used in applications up to 700°C.

(4) Type N thermocouples can only be used in applications up to 800°C.

The information represented in Table E.3 is shown graphically in Figure E.17 through Figure E.24.

Figure E.17 Thermocouple Module Resolution - Type B Thermocouple Connection in a -12 to 30mV Input Range

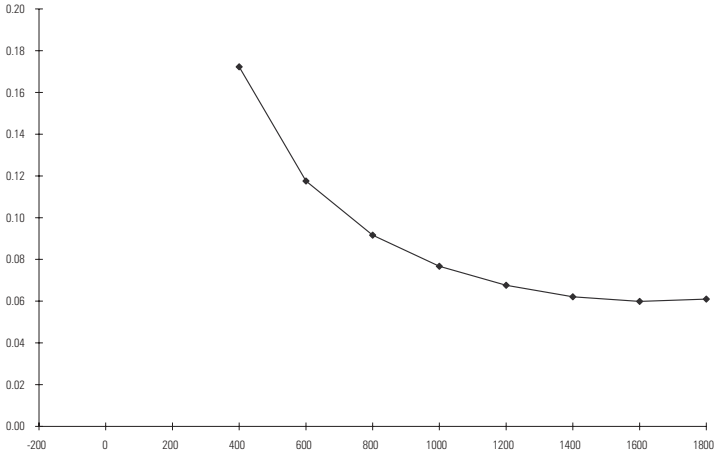


Figure E.18 Thermocouple Module Resolution - Type R Thermocouple Connection in a -12 to 30mV Input Range

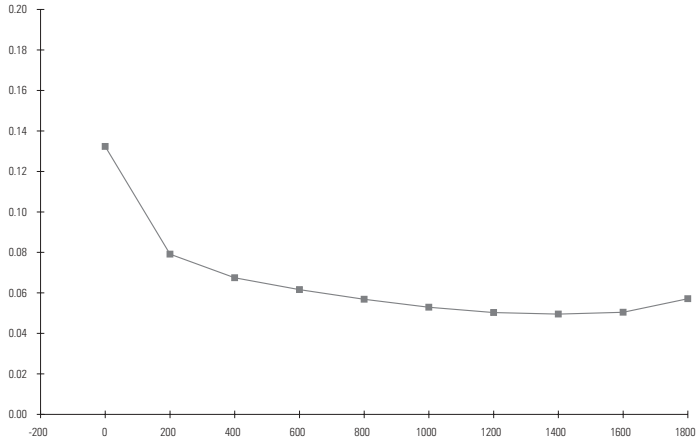


Figure E.19 Thermocouple Module Resolution - Type S Thermocouple Connection in a -12 to 30mV Input Range

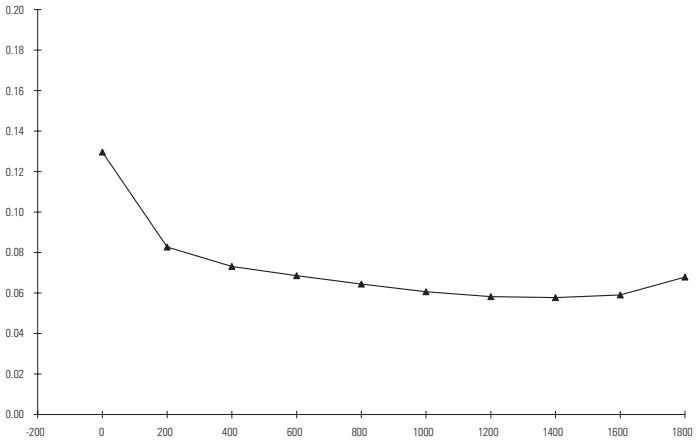


Figure E.20 Thermocouple Module Resolution - Type E Thermocouple Connection in a -12 to 30mV Input Range

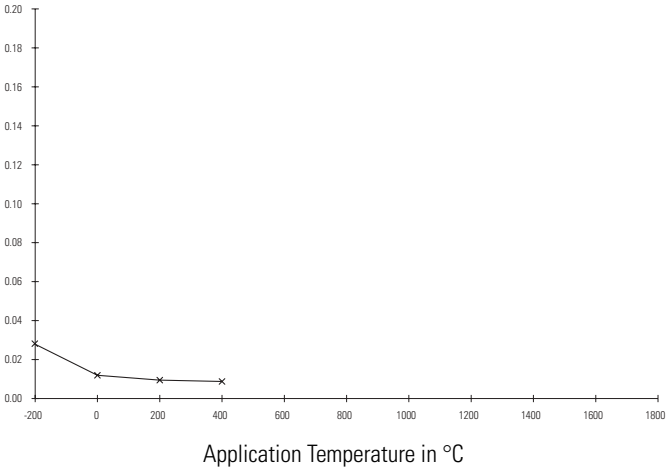


Figure E.21 Thermocouple Module Resolution - Type J Thermocouple Connection in a -12 to 30mV Input Range

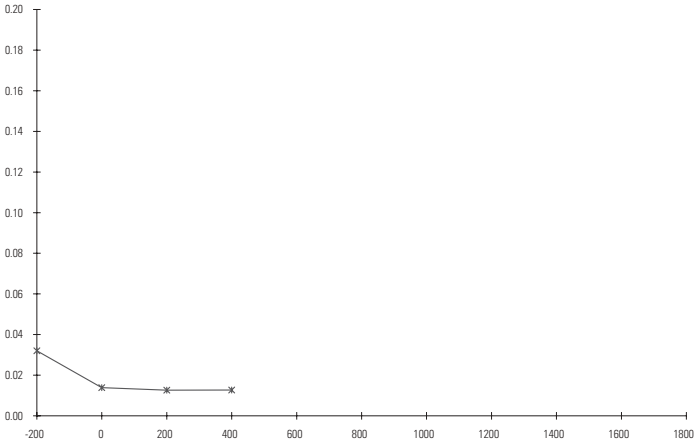


Figure E.22 Thermocouple Module Resolution - Type K Thermocouple Connection in a -12 to 30mV Input Range

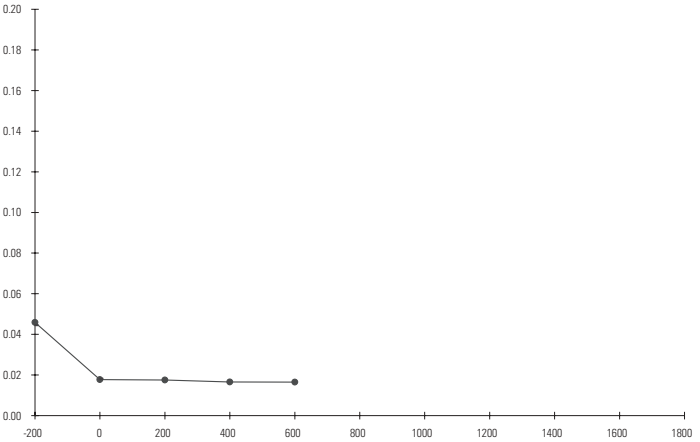


Figure E.23 Thermocouple Module Resolution - Type N Thermocouple Connection in a -12 to 30mV Input Range

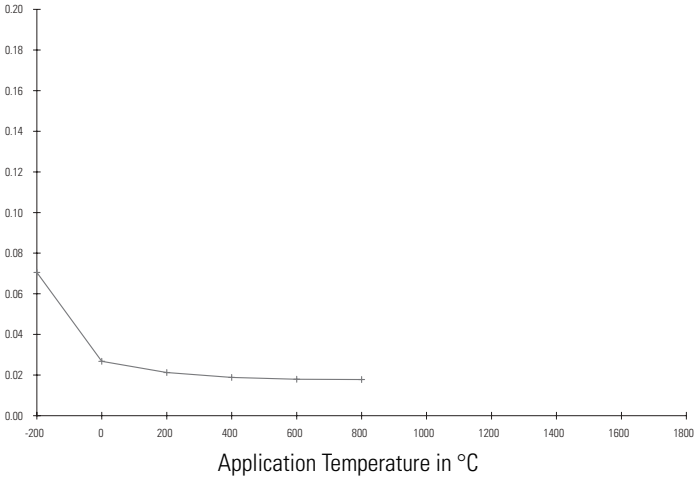
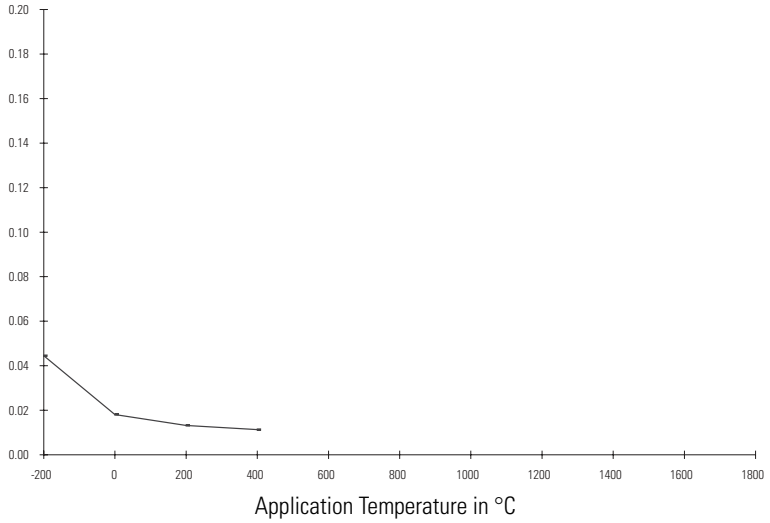


Figure E.24 Thermocouple Module Resolution - Type T Thermocouple Connection in a -12 to 30mV Input Range



Module Resolution (-12 to 78mV Range)

Table E.4 lists the resolution of ControlLogix thermocouple modules when used in the -12 to 78mV input range.

Table E.4

Application Temperature in °C:	Module Resolution (in degrees) When Connected to This Thermocouple Type:							
	B	R	S	E	J	K	N	T
-200°C (-328°F)				0.056	0.064	0.046	0.141	0.089
0°C (32°F)		0.26	0.26	0.024	0.028	0.092	0.054	0.036
200°C (392°F)		0.16	0.17	0.019	0.025	0.035	0.042	0.026
400°C (752°F)	0.28	0.14	0.15	0.017	0.025	0.035	0.038	0.023
600°C (1112°F)	0.23	0.12	0.14	0.017	0.024	0.033	0.04	
800°C (1472°F)	0.18	0.11	0.13	0.018	0.022	0.033	0.04	
1000°C (1832°F)	0.15	0.11	0.12	0.019	0.024	0.034	0.04	
1200°C (2192°F)	0.14	0.10	0.12		0.024	0.036	0.04	
1400°C (2552°F)	0.12	0.10	0.12			0.038		
1600°C (2912°F)	0.12	0.10	0.12					
1800°C (3272°F)	0.12	0.11	0.14					

The information represented in Table E.2 is shown graphically in Figure E.25 through Figure E.32.

Figure E.25 Thermocouple Module Resolution - Type B Thermocouple Connection in a -12 to 78mV Input Range

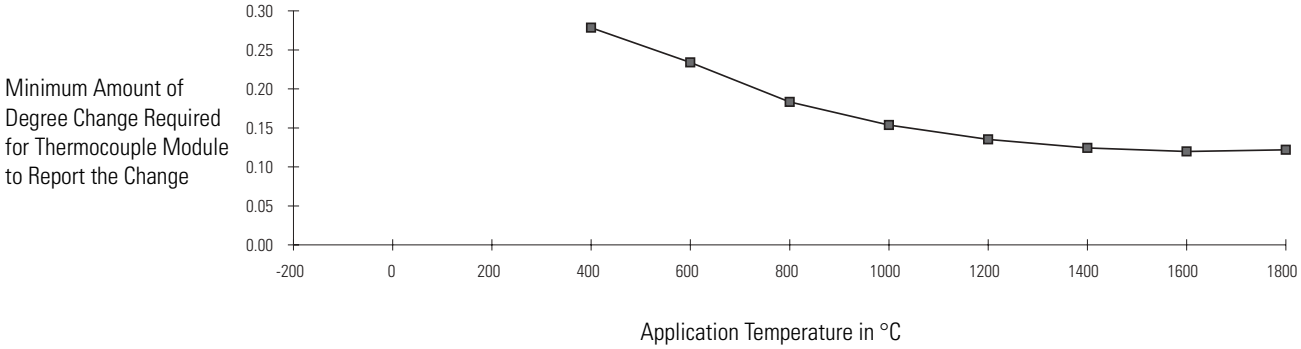


Figure E.26 Thermocouple Module Resolution - Type R Thermocouple Connection in a -12 to 78mV Input Range

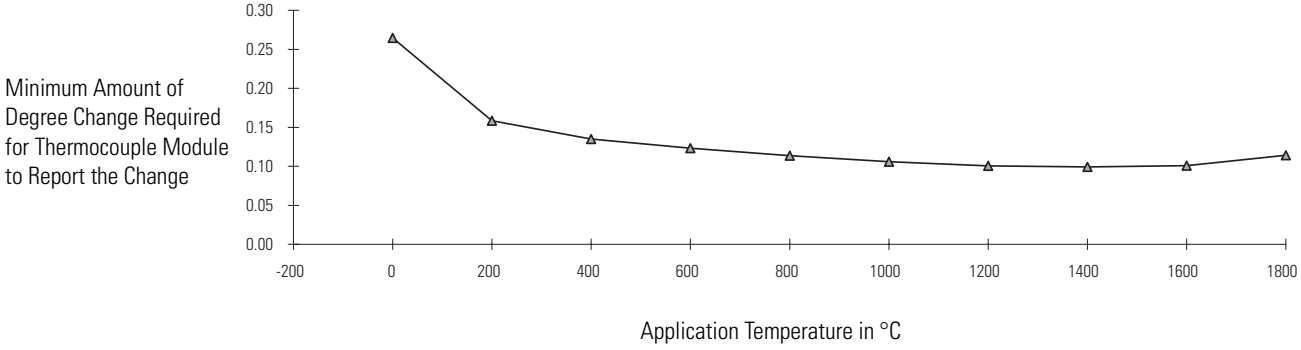


Figure E.27 Thermocouple Module Resolution - Type S Thermocouple Connection in a -12 to 78mV Input Range

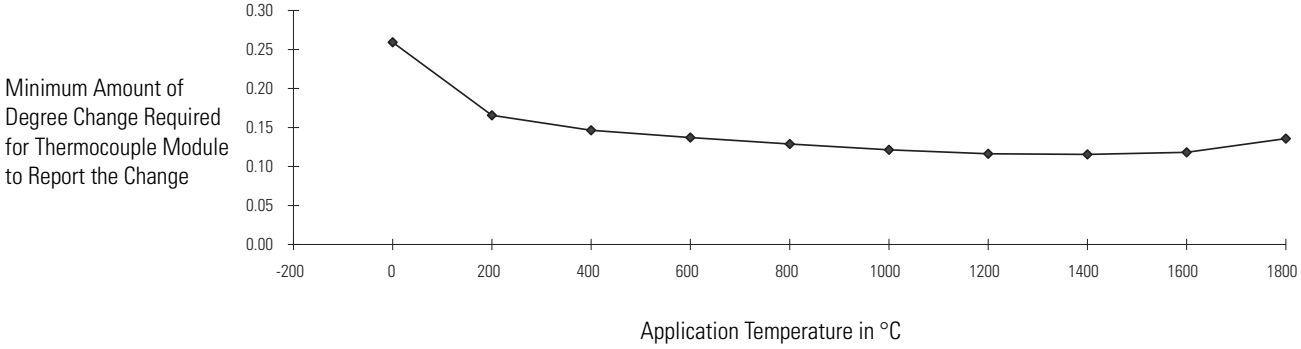


Figure E.28 Thermocouple Module Resolution - Type E Thermocouple Connection in a -12 to 78mV Input Range

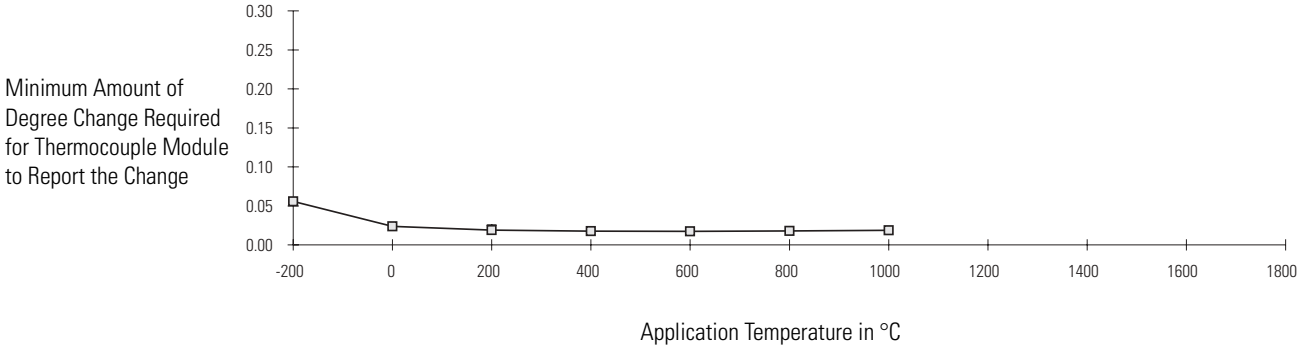


Figure E.29 Thermocouple Module Resolution - Type J Thermocouple Connection in a -12 to 78mV Input Range

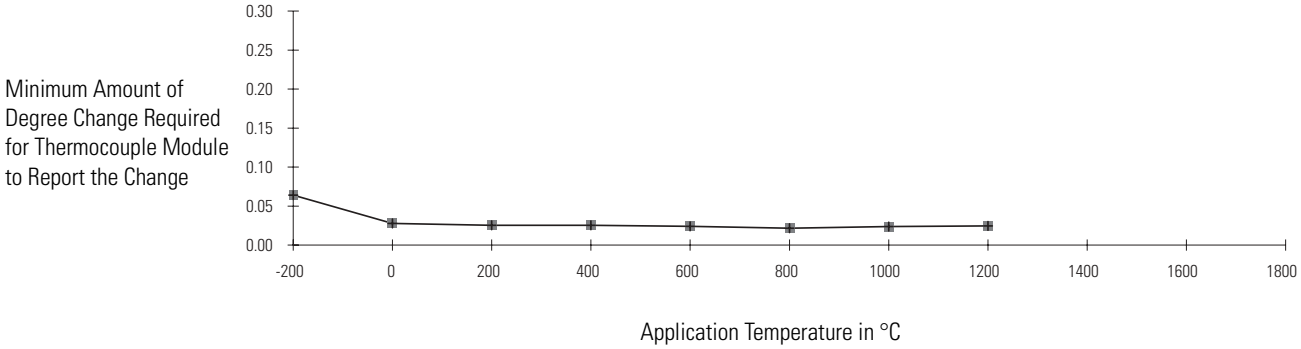


Figure E.30 Thermocouple Module Resolution - Type K Thermocouple Connection in a -12 to 78mV Input Range

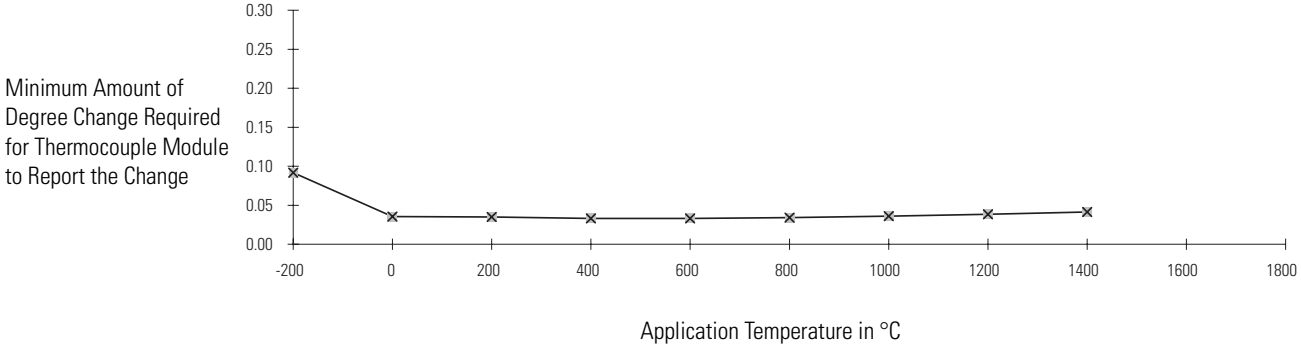


Figure E.31 Thermocouple Module Resolution - Type N Thermocouple Connection in a -12 to 78mV Input Range

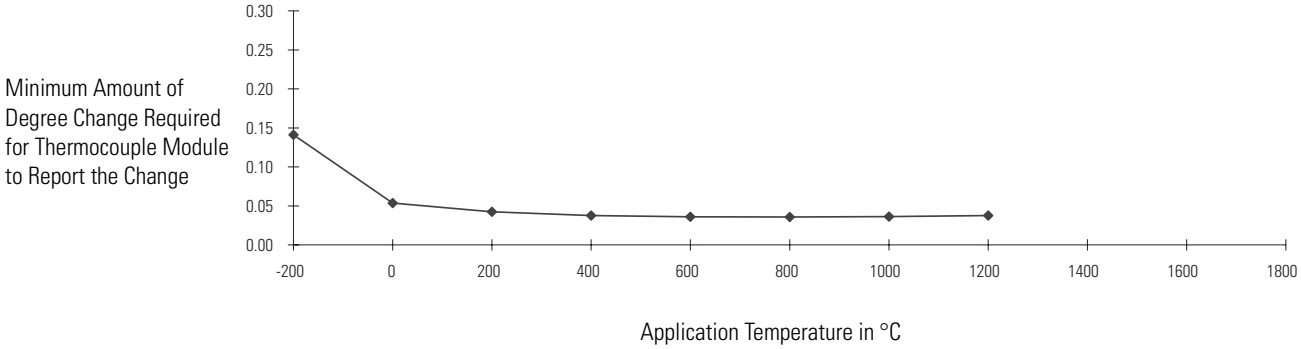
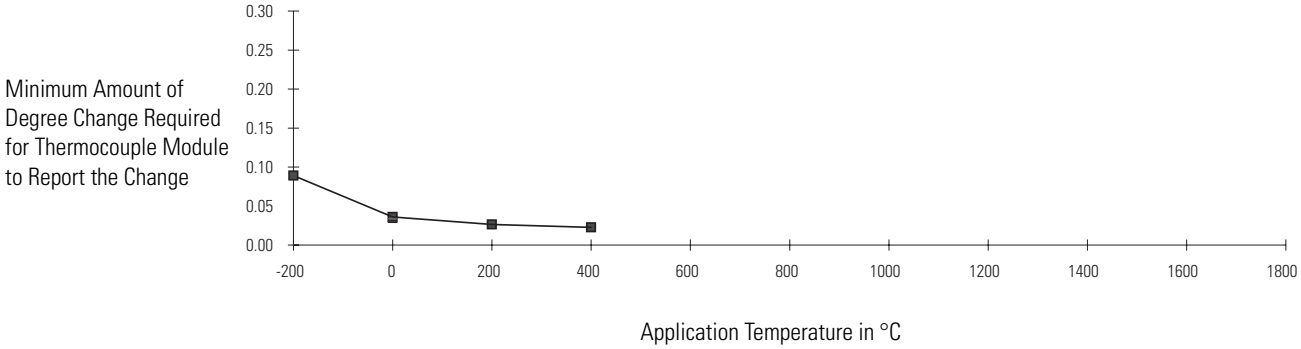


Figure E.32 Thermocouple Module Resolution - Type T Thermocouple Connection in a -12 to 78mV Input Range



Notes:

Using 1492 Wiring Systems with Your Analog I/O Module

As an alternative to buying RTBs and connecting the wires yourself, you can buy a wiring system of:

- **analog interface modules (AIFMs)** that mount on DIN rails provide the output terminal blocks for the I/O module. Use the AIFMs with the pre-wired cables that match the I/O module to the interface module.

  For a complete list of the AIFMs available for use with ControlLogix analog I/O modules, see Table F.2 on page F-3.

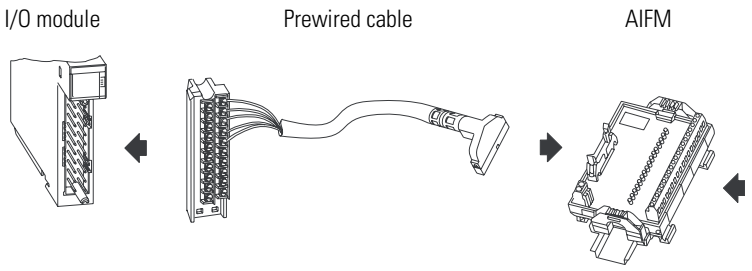
and

- **I/O-module-ready prewired cables**. One end of the cable assembly is an RTB that plugs into the front of the I/O module. The other end has individually color-coded conductors that connect to a standard terminal block.

  For a complete list of the prewired cables available for use with ControlLogix analog I/O modules, see Table F.3 on page F-3.

Figure F.1 shows the AIFM and prewired cables.

Figure F.1



IMPORTANT The 1492 IFMs may not be used in any application that requires agency certification of the ControlLogix system. Use of the IFM violates the UL, CSA and FM certifications of these products.

Table F.1 lists the AIFMs and prewired cables that can be used with specific ControlLogix analog I/O modules.

Table F.1

For this module:		Use this AIFM(s):[1]	With this prewired cable:
1756-IF6CIS		1492-AIFM6S-3	1492-ACABLExX
1756-IF6I	in current mode	1492-AIFM6S-3	1492-ACABLExX
	in voltage mode	1492-AIFM6S-3	1492-ACABLExY
1756-IF8	in single-ended current mode	1492-AIFM8-3 1492-AIFM8-F-5	1492-ACABLExTB
	in single-ended voltage mode	1492-AIFM8-3 1492-AIFM8-F-5	1492-ACABLExTA
	in differential current mode	1492-AIFM8-3 1492-AIFM8-F-5	1492-ACABLExTD
	in differential voltage mode	1492-AIFM8-3 1492-AIFM8-F-5	1492-ACABLExTC
1756-IF16	in single-ended current mode	1492-AIFM8-3 1492-AIFM16-F-3 1492-AIFM16-F-5	1492-ACABLExUB
	in single-ended voltage mode	1492-AIFM8-3 1492-AIFM16-F-3 1492-AIFM16-F-5	1492-ACABLExUA
	in differential current mode	1492-AIFM8-3 1492-AIFM16-F-3 1492-AIFM16-F-5	1492-ACABLExUD
	in differential voltage mode	1492-AIFM8-3 1492-AIFM16-F-3 1492-AIFM16-F-5	1492-ACABLExUC
1756-IR6I		1492-AIFM6S-3	1492-ACABLExZ
1756-IT6I		1492-AIFM6TC-3	1492-ACABLExY
1756-IT6I2		1492-AIFM6TC-3	1492-ACABLExYT
1756-OF4	in current mode	1492-AIFM4-3	1492-ACABLExVB
	in voltage mode	1492-AIFM4-3	1492-ACABLExVA
1756-OF6CI		1492-AIFM6S-3	1492-ACABLExY
1756-OF6VI		1492-AIFM6S-3	1492-ACABLExY
1756-OF8	in current mode	1492-AIFM8-3	1492-ACABLExWB
	in voltage mode	1492-AIFM8-3	1492-ACABLExWA

[1] When multiple AIFMs are listed for a catalog number, both fit the application listed. For example, when using the 1756-IF8 in single-ended current mode, you can use either the 1492-AIFM8-3 or 1492-AIFM8-F-5.

Table F.2 describes the AIFMs available for use with your ControlLogix analog I/O modules.

Table F.2

Catalog Number	Type of AIFM:	Description:
1492-AIFM4-3	feed through	4 channels with 3 terminals per channel
1492-AIFM6S-3	feed through	6 channels isolated with 3-4 terminals per channel
1492-AIFM8-3	feed through	8 channels with 3 terminals per channel
1492-AIFM6TC-3	thermocouple	6 channels with 3 terminals per channel
1492-AIFM8-F-5	fusible	8 channels with 5 terminals per channel
1492-AIFM16-F-3	fusible	16 channels with 3 terminals per channel
1492-AIFM16-F-5	fusible	16 channels with 5 terminals per channel

Table F.3 describes the I/O module-ready prewired cables available for use with your ControlLogix analog I/O modules.

Table F.3 t

Catalog Number:(1)	Number of Conductors:(2)	Conductor Size:	Nominal Outer Diameter:	RTB at the I/O Module End:
1492-ACABlExM	11 twisted pairs	22 AWG	11.5 mm (0.45 in)	1757-PIM
1492-ACABLExX	9 twisted pairs(3)	22 AWG	6.8 mm (0.27 in)	1756-TBNH
1492-ACABLExY	9 twisted pairs(4)	22 AWG	6.8 mm (0.27 in)	1756-TBNH
1492-ACABLExZ	20 conductors(5)	22 AWG	8.4 mm (0.33 in)	1756-TBNH
1492-ACABLExTA	20 conductors	22 AWG	8.4 mm (0.33 in)	1756-TBCH
1492-ACABLExTB	20 conductors	22 AWG	8.4 mm (0.33 in)	1756-TBCH
1492-ACABLExTC	5 twisted pairs	22 AWG	8.4 mm (0.33 in)	1756-TBCH
1492-ACABLExTD	5 twisted pairs	22 AWG	8.4 mm (0.33 in)	1756-TBCH
1492-ACABLExUA	20 conductors	22 AWG	8.4 mm (0.33 in)	1756-TBCH
1492-ACABLExUB	20 conductors	22 AWG	8.4 mm (0.33 in)	1756-TBCH
1492-ACABLExUC	9 twisted pairs	22 AWG	6.8 mm (0.27 in)	1756-TBCH
1492-ACABLExUD	9 twisted pairs	22 AWG	6.8 mm (0.27 in)	1756-TBCH
1492-ACABLExVA	20 conductors	22 AWG	8.4 mm (0.33 in)	1756-TBNH
1492-ACABLExVB	20 conductors	22 AWG	8.4 mm (0.33 in)	1756-TBNH
1492-ACABLExWA	9 twisted pairs	22 AWG	6.8 mm (0.27 in)	1756-TBNH
1492-ACABLExWB	9 twisted pairs	22 AWG	6.8 mm (0.27 in)	1756-TBNH

(1) Cables are available in lengths of 0.5m, 1.0m, 2.5m, and 5.0m. To order, insert the code for the desired cable length into the catalog number in place of the x: 005=0.5m, 010=1.0m, 25=2.5m, 050=5m. Build-to-order cable lengths are also available.

(2) Each cable for analog I/O has an overall shield with a ring lug on a 200mm (8.87 in) exposed drain wire at the I/O module end of the cable.

(3) One pair is not connected to the I/O module connector; two additional pairs are not used.

(4) Two pairs are not used.

(5) One conductor is not connected to the I/O module connector; one additional conductor is not used.

Notes:

Broadcast

Data transmissions to all addresses

Communications format

Format that defines the type of information transferred between an I/O module and its owner-controller. This format also defines the tags created for each I/O module.

On the 1756-IF16 and 1756-IF8 modules, the communications format must match module wiring.

Compatible match

An electronic keying protection mode that requires the physical module and the module configured in the software to match according to vendor, catalog number and major revision. In this case, the minor revision of the module must be greater than or equal to that of the configured slot.

Connection

The continuous communication mechanism from the controller to an I/O module in the control system

ControlBus

The backplane used by the 1756 chassis

Coordinated System Time (CST)

Timer value which is kept synchronized for all modules within a single ControlBus chassis. The CST is a 64-bit number with microsecond resolution.

Direct Connection

An I/O connection where the controller establishes an individual connection with I/O modules

Disable keying

An option that turns off all electronic keying to the module. Requires no attributes of the physical module and the module configured in the software to match.

Download

The process of transferring the contents of a project on the workstation into the controller

Electronic keying

A system feature which makes sure that the physical module attributes are consistent with what was configured in the software

Exact match

An electronic keying protection mode that requires the physical module and the module configured in the software to match identically, according to vendor, catalog number, major revision and minor revision

Field side

Interface between user field wiring and I/O module

Inhibit

A ControlLogix process that allows you to configure an I/O module but prevent it from communicating with the owner-controller. In this case, the controller does not establish a connection

Interface module (IFM)

A prewired removable terminal block (RTB)

Listen-only connection

An I/O connection that allows a controller to monitor I/O module data without owning the module

Major revision

A module revision that is updated any time there is a functional change to the module resulting in an interface change with software

Minor revision

A module revision that is updated any time there is a change to the module that does not affect its function or software user interface (e.g. bug fix)

Multicast

Data transmissions which reach a specific group of one or more destinations

Multiple owners

A configuration set-up where multiple owner-controllers use exactly the same configuration information to simultaneously own an input module

Network update time (NUT)

The smallest repetitive time interval in which the data can be sent on a ControlNet network. The NUT may be configured over the range from 2ms to 100ms using RSNetWorx

Owner-controller

The controller that creates and stores the primary configuration and communication connection to a module

Program mode

In this mode, the controller program is not executing. Inputs are actively producing data. Outputs are not actively controlled and go to their configured program mode state.

Remote connection

An I/O connection where the controller establishes an individual connection with I/O modules in a remote chassis

Removable terminal block (RTB)

Field wiring connector for I/O modules

Removal and insertion under power (RIUP)

ControlLogix feature that allows a user to install or remove a module or RTB while power is applied

Requested packet interval (RPI)

A configurable parameter which defines when the module will multicast data

Run mode

In this mode, the controller program is executing. Inputs are actively producing data. Outputs are actively controlled.

Service

A system feature that is performed on user demand

System side

Backplane side of the interface to the I/O module

Tag

A named area of the controller's memory where data is stored like a variable

Timestamping

ControlLogix process that stamps a change in input, output, or diagnostic data with a time reference indicating when that change occurred

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Installation Instructions

ControlLogix™ AC (79-132V) Input Module

Catalog Number 1756- IA16

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Obtain a User Manual

This product also has a user manual (pub. no. 1756-UM058). To view it, visit www.ab.com/manuals or www.theautomationbookstore.com.

To purchase a manual, you can:

- contact your distributor or Rockwell Automation representative
- visit www.theautomationbookstore.com and place an order
- call 800.963.9548 (USA/Canada) or 001.320.725.1574 (outside USA/Canada)

Publication 1756-IN029D-EN-P - February 2003

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WARNING	Identifies information about practices or circumstances that can cause an explosion in a hazardous environment, which may lead to personal injury or death, property damage, or economic loss.
ATTENTION	Identifies information about practices or circumstances that can lead to personal injury or death, property damage, or economic loss.
IMPORTANT	Identifies information that is critical for successful application and understanding of the product.

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Environment and Enclosure

This equipment is intended for use in a Pollution Degree 2 industrial environment, in overvoltage Category II applications (as defined in IEC publication 60664-1), at altitudes up to 2000 meters without derating.

This equipment is considered Group 1, Class A industrial equipment according to IEC/CISPR Publication 11. Without appropriate precautions, there may be potential difficulties ensuring electromagnetic compatibility in other environments due to conducted as well as radiated disturbance.

This equipment is supplied as "open type" equipment. It must be mounted within an enclosure that is suitably designed for those specific environmental conditions that will be present and appropriately designed to prevent personal injury resulting from accessibility to live parts. The interior of the enclosure must be accessible only by the use of a tool. Subsequent sections of this publication may contain additional information regarding specific enclosure type ratings that are required to comply with certain product safety certifications.

See NEMA Standards publication 250 and IEC publication 60529, as applicable, for explanations of the degrees of protection provided by different types of enclosure. Also, see the appropriate sections in this publication, as well as the Allen-Bradley publication 1770-4.1 ("Industrial Automation Wiring and Grounding Guidelines"), for additional installation requirements pertaining to this equipment.

Prevent Electrostatic Discharge

This equipment is sensitive to electrostatic discharge, which can cause internal damage and affect normal operation. Follow these guidelines when you handle this equipment:

- Touch a grounded object to discharge potential static.
- Wear an approved grounding wriststrap.
- Do not touch connectors or pins on component boards.
- Do not touch circuit components inside the equipment.
- If available, use a static-safe workstation.

When not in use, store the equipment in appropriate static-safe packaging.

Removal and Insertion Under Power

When you insert or remove the module while backplane power is on, an electrical arc can occur. This could cause an explosion in hazardous location installations. Be sure that power is removed or the area is nonhazardous before proceeding.

Repeated electrical arcing causes excessive wear to contacts on both the module and its mating connector. Worn contacts may create electrical resistance that can affect module operation.

Identify the Module Components

You received the following components with your order:

- 1756-IA16 module
- Removable Terminal Block (RTB) door label

If you did not receive these components, contact your local distributor Rockwell Automation sales office.

This module mounts in a 1756 chassis and uses a separately-ordered RTB or a Bulletin 1492 Interface Module (IFM)[1] to connect all field-side wiring. This module uses one of the following RTBs:

- 1756-TBNH 20 position NEMA RTB
- 1756-TBSH 20 position Spring Clamp RTB

[1] The Bulletin 1492 IFM may not be used in any application that requires agency certification of the [illegible] wiring. Consult the factory for certification status of this product.

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Use an extended-depth cover (1756-TBE) for applications with heavy gauge wiring or requiring additional routing space. When using an IFM, consult the documentation that came with it to connect wiring.

IMPORTANT Before you install your module, you should:

- install and ground a 1756 chassis and power supply.
- order and receive an RTB or IFM, and its components, for your application.

Note the Power Requirements

This module receives power from the 1756 chasis power supply and requires 2 sources of power from the backplane:

- 105mA at 5.1V dc
- 2mA at 24V dc

Add this current/power value (0.58W) to the requirements of all other modules in the chassis to prevent overloading the power supply.

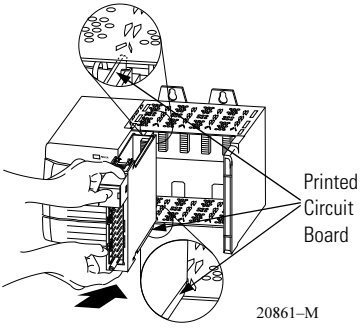
Install the Module

You can install or remove the module while chassis power is applied.

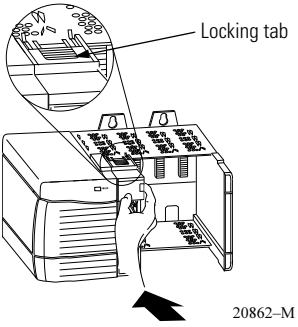
WARNING

When you insert or remove the module while backplane power is on, an electrical arc can occur. This could cause an explosion in hazardous location installations. Be sure that power is removed or the area is nonhazardous before proceeding.

1. Align the circuit board with the top and bottom chassis guides.



2. Slide the module into the chassis until the module locking tabs click.

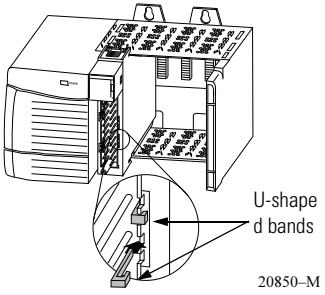


Key the Module and Removable Terminal Block/Interface Module

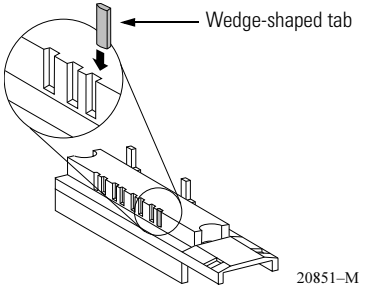
Use the wedge-shaped keying tabs and U-shaped keying bands to prevent connecting the wrong wires to your module.

Key positions on the module that correspond to unkeyed positions on the RTB. For example, if you key the first position on the module, leave the first position on the RTB unkeyed.

1. To key the module, insert the U-shaped band, as shown.



2. Push the band until it snaps in place.
3. To key the RTB or IFM, insert the wedge-shaped tab with rounded edge first, as shown.



4. Push the tab until it stops.

Reposition the tabs to key future module applications.

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Wire the Removable Terminal Block

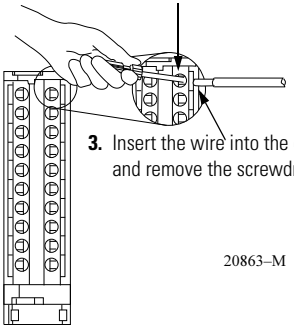
Wire the RTB with a 5/16 inch (8mm) maximum flat-bladed screwdriver before installing it onto the module.

WARNING

When you connect or disconnect the Removable Terminal Block (RTB) with field side power applied, an electrical arc can occur. This could cause an explosion in hazardous location installations. Make sure that power is removed or the area is nonhazardous before proceeding.

Spring Clamp RTB

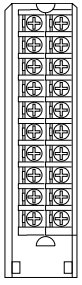
1. Strip 7/16 inch (11mm) maximum length of wire.
2. Insert the screwdriver into the inner hole of the RTB.
3. Insert the wire into the open terminal and remove the screwdriver.



20863–M

NEMA Screw RTB

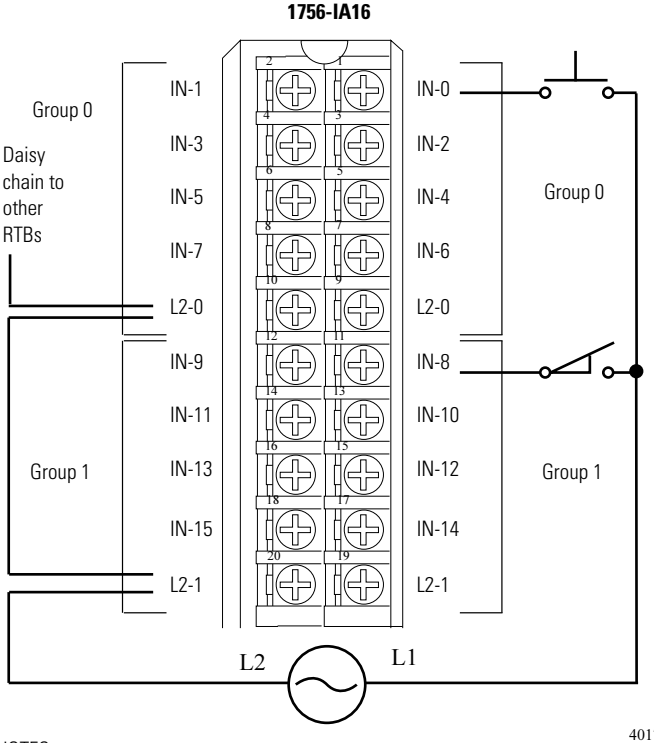
1. Strip 5/16 inch (8mm) maximum length of wire.
2. Turn the terminal screw counterclockwise.
3. Wrap wire around the terminal.
4. Turn the terminal screw clockwise.



42516

Wire the Module

You can only connect wiring to your module through an RTB or IFM. The example below shows how to wire the module.



NOTES:
1. All terminals with the same name are connected together on the module. For example, L2 can be connected to any terminal marked L2-0.
2. When you daisy chain from a group to another RTB, always connect the daisy chain as shown above. Do not connect more than 2 wires to any single terminal.
3. This wiring example shows a single voltage source.
4. If separate power sources are used, do not exceed the specified isolation voltage.

After completing field-side wiring, secure the wires in the strain relief area with a cable tie.

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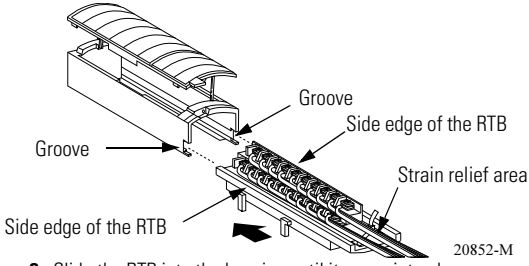
Assemble the Removable Terminal Block and the Housing

1. Align the grooves at the bottom of the housing with the side edges of the RTB.



2. Slide the RTB into the housing until it snaps into place.

Install the Removable Terminal Block onto the Module

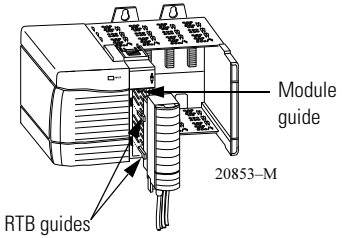
WARNING

When you connect or disconnect the Removable Terminal Block (RTB) with field side power applied, an electrical arc can occur. This could cause an explosion in hazardous location installations. Be sure that power is removed or the area is nonhazardous before proceeding.

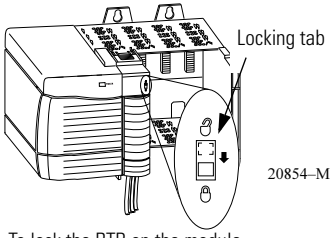
Before installing the RTB, make certain:

- field-side wiring of the RTB has been completed.
- the RTB housing is snapped in place on the RTB.
- the RTB housing is closed.
- the locking tab at the top of the module is unlocked.

1. Align the side and top, bottom guides.



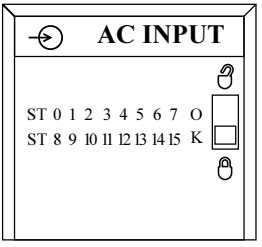
2. Press quickly and evenly to seat the RTB until the latches snap into place.



3. To lock the RTB on the module, slide the locking tab down.

Check the Indicators

The indicators show individual I/O status (yellow) for each point and a bi-colored LED for module "OK" (red/green).



20945-M

During power up, an indicator test is done and the following occurs:

- "OK" indicator turns red for 1 second and then turns to flashing green if it has passed the self-test.
- I/O status indicators turn ON for a maximum of 2 seconds and then turn OFF.

Indicator:	Displaying:	Means:	Take this action:
OK	Steady green light	The inputs are being multicast and in normal operating state.	None
OK	Flashing green light	The module has passed internal diagnostics but is not multicasting inputs.	Configure the module with RSLogix 5000 programming software.
OK	Flashing red light	Previously established communication has timed out.	Check controller and chassis communication.
OK	Steady red light	An unrecoverable error has occurred on the module.	Replace the module.
I/O State	Yellow	The input is active.	None

This completes installation of the module. Use the following information to remove the module, if necessary.

Remove the Removable Terminal Block from the Module

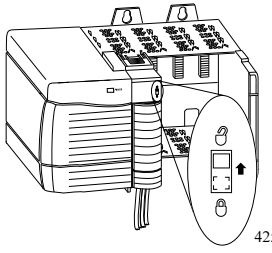
If you need to remove the module, you must remove the RTB first.

WARNING

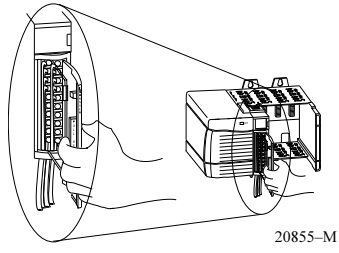
When you insert or remove the module while backplane power is on, an electrical arc can occur. This could cause an explosion in hazardous location installations. Be sure that power is removed or the area is nonhazardous before proceeding.

Before removing the module, you must remove the RTB.

1. Unlock the locking tab at the top of the module.

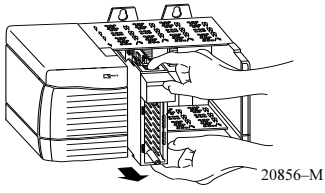


2. Open the RTB door and pull the RTB off the module.

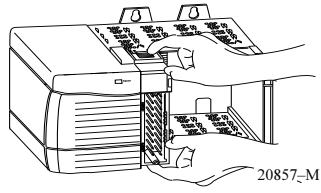


Remove the Module

1. Push in top and bottom locking tabs.



2. Pull module out of the chassis.



Publication 1756-IN029D-EN-P - February 2003

1756-IA16 Specifications

Number of Inputs	16 (8 points/common)
Module Location	1756 ControlLogix Chassis
Backplane Current	105mA @ 5.1V dc & 2mA @ 24V dc (Total backplane power 0.58W)
Maximum Power Dissipation (Module)	5.8W @ 60°C
Thermal Dissipation	18.41 BTU/hr
On-State Voltage Range	74-132V ac, 47-63Hz
Nominal Input Voltage	120V ac
On-State Current	5mA @ 74V ac minimum 13mA @ 132V ac maximum
Maximum Off-State Voltage	20V
Maximum Off-State Current	2.5mA
Maximum Input Impedance @ 132V ac	10.15kΩ @ 60Hz
Input Delay Time	
Off to on	Programmable filter: 1ms & 2ms
Hardware delay	10ms maximum plus filter time
On to off	Programmable filter: 9ms & 18ms
Hardware delay	8ms maximum plus filter time
Diagnostic Functions	
Change of State	Software configurable
Timestamp of Inputs	+/- 200µs
Short/Inrush Current	250mA peak (decaying to <37% in 22ms, without activation)
Change of State on Inputs	Software configurable (Within 200µs)
Cyclic Update Time	User selectable (100µs minimum/750ms maximum)
Isolation Voltage	
Group to group	250V maximum continuous 100% tested at 2546V dc for 1s
User to system	250V maximum continuous 100% tested at 2546V dc for 1s
Module Keying (Backplane)	Software configurable
RTB Screw Torque (NEMA)	7-9 inch-pounds (0.8-1Nm)
RTB Keying	User defined mechanical keying
RTB and Housing	20 Position RTB (1756-TBNH or TBSH)

Environmental Conditions	
Operating Temperature	IEC 60068-2-1 (Test Ad, Operating Cold), IEC 60068-2-2 (Test Bd, Operating Dry Heat), IEC 60068-2-14 (Test Nb, Operating Thermal Shock): 0 to 60°C (32 to 140°F)
Storage Temperature	IEC 60068-2-1 (Test Ab, Un-packaged Non-operating Cold), IEC 60068-2-2 (Test Bb, Un-packaged Non-operating Dry Heat), IEC 60068-2-14 (Test Na, Un-packaged Non-operating Thermal Shock): –40 to 85°C (–40 to 185°F)
Relative Humidity	IEC 60068-2-30 (Test Db, Un-packaged Non-operating Damp Heat): 5 to 95% non-condensing
Vibration	IEC60068-2-6 (Test Fc, Operating): 2g @ 10-500Hz
Shock	IEC60068-2-27 (Test Ea, Unpackaged shock): Operating 30g Non-operating 50g
Emissions	CISPR 11: Group 1, Class A
ESD Immunity	IEC 61000-4-2: 6kV contact discharges 8kV air discharges
Radiated RF Immunity	IEC 61000-4-3: 10V/m with 1kHz sine-wave 80%AM from 30MHz to 1000MHz 10V/m with 200Hz 50% Pulse 100%AM at 900Mhz
EFT/B Immunity	IEC 61000-4-4: ±4kV at 2.5kHz on power ports ±4kV at 2.5kHz on signal ports
Surge Transient Immunity	IEC 61000-4-5: ±1kV line-line(DM) and ±2kV line-earth(CM) on power ports (8.10.5) ±1kV line-line(DM) and ±2kV line-earth(CM) on signal ports (8.10.8)
Conducted RF Immunity	IEC 61000-4-6: 10Vrms with 1kHz sine-wave 80%AM from 150kHz to 80MHz
Enclosure Type Rating	None (open-style)

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Conductors	Wire Size	#22 to #14 AWG (0.324 to 2.08 sq. mm) stranded[1] 3/64 inch (1.2mm) insulation maximum
	Category	1[2], [3]
Screwdriver Blade Width for RTB		5/16 inch (8mm) maximum
Certifications (when product is marked)		UL UL Listed Industrial Control Equipment CSA CSA Certified Process Control Equipment CSA CSA Certified Process Control Equipment for Class I, Division 2 Group A,B,C,D Hazardous Locations FM FM Approved Equipment for use in Class I Division 2 Group A,B,C,D Hazardous Locations CE[4] European Union 89/336/EEC EMC Directive, compliant with: EN 50082-2; Industrial Immunity EN 61326; Meas./Control/Lab., Industrial Requirements EN 61000-6-2; Industrial Immunity EN 61000-6-4; Industrial Emissions European Union 73/23/EEC LVD Directive, compliant with: EN 61131-2; Programmable Controllers C-Tick[4] Australian Radiocommunications Act, compliant with: AS/NZS 2064; Industrial Emissions

(1) Maximum wire size requires extended housing - 1756-TBE.

(2) Use this conductor category information for planning conductor routing as described in the system level installation manual.

(3) Refer to publication 1770-4.1 *Industrial Automation Wiring and Grounding Guidelines*.

(4) See the Product Certification link at www.ab.com for Declarations of Conformity, Certificates, and other certification details.

The following information applies when operating this equipment in hazardous locations:	**Informations sur l'utilisation de cet équipement en environnements dangereux :**
Products marked "CL I, DIV 2, GP A, B, C, D" are suitable for use in Class I Division 2 Groups A, B, C, D, Hazardous Locations and nonhazardous locations only. Each product is supplied with markings on the rating nameplate indicating the hazardous location temperature code. When combining products within a system, the most adverse temperature code (lowest "T" number) may be used to help determine the overall temperature code of the system. Combinations of equipment in your system are subject to investigation by the local Authority Having Jurisdiction at the time of installation.	Les produits marqués "CL I, DIV 2, GP A, B, C, D" ne conviennent qu'à une utilisation en environnements de Classe I Division 2 Groupes A, B, C, D dangereux et non dangereux. Chaque produit est livré avec des marquages sur sa plaque d'identification qui indiquent le code de température pour les environnements dangereux. Lorsque plusieurs produits sont combinés dans un système, le code de température le plus défavorable (code de température le plus faible) peut être utilisé pour déterminer le code de température global du système. Les combinaisons d'équipements dans le système sont sujettes à inspection par les autorités locales qualifiées au moment de l'installation.

WARNING	**EXPLOSION HAZARD** • Do not disconnect equipment unless power has been removed or the area is known to be nonhazardous. • Do not disconnect connections to this equipment unless power has been removed or the area is known to be nonhazardous. Secure any external connections that mate to this equipment by using screws, sliding latches, threaded connectors, or other means provided with this product. • Substitution of components may impair suitability for Class I, Division 2. • If this product contains batteries, they must only be changed in an area known to be nonhazardous.	**AVERTISSEMENT**	**RISQUE D'EXPLOSION** • Couper le courant ou s'assurer que l'environnement est classé non dangereux avant de débrancher l'équipement. • Couper le courant ou s'assurer que l'environnement est classé non dangereux avant de débrancher les connecteurs. Fixer tous les connecteurs externes reliés à cet équipement à l'aide de vis, loquets coulissants, connecteurs filetés ou autres moyens fournis avec ce produit. • La substitution de composants peut rendre cet équipement inadapté à une utilisation en environnement de Classe I, Division 2. • S'assurer que l'environnement est classé non dangereux avant de changer les piles.

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Relay Output Module, 16-PT, 1756-OW161

Motor Circuit Protector, 140M-D8E-C20

Motor Protection Circuit Breakers

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- Bulletin 140M Motor Circuit Protectors — Page 7
- Bulletin 140M Accessories — Page 12

Molded Case Circuit Breakers

- Bulletin 140U Molded Case Circuit Breakers — Page 35

IEC Contactors

- Bulletin 100/104-M Miniature Contactors — Page 62
- Bulletin 100/104-C Contactors — Page 63
- Bulletin 100/104-D Contactors — Page 66
- Bulletin 100-G Contactors — Page 70
- Bulletin 100Q Capacitor Switching Contactors — Page 71
- Bulletin 100L Lighting Contactors — Page 72
- Bulletin 100S/104S Safety Contactors — Page 73
- Bulletin 170 Wye-Delta Kits — Page 82
- Bulletin 100 DeviceNet™ Starter Accessory — Page 81
- Bulletin 100 Line Accessories — Page 78

IEC Overload Relays

- Bulletin 193-E (E1 and E2) Solid-State Overload Relays — Page 134
- Bulletin 193 E3 and E3 Plus Solid-State Overload Relays — Page 139
- Bulletin 193-EF Solid-State Overload Relays — Page 154
- Bulletin 193-T Bimetallic Overload Relays — Page 159
- Bulletin 193-M Bimetallic Overload Relays — Page 164

Overload Relay Code Selection for IEC Starters

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Motor Protection Circuit Breakers

- Short Circuit Protection — High Magnetic Trip (Fixed at 16…20 x I_e)
- Overload Protection — Trip Class 10

Cat. No. 140M-C

Cat. No. 140M-D

Cat. No. 140M-F

Rated Operational Current [A] (I_e)	Motor Current Adjustment Range [A]	Magnetic Trip Current [A]	1-phase Hp Ratings [Hp] ❶		3-phase Hp Ratings [Hp] ❶				Cat. No.
			115V	230V	200V	230V	460V	575V	
C-Frame									
0.16	0.10…0.16	3.2	—	—	—	—	—	—	140M-C2T-A16
0.25	0.16…0.25	5.2	—	—	—	—	—	—	140M-C2T-A25
0.40	0.25…0.40	8.2	—	—	—	—	—	—	140M-C2T-A40
0.63	0.40…0.63	13	—	—	—	—	—	—	140M-C2T-A63
1.0	0.63…1.0	21	—	—	—	—	1/2	3/4	140M-C2T-B10
1.6	1.0…1.6	32	—	1/10	—	—	1	1	140M-C2T-B16
2.5	1.6…2.5	52	1/10	1/6	1/2	3/4	1-1/2	2	140M-C2T-B25
4.0	2.5…4	82	1/8	1/3	1	1	3	3	140M-C2T-B40
6.3	4…6.3	130	1/4	3/4	1-1/2	2	5	5	140M-C2T-B63
10	6.3…10	208	1/2	1-1/2	3	3	7-1/2	10	140M-C2T-C10
16	10…16	260	1	3	3	5	10	15	140M-C2T-C16
D-Frame									
16	10…16	260	1	3	3	5	10	15	140M-D8T-C16
20	14.5…20	325	1-1/2	3	5	7-1/2	15	20	140M-D8T-C20
F-Frame									
25	18…25	416	2	3	7-1/2	10	20	25	140M-F8T-C25
32	23…32	585	2	5	10	10	25	30	140M-F8T-C32

❶ Horsepower ratings shown in the table above are maximum values for each device. The final selection of the manual starter depends on the actual motor full load current and service factor.

Motor Circuit Protector, 140M-C2E-C10

	C-Frame	**D-Frame**	**F-Frame**	**CMN-Frame**	**I-Frame**	**J-Frame**	**L-Frame**
Max. Current I_e	25 A	25 A	45 A	90 A	205 A	250 A	630 A
Current Rating	0.1…25 A	1.6…25 A	6.3…45 A	16…90 A	40…205 A	20…250 A	100…630 A
Short Circuit Protection	✓	✓	✓	✓	✓	✓	✓
Standard Magnetic Trip	✓	✓	✓	✓	✓	✓	✓
High Magnetic Trip	✓	✓	✓	✓	—	—	—
Overload Protection	✓	✓	✓	✓	✓	✓	✓
Trip Class	10	10	10	10	5…20	10…30	10…30
Standards Compliance:							
CSA 22.2, No. 14	✓	✓	✓	✓	✓	✓	✓
CSA 22.2, No. 5	—	—	—	—	✓	✓	✓
UL 508 (Group Install.)	✓	✓	✓	✓	—	—	—
UL 508 Manual, Self Protected (Type E)	✓	✓	✓	—	—	—	—
UL 508 (Overload Protection)	✓	✓	✓	✓	✓	✓	✓
UL 489	—	—	—	—	✓	✓	✓
IEC 60947-1, -2	✓	✓	✓	✓	✓	✓	✓
IEC 60947-4-1	✓	✓	✓	✓	✓	✓	✓
CE	✓	✓	✓	✓	✓	✓	✓
ATEX	✓	✓	—	—	—	—	—
CCC	✓	✓	✓	—	—	—	—
Accessories							
Ext. Rotary Operator	✓	✓	✓	✓	✓	✓	✓
Flex Cable Operator	—	—	—	—	✓	✓	✓
Auxiliary Contacts	✓	✓	✓	✓	✓	✓	✓
Trip Indication Contacts	✓	✓	✓	✓	✓	✓	✓

Cat. No. Explanation

Examples given in this section are for reference purposes. This basic explanation should not be used for product selection; not all combinations will produce a valid catalog number.

140M	–	C	–	2	–	E	–	A63	–	KN	–	CC	–	GJ
		a		*b*		*c*		*d*		*e*		*f*		*g*		*h*

a

Bulletin Number	
Code	**Description**
140M	Motor Protection Circuit Breakers (MPCBs)

b

Frame Size and Rating	
Code	**Description**
C	25 A
D	25 A
F	45 A
I	205 A
J	250 A
L	400 A and 600 A

c

Interrupting Rating / Breaking Capacity	
Code	**Description**
2	Normal Break
8	High Break

d

Protection Type	
Code	**Description**
E	Adj Thermal/ Fixed Mag (13 x In)
T	Adj Thermal / Fixed Mag (Fixed at 16...20 x In)

e

Current Range		
Code	**Description**	**Example**
A	A = .10	A16 = 0.16
B	B = 1.0	B16 = 1.6
C	C = 10	C16 = 16
D	D = 100	D16 = 160
E	E = 1000	E16 = 1600

f, g, h

Factory-Installed Options

f

Miscellaneous See page 2-33

g

Aux/Trip Contacts See page 2-33

h

UV and Shunt Trips See page 2-33

Circuit Breaker, 1-Pole, 10A, 1489-A1C100

PRODUCT PROFILE

INDUSTRIAL DIN RAIL CIRCUIT BREAKERS

Bulletin 1489

Rockwell Automation introduces a new line of circuit breakers approved for branch circuit applications in the United States and Canada and certified as a Miniature Circuit Breaker for IEC applications. The Allen-Bradley Bulletin 1489 Circuit Breakers are UL489 listed and CSA 22.2 No. 5.1 to provide branch circuit protection and are MCBs to IEC 60 947-2.

VERSATILITY

The Bulletin 1489 Circuit Breakers provide a variety of product configurations by offering current ranges of 0.5 A to 40 A with voltage ranges of 240V AC and 480Y/277V AC. The Bulletin 1489 DIN Rail-mounted circuit breakers are similar in width and current range to MCBs and supplementary protectors with the added benefit of providing a listed branch circuit protection circuit breaker for US/Canada applications.

Bulletin 1489 features finger-safe IPX/2 from the front of the circuit breaker. Also available for control circuit applications are add-on auxiliary and signal contacts plus shunt trip modules to provide modern control circuit applications.

A lock-off attachment is available for applications requiring that feature.

Listed bus bars may be added to applications for convenience in panel assembly.

SIMPLIFIED MAINTENANCE

A convenient on (red) off (green) indicator is provided for quickly checking the status of the circuit breaker.

Terminals for applications requiring ring terminal connectors are available. This unique terminal may be field converted to accept normal wire connection using included lugs.

ESSENTIAL COMPONENTS.
EXCEPTIONAL VALUE.

UL489 LISTED FOR US APPLICATIONS
CSA 22.2 NO. 5.1 FOR CANADIAN APPLICATIONS
IEC 60 947-2 FOR IEC APPLICATIONS

Branch Circuit Protection 10,000 AIC

UL489/CSA 22.2 No. 5.1

240 VAC	0.5 ... 40 A
480Y/277 VAC	0.5 ... 20A

IEC 60 947-2

415 VAC	0.5 ... 40 A

UL489 IEC 60 CSA 22.2

ALLEN-BRADLEY • ROCKWELL SOFTWARE • DODGE • RELIANCE ELECTRIC
Rockwell Automation

SPECIFICATION OVERVIEW

Bulletin 1489	
Number of Poles	1-, 2- and 3-pole
Specification/listing/certification	UL489, CSA 22.2 No. 5.1 IEC 60 947-2
Approvals	UL Listed Circuit Breaker (File Number E197878) CSA Certified, VDE Approved MCB, CE
HACR rating (US/Canada))	Yes
SWD rating (US/Canada)	Yes (all current ratings < 20 A)
Calibration Temperature	40° C
Rated Interrupting Capability	UL/CSA – 10,000 AIC IEC – (Icu) – 10,000 A
Rated Tripping Current	UL/CSA 0.5 … 20 A 480Y/277 VAC 0.5 … 40 A 240 VAC IEC 0.5 … 40 A 415 VAC
Degree of Protection	Finger-safe from front (IP20 per IEC 529 from Front - IP00 at wire terminals)
Normal Operating Environment	-25° C … +55° C (non-condensing)
Trip Curves	C Curve (Inductive) 5 … 10 In D Curve Highly Inductive 10 … 20 In

1489[1] - A 1 C 050 R

Bulletin Number

UL489/CSA 22.2 No 5.1 Circuit Breaker	

Configuration

A	Standard configuration

Number of Poles

1	1 pole
2	2 pole
3	3 pole

Trip Curve

C	Inductive
D	Highly Inductive

Current Rating

005	0.5 A
010	1 A
015	1.5 A
020	2 A
030	3 A
040	4 A
050	5 A
060	6 A
070	7 A
080	8 A
100	10 A
130	13 A
150	15 A
160	16 A
200	20 A
250	25 A
300	30 A
320	32 A
350	35 A
400	40 A

Option

R	Ring Terminal

[1] Important: The following catalog number breakdown is for explanation purposes only. It is NOT a product configurator. Not all combinations of fields may be valid product catalog numbers.

www.rockwellautomation.com

Power, Control and Information Solutions Headquarters

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Asia Pacific: Rockwell Automation, Level 14, Core F, Cyberport 3, 100 Cyberport Road, Hong Kong, Tel: (852) 2887 4788, Fax: (852) 2508 1846

BGMU Submittal Package, Part 2 of 2, 05/03/2010, Page 996 of 1071

Publication 1489-PP001A-EN-P – August 2005

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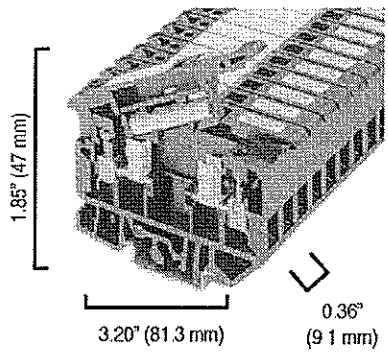
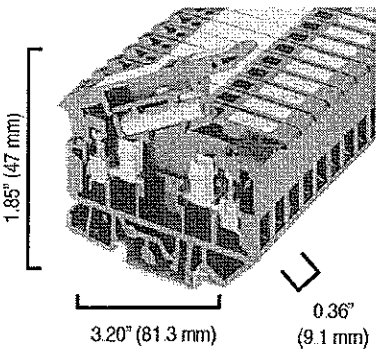
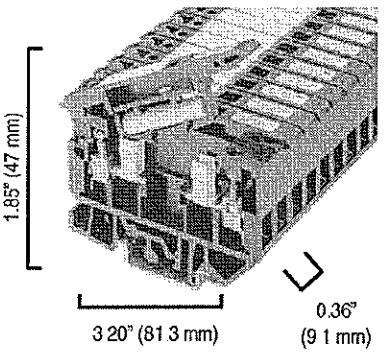
Fused Terminal w/ Neon Indicator (120VAC), 1492-H4

DIN Rail — Heavy Duty	—	—	1492-EAH35	10
Side Jumpers:				
Side Jumper — 10-pole Uninsulated	—	—	1492-N49	10
	—	—	—	—
Fanning Strip (12-pole can cut to desired length)	—	—	1492-SJS	10
Marking Systems	—	—	1492-MS8X12 (56/sheet)	5

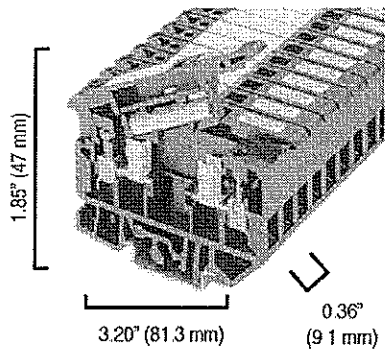
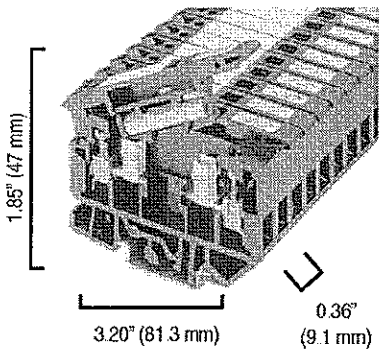
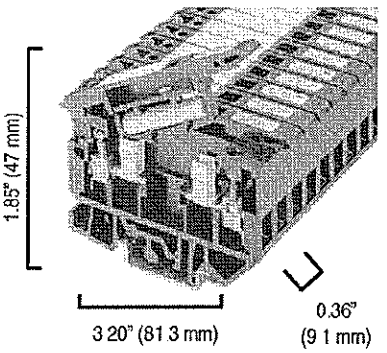
Fuse Blocks

	1492-H4			1492-H5			1492-H6		
Dimensions are not intended to be used for manufacturing purposes. **Note:** Height dimension is measured from top of rail to top of terminal block.									
Specifications	***Single-circuit fusible terminal block with neon blown fuse indicator.***			***Single-circuit fusible terminal block with LED blown fuse indicator.***			***Single-circuit fusible terminal block without a blown fuse indicator.***		
Approvals	cULus	CSA	IEC	cULus	CSA	IEC	cULus	CSA	IEC
Voltage Rating	300V AC/DC	300V AC/DC	500V AC/DC	300V AC/DC	300V AC/DC	500V AC/DC	300V AC/DC	300V AC/DC	500V AC/DC
Maximum Current	12 A	12 A	12 A	12 A	12 A	12 A	12 A	12 A	12 A
Wire Range (Rated Cross Section)	#30...#12 AWG	#30...#12 AWG	0.05...4 mm2	#30...#12 AWG	#30...#12 AWG	0.05...4 mm2	#30...#12 AWG	#30...#12 AWG	0.05...4 mm2
Indicator Type	Neon			LED			Non-Indicating		
Leakage Current	2 mA @ 300V			2 mA @ 24V			—		
Working Voltage	100...300V AC			10...57V AC/DC			Per Fuse Rating		
Fuse Size (Not Supplied)	1/4 in. x 1-1/4 in.			1/4 in. x 1-1/4 in.			1/4 in. x 1-1/4 in.		
Wire Strip Length	0.38 in. (9.7 mm)			0.38 in. (9.7 mm)			0.38 in. (9.7 mm)		
Recommended Tightening Torque	3...7 lb-in. (0.3...0.8 N•m)			3...7 lb-in. (0.3...0.8 N•m)			3...7 lb-in. (0.3...0.8 N•m)		
Density	33 pcs./ft (109/m)			33 pcs./ft (109/m)			33 pcs./ft (109/m)		
Insulation Temperature Range	-40...+221°F (-40...+105°C)			-40...+221°F (-40...+105°C)			-40...+221°F (-40...+105°C)		
Terminal Blocks	Cat. No.		Pcs./ Pkg.	Cat. No.		Pcs./ Pkg.	Cat. No.		Pcs./ Pkg.

Fused Terminal w/ Neon Indicator (120VAC), 1492-H5

DIN Rail — Heavy Duty	—	—	1492-EAH35	10
Side Jumpers:				
Side Jumper — 10-pole Uninsulated	—	—	1492-N49	10
	—	—	—	—
Fanning Strip (12-pole can cut to desired length)	—	—	1492-SJS	10
Marking Systems	—	—	1492-MS8X12 (56/sheet)	5

Fuse Blocks

	1492-H4			1492-H5			1492-H6		
Dimensions are not intended to be used for manufacturing purposes. **Note:** Height dimension is measured from top of rail to top of terminal block.									
Specifications	***Single-circuit fusible terminal block with neon blown fuse indicator.***			***Single-circuit fusible terminal block with LED blown fuse indicator.***			***Single-circuit fusible terminal block without a blown fuse indicator.***		
Approvals	cULus	CSA	IEC	cULus	CSA	IEC	cULus	CSA	IEC
Voltage Rating	300V AC/DC	300V AC/DC	500V AC/DC	300V AC/DC	300V AC/DC	500V AC/DC	300V AC/DC	300V AC/DC	500V AC/DC
Maximum Current	12 A	12 A	12 A	12 A	12 A	12 A	12 A	12 A	12 A
Wire Range (Rated Cross Section)	#30...#12 AWG	#30...#12 AWG	0.05...4 mm2	#30...#12 AWG	#30...#12 AWG	0.05...4 mm2	#30...#12 AWG	#30...#12 AWG	0.05...4 mm2
Indicator Type	Neon			LED			Non-Indicating		
Leakage Current	2 mA @ 300V			2 mA @ 24V			—		
Working Voltage	100...300V AC			10...57V AC/DC			Per Fuse Rating		
Fuse Size (Not Supplied)	1/4 in. x 1-1/4 in.			1/4 in. x 1-1/4 in.			1/4 in. x 1-1/4 in.		
Wire Strip Length	0.38 in. (9.7 mm)			0.38 in. (9.7 mm)			0.38 in. (9.7 mm)		
Recommended Tightening Torque	3...7 lb-in. (0.3...0.8 N•m)			3...7 lb-in. (0.3...0.8 N•m)			3...7 lb-in. (0.3...0.8 N•m)		
Density	33 pcs./ft (109/m)			33 pcs./ft (109/m)			33 pcs./ft (109/m)		
Insulation Temperature Range	-40...+221°F (-40...+105°C)			-40...+221°F (-40...+105°C)			-40...+221°F (-40...+105°C)		
Terminal Blocks	Cat. No.		Pcs./ Pkg.	Cat. No.		Pcs./ Pkg.	Cat. No.		Pcs./ Pkg.

RFI Filter, Corcom, 20V56

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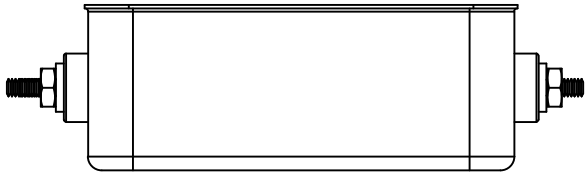

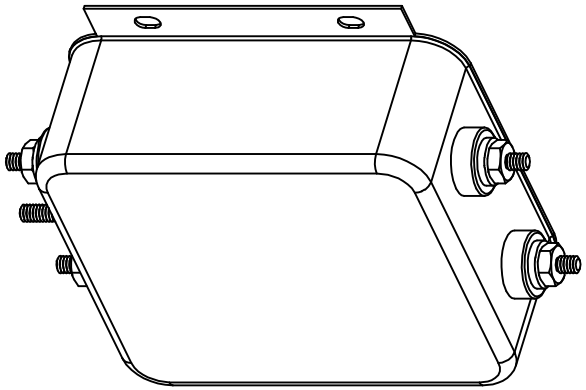

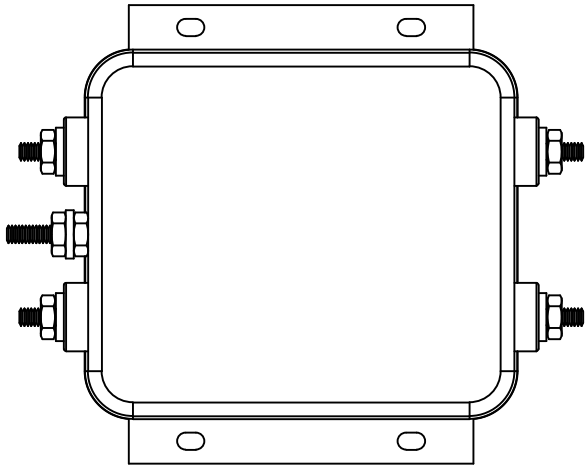

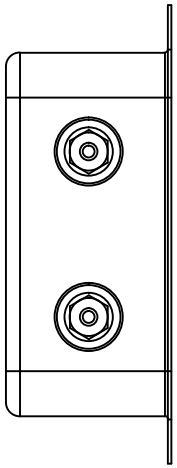

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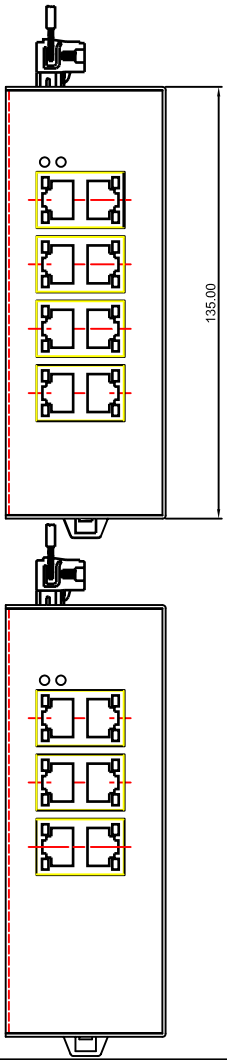
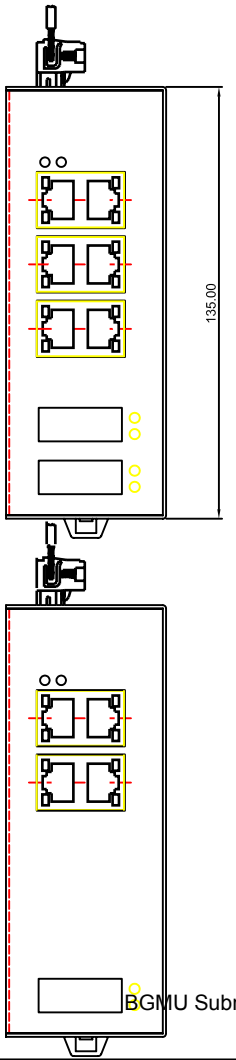
Tyco Electronics Corporation
Harrisburg, PA 17105-3608

NAME: CUSTOMER VIEW MODEL DRAWING

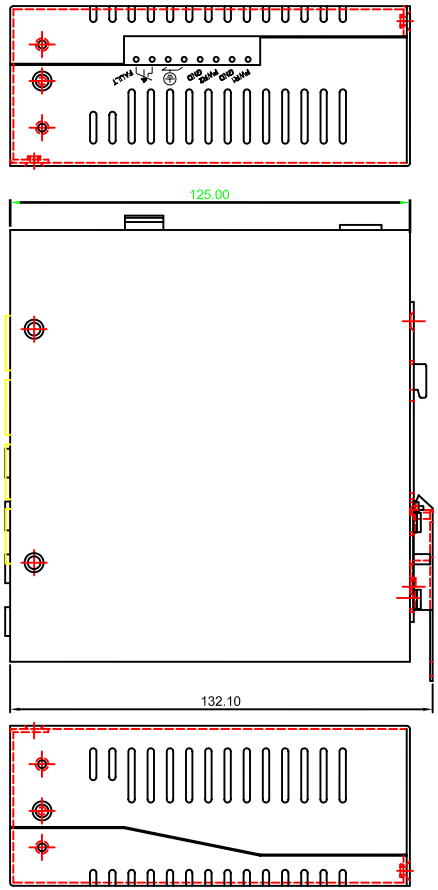
SIZE	DRAWING NO	VERSION	DATE
A3	C-6609042-5	-	14-Aug-09

Ethernet Switch, BB Electronics, EIR308

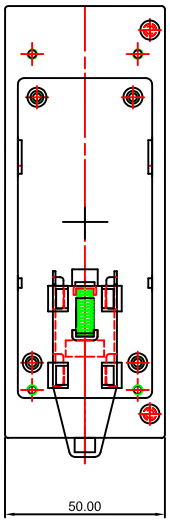




TERMINAL BLOCK



DIN RAIL



B&B electronics MANUFACTURING COMPANY

EIR300 Series

Dimensions in mm

B&B ELECTRONICS

PRODUCT INFORMATION

Model: EIR30x series

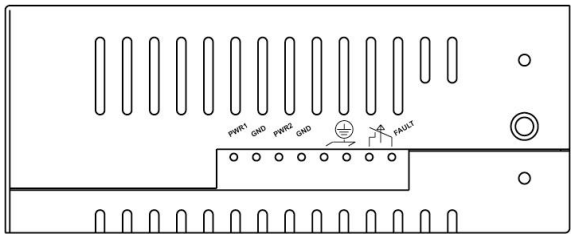
Hardened Compact Ethernet Switches

Description

This quick installation guide describes how to install and use the hardened compact Ethernet Switch. Capable of operating at temperature extremes of -34 to +74°C, this is the switch of choice for harsh environments constrained by space.

Physical Description

Terminal Block and Power Inputs



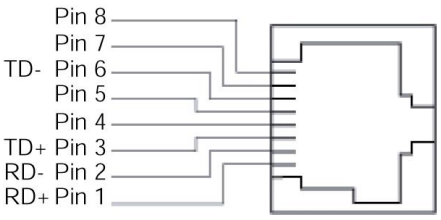
Terminal Block	
PWR1	Power Input 1 (+24VDC)
GND	Power Power Ground
PWR2	Power Input 2 (+24VDC)
GND	Power Ground
	Earth Ground
FAULT	The relay opens if PWR1 or PWR2 fails (1A)

There are two pairs of voltage inputs that can be used to power up this switch. Redundant voltage supplies are supported. You only need one voltage supply connected to run the switch.

10/100BaseTX and 100BaseFX Connectors

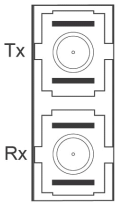
10/100BaseTX Connections

The following diagram lists the pinouts of 10/100BaseTX ports.



Pin	Regular Ports	Uplink Port
1	Input Receive Data +	Output Transmit Data +
2	Input Receive Data -	Output Transmit Data -
3	Output Transmit Data +	Input Receive Data +
4	NC	NC
5	NC	NC
6	Output Transmit Data -	Input Receive Data -
7	NC	NC
8	NC	NC

100BaseFX Connections



Fiber Port Pinouts

The Tx (transmit) port of device I is connected to the Rx (receive) port of device II, and the Rx (receive) port of device I to the Tx (transmit) port of device II.

B&B electronics MANUFACTURING COMPANY

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European Headquarters: Westlink Commercial Park Oranmore Co. Galway Ireland
+353 91 792444 Fax +353 91 792445 *www.bb-europe.com orders@bb-europe.com support@bb-europe.com*

B&B ELECTRONICS

PRODUCT INFORMATION

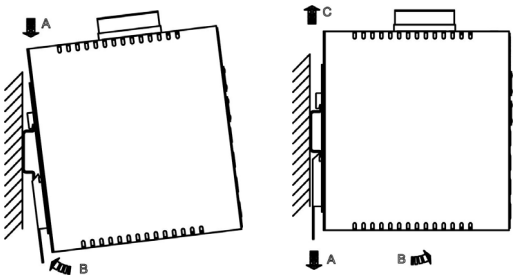
LED	State	Indication
LNK/ACT	Steady	Network connection established, LNK stands for LINK
(Green)	Flashing	Transmitting or receiving data, ACT stands for ACTIVITY
10/100	Steady	100 Mbps data
(Yellow)	Off	10 Mbps data

Functional Description

- Meets NEMA TS1/2 Environmental requirements for temperature, shock, vibration for traffic control equipment.
- Meets IEC61000-6-2 EMC Generic Standard Immunity for industrial environment.
- Support 802.3/802.3u/802.3x. Auto-negotiation: 10/100Mbps, Full/half-duplex; Auto MDI/MDIX.
- 100BaseFX: Multi mode SC or ST type; Single mode SC type.
- Support 2K MAC addresses. Provides 96K bytes memory buffer.
- Alarms for power failure by relay output.
- Redundant 10-30 VDC terminal block power inputs.
- Operating temperature ranges from -34 to 74°C.
- Supports Din-rail mounting installation.

Assembly, Startup, and Dismantling

- Assembly: Place the switch on the DIN rail from above using the slot. Push the front of the switch toward the mounting surface until it audibly snaps into place.
- Startup: Connect the supply voltage to start up the switch via the terminal block.
- Dismantling: Pull out the lower edge and then remove the switch from the DIN rail.



DECLARATION OF CONFORMITY

Name:	B&B Electronics Manufacturing Company
Address:	P.O. Box 1040 707 Dayton Road Ottawa, IL 61350 USA
Model Numbers:	EIR305-1ST, EIR305-1SC, EIR306, EIR308, EIR308-2ST, EIR308-2SC, EIR308-2SC-SM
Description:	5, 6, 8 port Ethernet Switches
Type:	Light industrial ITE equipment
Application of Council Directive:	89/336/EEC
Standards:	EN 55022 EN 61000 (-3-2, -3-3) EN 61000 (-4-2, -4-3, -4-4, -4-5, -4-6, -4-8, -4-11)

CE

Michael J. Fahrion, Director of Engineering

Specifications

Hardened Compact Switch	10/100BaseT/TX auto-negotiating ports with RJ-45 connectors, 100BaseFX fiber ports
Applicable Standards	IEEE 802.3 10BaseT, IEEE 802.3u 100BaseTX/FX
Switching Method	Store-and-Forward
Forwarding Rate	
10BaseT:	10 / 20Mbps half / full-duplex
100BaseTX/FX:	100 / 200Mbps half / full-duplex
Performance	148,80pps for 10Mbps, 148,800pps for 100Mbps
Cable	
10BaseT:	2-pair UTP/STP Cat. 3, 4, 5 up to 100m
100BaseTX:	2-pair UTP/STP Cat. 5 up to 100m
100BaseFX:	MMF (50 or 62.5µm), SMF (9 or10µm)
LED Indicators	Per unit – Power status (PWR1, PWR2) Per port – LNK/ACT – (Green) 10/100TX or 100FX, 100 – (Yellow) 10/100TX or 100FX
Dimensions / Net Weight	W13.5 cm × D12.5 cm × H5 cm Compact Size / 0.8kg approx.
Power Input	Terminal Block: 24VDC @ 400mA
Power Consumption	9.6W Maximum
Operating / Storage Temperature	-34°C to 74° C / -45°C to 93°C
Humidity	10%-95% non-condensing
Safety	UL/CUL 60950, EN60950, IEC 60950, IEC61000-6-2
Emissions	FCC Class A, CE Class A

B&B electronics MANUFACTURING COMPANY

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Power Supply, PULS, CS5-241

CS5.241, CS5.241-C1, CS5.241-S1

24V, 5A, SINGLE PHASE INPUT

POWER SUPPLY

- AC 100-120 / 200-240V Auto Select Input
- Efficiency up to 90.2%
- Width only 32mm
- 20% Output Power Reserves
- Full Output Power Between -25°C and +60°C
- Minimal Inrush Current Surge
- 3 Year Warranty

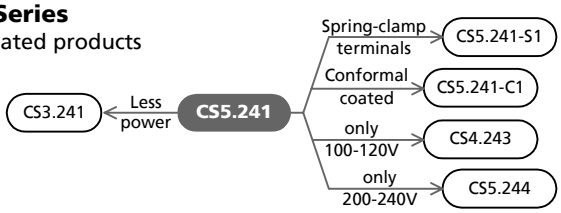
1. GENERAL DESCRIPTION

The Dimension C-Series are cost optimized power supplies without compromising quality, reliability and performance. The C-Series is part of the Dimension power supply family, existing alongside the high featured Q-series.

The C series includes all the essential basic functions and the devices have a power reserve of 20%. This extra current may even be used continuously at temperatures up to +45°C. The most important features are the small size, the high efficiency and the wide temperature range.

The Auto-select input makes worldwide installation and usage very simple. Defects or system failures caused by wrongly set switches can not occur.

C-Series
Related products



2. SHORT-FORM DATA

Output voltage	DC 24V	
Adjustment range	24 - 28V	
Output current	5 – 4.3A	ambient <60°C
	6 – 5,1A	ambient <45°C
Output power	120W	ambient <60°C
	144W	ambient <45°C
Output ripple	< 50mVpp	20Hz to 20MHz
Input voltage	AC 100-120 / 200-240V	Auto-select Input
Mains frequency	50-60Hz	±6%
AC Input current	typ. 2.05 / 1.23A	at 120 / 230Vac
Power factor	typ. 0.56 / 0.47	at 120 / 230Vac
AC Inrush current	typ. 3A peak	
DC Input	not allowed	
Efficiency	typ. 89.4 / 90.2%	at 120 / 230Vac
Losses	typ. 14.5 / 13.2W	at 120 / 230Vac
Temperature range	-25°C to +70°C	operational
Derating	3W/°C	+60 to +70°C
Hold-up time	typ. 80 / 78ms	at 120 / 230Vac
Dimensions	32x124x117mm	WxHxD

3. ORDER NUMBERS

Power Supply	**CS5.241**	Standard unit
	CS5.241-C1	Conformal coated PC-boards
	CS5.241-S1	Quick-connect spring-clamp terminals
Accessory	ZM1.WALL	Wall mount bracket
	ZM11.SIDE	Side mount bracket
	YRM2.DIODE	Redundancy module

4. MARKINGS

18WM LISTED IND. CONT. EQ.
UL 508

UL 60950-1

Marine, pending

EMC, LVD

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INTENDED USE

The power supply shall only be installed and put into operation by qualified personnel.

This power supply is designed for installation in an enclosure and is intended for the general use, such as in industrial control, office, communication, and instrumentation equipment. Do not use this device in aircraft, trains and nuclear equipment, where malfunctioning of the power supply may cause severe personal injury or threaten human life.

TERMINOLOGY AND ABREVIATIONS

PE and ⏚ symbol	PE is the abbreviation for **P**rotective **E**arth and has the same meaning as the symbol ⏚.
Earth, Ground	This document uses the term "earth" which is the same as the U.S. term "ground".
T.b.d.	To be defined, value or description will follow later.
AC 230V	A figure displayed with the AC or DC before the value represents a nominal voltage with standard tolerances (usually ±20%) included. E.g.: DC 12V describes a 12V battery disregarding whether it is full (13.7V) or flat (10V) As long as not otherwise stated, AC 100V and AC 230V parameters are valid at 50Hz and AC 120V parameters are valid at 60Hz mains frequency.
230Vac	A figure with the unit (Vac) at the end is a momentary figure without any additional tolerances included.

DISCLAIMER

The information presented in this document is believed to be accurate and reliable and may change without notice.

5. AC-INPUT

AC input	nom.	AC 100-120V / 200-240V	auto-select input, TN-, TT-, IT-Mains, see **Fig. 5-1**
AC input range		90-132Vac	100-120V range, continuous operation
		180-264Vac	200-240V range, continuous operation
		85-90Vac	Short term or with output derating
		264-300Vac	< 0.5s
Input frequency	nom.	50 – 60Hz	±6%

		AC 100V	**AC 120V**	**AC 230V**	
Input current	typ.	2.34A	2.05A	1.23A	at 24V, 5A see **Fig. 5-3**
Power factor *)	typ.	0.58	0.56	0.47	at 24V, 5A see **Fig. 5-1**
Crest factor **)	typ.	2,9	3,1	3,7	at 24V, 5A
Start-up delay	typ.	740ms	900ms	720ms	see **Fig. 5-2**
Rise time	typ.	8ms	8ms	8ms	0mF, 24V, 5A, see **Fig. 5-2**
	typ.	25ms	25ms	25ms	5mF, 24V, 5A, see **Fig. 5-2**
Turn-on overshoot	max.	400mV	400mV	400mV	see **Fig. 5-2**
Turn-on voltage	typ.	75Vac	75Vac	N / A	steady-state value, see **Fig. 5-1**
Shut-down voltage	typ.	55Vac	55Vac	N / A	steady-state value, see **Fig. 5-1**

*) The power factor is the ratio of the true (or real) power to the apparent power in an AC circuit.
**) The crest factor is the mathematical ratio of the peak value to the RMS value of the input current waveform

Fig. 5-1 **Input voltage range**

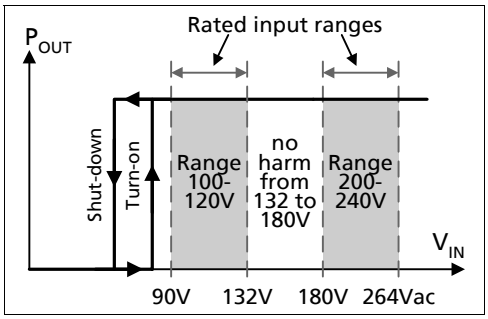


Fig. 5-2 **Turn-on behavior, definitions**

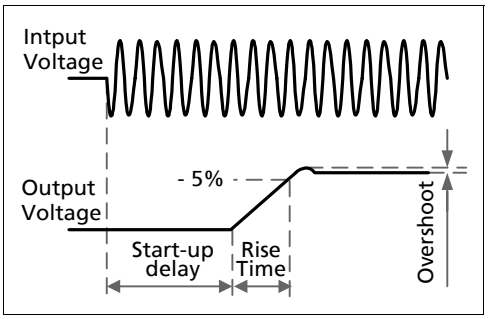


Fig. 5-3 **Input current vs. output load**

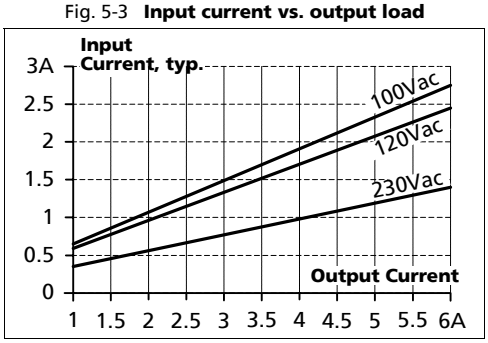
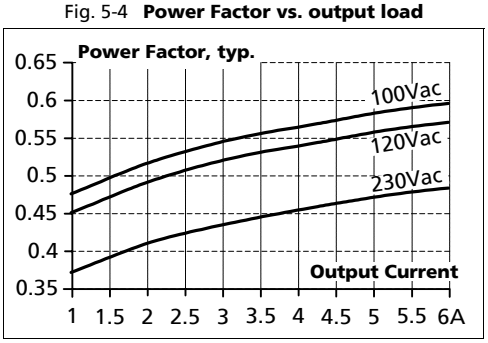


Fig. 5-4 **Power Factor vs. output load**

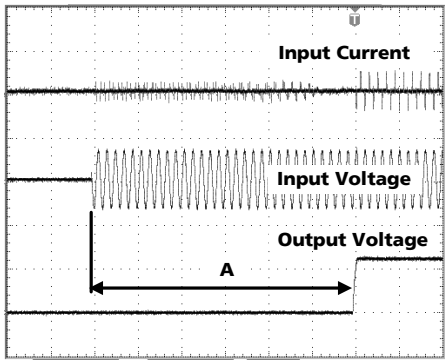


6. INPUT INRUSH CURRENT SURGE

An active inrush limitation circuitry limits the input inrush current after turn-on of the input voltage.
The charging current into EMI suppression capacitors is disregarded in the first milliseconds after switch-on.

		AC 100V	AC 120V	AC 230V	
Inrush current	max.	$10A_{peak}$	$10A_{peak}$	$10A_{peak}$	-25°C to +70°C
	typ.	$3A_{peak}$	$3A_{peak}$	$3A_{peak}$	-25°C to +70°C
Inrush energy	typ.	$1A^2s$	$1A^2s$	$1A^2s$	-25°C to +70°C

Fig. 6-1 **Input inrush current, typical behavior**



A: Start-up delay = Inrush delay

Input: 230Vac
Output: 24V, 5A
Ambient: 25°C

Upper curve: Input current 10A / DIV
Medium curve: Input voltage 500V / DIV
Lower curve: Output voltage 20V / DIV
Time scale: 100ms / DIV

7. HOLD-UP TIME

		AC 100V	AC 120V	AC 230V	
Hold-up Time	typ.	109ms	165ms	161ms	2,5A, 24V, see **Fig. 7-1**
	typ.	50ms	80ms	78ms	5A, 24V, see **Fig. 7-1**
	typ.	37ms	62ms	63ms	6A, 24V, see **Fig. 7-1**

Fig. 7-1 **Hold-up time vs. input voltage**

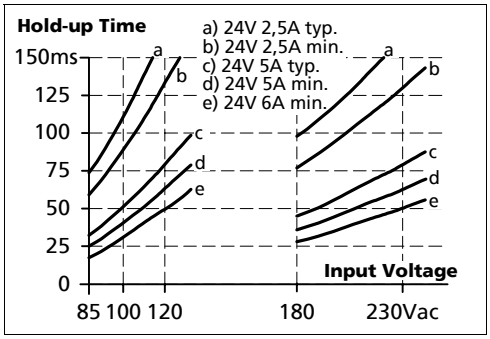
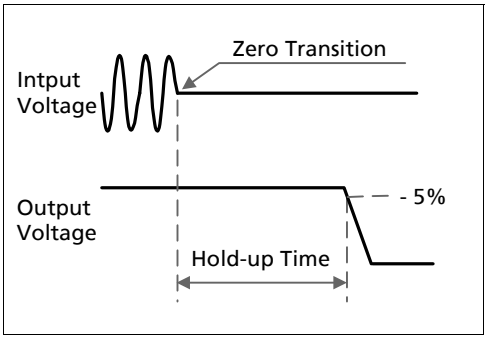


Fig. 7-2 **Shut-down behavior, definitions**



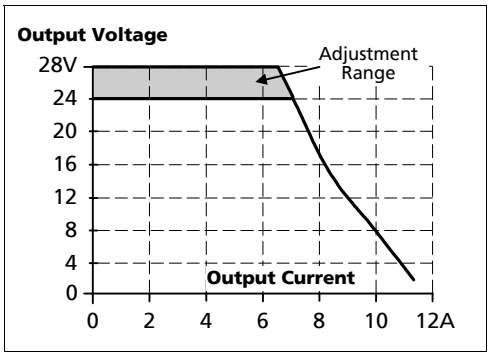
Note: At no load, the hold-up time can be up to several seconds. The green DC-ok lamp is on during this time.

8. OUTPUT

Output voltage	nom.	24V	
Adjustment range	min.	24-28V	guaranteed
	max.	30V	at clockwise end position of potentiometer
Factory setting		24.1V	±0.2%, at full load, cold unit
Line regulation	max.	70mV	90 to 132Vac or 180 to 264Vac
Load regulation	max.	100mV	static value, 0A → 5A → 0A
Ripple and noise voltage	max.	50mVpp	20Hz to 20MHz, 50Ohm
Output capacitance	typ.	1 800µF	
Output current	nom.	6A U)	at 24V, ambient < 45°C, see **Fig. 8-1**
	nom.	5A	at 24V, ambient < 60°C, see **Fig. 8-1**
	nom.	5.1A U)	at 28V, ambient < 45°C, see **Fig. 8-1**
	nom.	4.3A	at 28V, ambient < 60°C, see **Fig. 8-1**
Output power	nom.	144W U)	ambient < 45°C
	nom.	120W	ambient < 60°C
Short-circuit current	min.	10A	load impedance 200mOhm, see **Fig. 8-1**
	max.	14A	load impedance 200mOhm, see **Fig. 8-1**

U) The unit may respond with a thermal shut-down when continuously loaded with more than 120W and operated with a mains voltage of 100V or below.

Fig. 8-1 **Output voltage vs. output current, typ.**



Peak current capability (up to several ms)

The power supply can deliver a peak current which is higher than the specified short term current. This helps to start current demanding loads or to safely operate subsequent circuit breakers.

The extra current is supplied by the output capacitors inside the power supply. During this event, the capacitors will be discharged and causes a voltage dip on the output. Detailed curves can be found in chapter 25.1.

Peak current voltage dips	typ.	from 24V to 18.5V	at 10A for 50ms, resistive load
	typ.	from 24V to 22V	at 25A for 2ms, resistive load
	typ.	from 24V to 20V	at 25A for 5ms, resistive load

9. EFFICIENCY AND POWER LOSSES

		AC 100V	AC 120V	AC 230V	
Efficiency	typ.	88.8%	89.4%	90.2%	5A, 24V
Power losses	typ.	1.9W	2.0W	1.7W	0A
	typ.	9.1W	8.8W	8.2W	2.5A, 24V
	typ.	15.3W	14.5W	13.2W	5A, 24V
	typ.	19.4W	18.2W	16.1W	6A, 24V

Fig. 9-1 **Efficiency vs. output current at 24V**

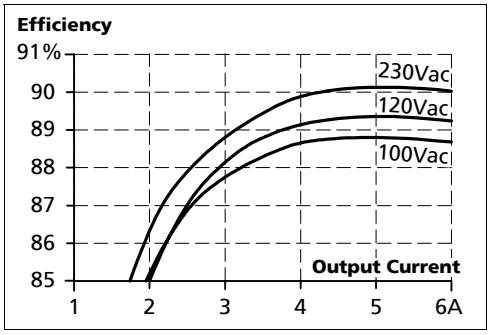


Fig. 9-2 **Losses vs. output current at 24V**

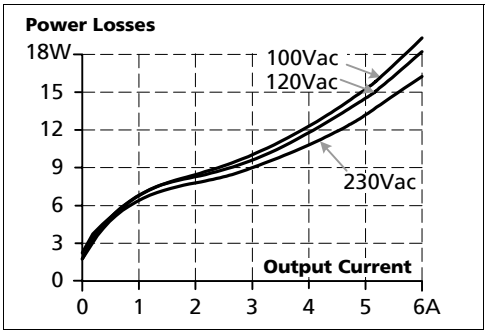


Fig. 9-3 **Efficiency vs. input voltage, 24V, 5A**

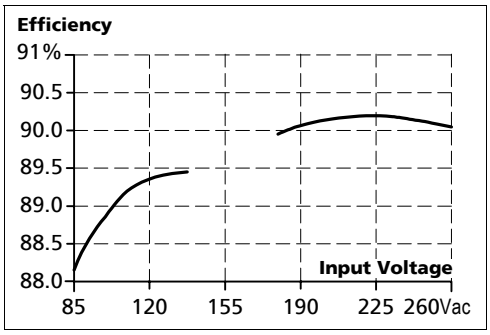
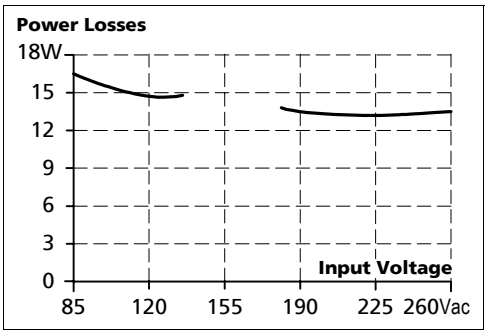
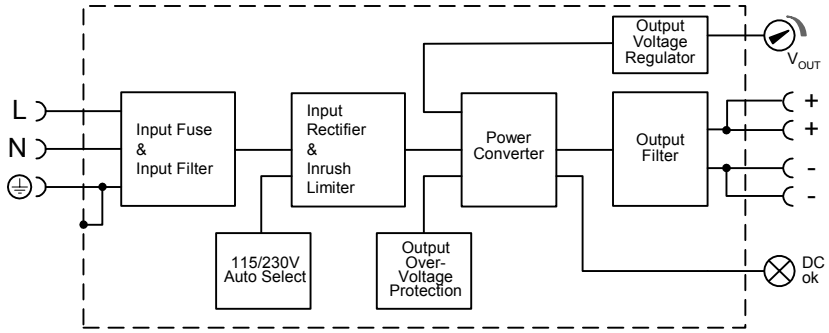


Fig. 9-4 **Losses vs. input voltage, 24V, 5A**



10. FUNCTIONAL DIAGRAM

Fig. 10-1 **Functional diagram**



11. RELIABILITY

		AC 100V	AC 120V	AC 230V	
Lifetime expectancy	min.	52 000h	58 000h	72 000h	40°C, 24V, 5A
	min.	27 000h	34 000h	42 000h	40°C, 24V, 6A
	min.	135 000h	128 000h	144 000h	40°C, 24V, 2,5A
	min.	142 000h	15 years	15 years	25°C, 24V, 5A
MTBF SN 29500, IEC 61709		638 000h	661 000h	869 000h	40°C, 24V, 5A
		542 000h	562 000h	739 000h	40°C, 24V, 6A
		1 077 000h	1 111 000h	1 495 000h	25°C, 24V, 5A
MTBF MIL HDBK 217F		552 000h	546 000h	574 000h	40°C, 24V, 5A, Ground Benign GB40
		497 000h	491 000h	517 000h	40°C, 24V, 6A, Ground Benign GB40
		788 000h	775 000h	800 000h	25°C, 24V, 5A, Ground Benign GB25

The **Lifetime expectancy** shown in the table indicates the operating hours (service life) and is determined by the lifetime expectancy of the built-in electrolytic capacitors.

Lifetime expectancy is specified in operational hours. Lifetime expectancy is calculated according to the capacitor's manufacturer specification. The prediction model allows a calculation of up to 15 years from date of shipment.

MTBF stands for **M**ean **T**ime **B**etween **F**ailure, which is calculated according to statistical device failures, and indicates reliability of a device. It is the statistical representation of the likelihood of a unit to fail and does not necessarily represent the life of a product.

12. FRONT SIDE AND USER ELEMENTS

Fig. 12-1 Front side

Output Terminals
Screw terminals
(Spring-clamp terminals on the CS5.241-S1)

+ Positive output
- Negative (return) output
Dual pins per pole

Output voltage potentiometer
Open the flap to tune the output voltage.
Factory set: 24.1V

DC-on lamp (green)
On when the voltage on the output terminals is > 21 V

Input Terminals
Screw terminals
(Spring-clamp terminals on the CS5.241-S1)
N … Neutral input
L … Line (hot) input
⏚ … PE (Protective Earth) input

13. TERMINALS AND WIRING

Type	Screw terminals (CS5.241, CS5.241-C1),); Spring-clamp terminals (CS5.241-S1)
Solid wire	0.5-6mm^2
Stranded wire	0.5-4mm^2
American wire gauge	20-10 AWG
Ferrules	allowed, but not required
Wire stripping length	7mm / 0.275inch
Screwdriver	3.5mm slotted or Pozidrive No 2 (only for screw terminals)
Recommended tightening torque	0.8Nm, 7lb.in (only for screw terminals)

Instructions:

a) Use appropriate copper cables that are designed for an operating temperature of:
60°C for ambient up to 45°C and
75°C for ambient up to 60°C minimum.

b) Follow national installation codes and installation regulations!

c) Ensure that all strands of a stranded wire enter the terminal connection!

d) Up to two stranded wires with the same cross section are permitted in one connection point (except PE wire).

e) Do not use the unit without PE connection.

14. EMC

The CE mark is in conformance with EMC guideline 89/336/EEC and 93/68/EEC and the low-voltage directive (LVD) 73/23/EWG. A detailed EMC Report is available on request.

EMC Immunity	EN 61000-6-2 EN 61000-6-1		Generic standards	
Electrostatic discharge	EN 61000-4-2	Contact discharge Air discharge	8kV 15kV	Criterion A Criterion A
Electromagnetic RF field	EN 61000-4-3	80MHz-1GHz	10V/m	Criterion A
Fast transients (Burst)	EN 61000-4-4	Input lines Output lines	4kV 2kV	Criterion A Criterion A
Surge voltage on input	EN 61000-4-5	L → N N / L → PE	2kV 4kV	Criterion A Criterion A
Surge voltage on output	EN 61000-4-5	+ → - + / - → PE	500V 500V	Criterion A Criterion A
Conducted disturbance	EN 61000-4-6	0,15-80MHz	10V	Criterion A
Mains voltage dips	EN 61000-4-11	0% of 100Vac 40% of 100Vac 70% of 100Vac 0% of 200Vac 40% of 200Vac 70% of 200Vac	0Vac, 20ms 40Vac, 200ms 70Vac, 500ms 0Vac, 20ms 80Vac, 200ms 140Vac, 500ms	Criterion A Criterion C Criterion A Criterion A Criterion C Criterion A
Voltage interruptions	EN 61000-4-11		0Vac, 5000ms	Criterion C
Input voltage swells	PULS internal standard		300Vac, 500ms	Criterion A
Powerful transients	VDE 0160	over entire load range	750V, 1.3ms	Criterion A

Criterions:
A: Power supply shows normal operation behavior within the defined limits.
C: Temporary loss of function is possible. Power supply might shut-down and restarts by itself. No damages or hazards for the power supply occur.

Switching frequency	175kHz to 225kHz	input voltage dependent 24V, 2.5A
	100kHz to 130kHz	input voltage dependent 24V, 5A

EMC Emission	EN 61000-6-4	Generic standards
Conducted emission	EN 55011, EN 55022, FCC Part 15, CISPR 11, CISPR 22	Class B, input lines
	EN 55022	Class A, output lines
Radiated emission	EN 55011, EN 55022	Class B
Harmonic input current	EN 61000-3-2	>2.7A output current not fulfilled
Voltage fluctuations, flicker	EN 61000-3-3	fulfilled

This device complies with FCC Part 15 rules.
Operation is subjected to following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Above an average output current of 2.7A, the harmonic current standard EN61000-3-2 is not fulfilled.

Please note:

A power supply has to comply with EN 61000-3-2 (Standard for harmonic input current) when:
1) the end-device is used within the European Union **and**
2) the end-device is connected to a public mains supply with a nominal voltage ≥ 220Vac **and**
3) the power supply is:
- fitted in an end-device with an average input power in excess of 75W **or**
- fitted in an end-device with a continuous input power in excess of 75W **or**
- part of a lighting system.

Exceptions:
End-devices for professional applications with an input power > 1000W do not need to fulfill EN 61000-3-2.

Comments:
- The average input power must be determined in accordance with EN 61000-3-2.
- Industrial mains supplies with their own transformer are considered to be "non-public".
- Where individual self-contained items of equipment are installed in a rack or case (e.g. devices connected in parallel), they are regarded as being individually connected to the mains supply. The rack or case need not be tested as a whole. Alternatively it is also permitted to assess the whole rack or case. This is recommended for devices used in professional applications with an input power greater than 1000W.

15. ENVIRONMENT

Operational temperature	-25°C to +70°C (-13°F to 158°F)	reduce output power according **Fig. 15-1**
Output de-rating	1.6W/°C	45-60°C (113°F to 140°F),
	3W/°C	60-70°C (140°F to 158°F),
Storage temperature	-40 to +85°C (-40°F to 185°F)	storage and transportation
Humidity	5 to 95% r.H.	IEC 60068-2-30 Do not energize while condensation is present
Vibration sinusoidal	2-17.8Hz: ±1.6mm; 17.8-500Hz: 2g 2 hours / axis	IEC 60068-2-6
Shock	30g 6ms, 20g 11ms 3 bumps / direction, 18 bumps in total	IEC 60068-2-27
Altitude	0 to 6000m (0 to 20 000ft)	Reduce output power or ambient temperature above 2000m sea level.
Output de-rating (for altitude)	7.5W/1000m or 5°C/1000m	above 2000m (6500ft), see **Fig. 15-2**
Over-voltage category	III	EN 50178, altitudes up to 2000m
	II	Altitudes from 2000m to 6000m
Degree of pollution	2	EN 50178, not conductive

Fig. 15-1 **Output current vs. ambient temp.,**

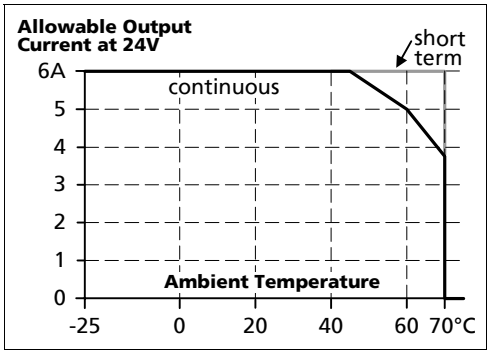
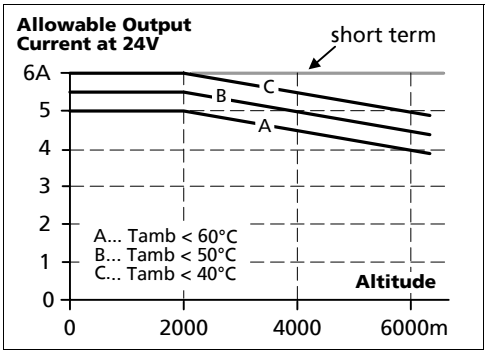


Fig. 15-2 **Output current vs. altitude, 24V**



The ambient temperature is defined 2cm below the unit.

16. PROTECTION FEATURES

Output protection	Electronically protected against overload, no-load and short-circuits	
Output over-voltage protection	typ. 35Vdc max. 39Vdc	In case of an internal power supply defect, a redundant circuitry limits the maximum output voltage. The output shuts down and automatically attempts to restart.
Output over-current protection	electronically limited	see **Fig. 8-1**
Degree of protection	IP 20	EN/IEC 60529
Penetration protection	> 3.5mm	e.g. screws, small parts
Over-temperature protection	yes	output shut-down with automatic restart
Input transient protection	MOV	Metal Oxide Varistor
Internal input fuse	T4A H.B.C.	not user replaceable

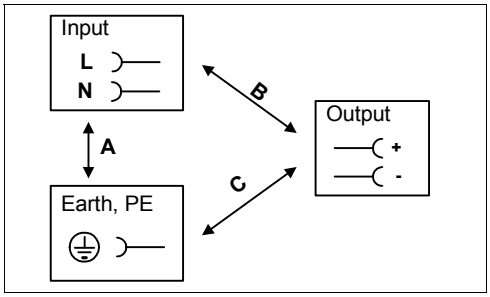
Note: In case of a protection event, audible noise may occur.

17. SAFETY

Input / output separation	SELV	IEC/EN 60950-1
	PELV	EN 60204-1, EN 50178, IEC 60364-4-41
	double or reinforced insulation	
Class of protection	I	PE (Protective Earth) connection required
Isolation resistance	> 5MOhm	input to output, 500Vdc
PE resistance	< 0.1Ohm	between housing and PE terminal
Touch current (leakage current)	typ. 0.24mA	100Vac, 50Hz, TN mains
	typ. 0.35mA	120Vac, 60Hz, TN mains
	typ. 0.40mA	230Vac, 50Hz, TN mains
	< 0.36mA	110Vac, 50Hz, TN mains
	< 0.53mA	132Vac, 60Hz, TN mains
	< 0.60mA	264Vac, 50Hz, TN mains

18. DIELECTRIC STRENGTH

Fig. 18-1 **Dielectric strength**



		A	B	C
Type test	60s	2500Vac	3000Vac	500Vac
Factory test	5s	2500Vac	2500Vac	500Vac
Field test	5s	2000Vac	2000Vac	500Vac

Type tests and factory tests:
Conducted by the manufacturer. Do not repeat test in field!
Rules for field test:
Use appropriate test equipment which applies the voltage with a slow ramp! Connect L and N together as well as all output poles.

The output voltage is floating and has no ohmic connection to ground.

To fulfill the PELV requirements according to EN60204-1 § 6.4.1, we recommend that either the + pole, the – pole or any other part of the output circuit shall be connected to the protective earth system. This helps to avoid situations in which a load starts unexpectedly or can not be switched off any more when unnoticed earth faults occur.

19. APPROVALS

IEC 60950-1	IECEE CB SCHEME	CB Scheme, Information Technology Equipment
UL 508	18WM LISTED IND. CONT. EQ.	LISTED as Industrial Control Equipment E198865
UL 60950-1	c UL us	RECOGNIZED E137006 recognized for the use in U.S.A. (UL 60950-1) and Canada (C22.2 No. 60950) Information Technology Equipment, Level 3
Marine pending	GL ABS	GL (Germanischer Lloyd) classified and ABS (American Bureau for Shipping) PDA for marine and offshore applications. Environmental category: C, EMC2

20. FULFILLED STANDARDS

EN 61558-2-17	Safety of Power Transformers
EN/IEC 60204-1	Safety of Electrical Equipment of Machines
EN/IEC 61131-2	Programmable Controllers
EN 50178	Electronic Equipment in Power Installations

21. USED SUBSTANCES

The unit does not release any silicone and is suitable for the use in paint shops.

Electrolytic capacitors included in this unit do not use electrolytes such as Quaternary Ammonium Salt Systems.

Plastic housings and other molded plastic materials are free of halogens, wires and cables are not PVC insulated.

The production material within our production does not include following toxic chemicals:
Polychlorized Biphenyl (PCB), Polychlorized Terphenyl (PCB), Pentachlorophenol (PCP), Polychlorinated naphthalene (PCN), Polybrom Biphenyl (PBB), Polybrom Bipheny-oxyd (PBO), Polybrominated Diphenylether (PBDE), Polychlorinated Diphenylether (PCDE), Polydibromphenyl Oxyd (PBDO), Cadmium, Asbest, Mercury, Silicia

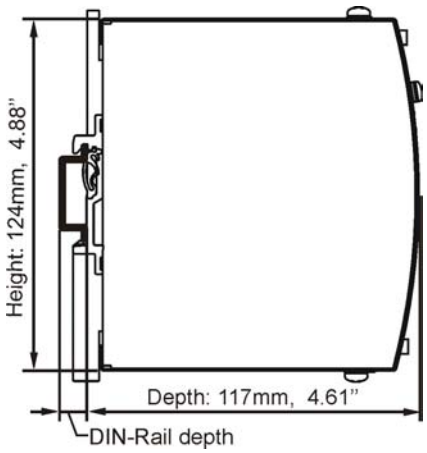
22. PHYSICAL DIMENSIONS AND WEIGHT

Weight	500g / 1.1lb
DIN-Rail	Use 35mm DIN-rails according to EN 60715 or EN 50022 with a height of 7.5 or 15mm. The DIN-rail height must be added to the depth (117mm) to calculate the total required installation depth.

Electronic files with mechanical data can be downloaded at www.pulspower.com

Fig. 22-1 **Front view**

Fig. 22-2 **Side view**



23. INSTALLATION AND OPERATION INSTRUCTIONS

Mounting Orientation:
Output terminal must be located on top and input terminal on the bottom. For other orientations see chapter 25.12.

Cooling:
Convection cooled, no forced cooling required. Do not cover ventilation grid (e.g. cable conduits) by more than 30%!

Installation clearances:
40mm on top, 20mm on the bottom, 5mm on the left and right side are recommended when loaded permanently with full power. In case the adjacent device is a heat source, 15mm clearance are recommended.

Risk of electrical shock, fire, personal injury or death!
Do not use the unit without proper earth connection (Protective Earth). Use the pin on the terminal block for earth connection and not one of the screws on the housing.
Turn power off before working on the power supply. Protect against inadvertent re-powering.
Make sure the wiring is correct by following all local and national codes.
Do not open, modify or repair the unit.
Use caution to prevent any foreign objects from entering into the housing.
Do not use in wet locations or in areas where moisture or condensation can be expected.

Service parts:
The unit does not contain any service parts. The tripping of an internal fuse is caused by an internal defect. If damage or malfunctioning should occur during operation, immediately turn power off and send unit to factory for inspection!

24. ACCESSORY

ZM1.WALL Wall mounting bracket

This bracket is used to mount Dimension units onto a flat surface without utilizing a DIN-Rail. The two aluminum brackets and the black plastic slider of the unit have to be detached, so that the two steel brackets can be mounted.

Fig. 24-1 **ZM1.WALL Wall Mounting Bracket**

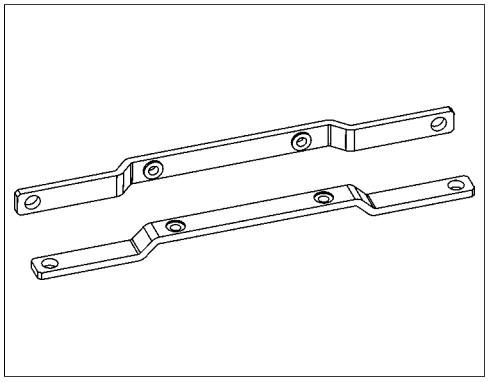
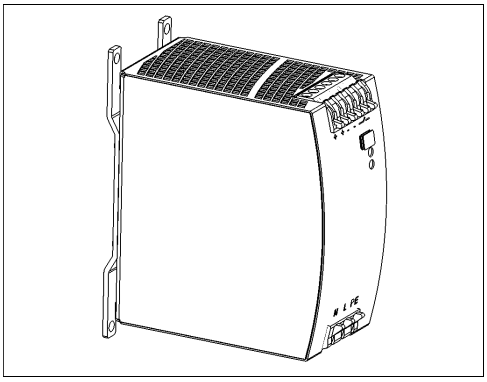


Fig. 24-2 **Assembled Wall Mounting Bracket**



ZM11.SIDE Side mounting bracket

This bracket is used to mount Dimension units sideways with or without utilizing a DIN-Rail. The two aluminum brackets and the black plastic slider of the unit have to be detached, so that the steel brackets can be mounted.

For sideway DIN-rail mounting, the removed aluminum brackets and the black plastic slider need to be mounted on the steel bracket.

Fig. 24-3 **ZM13.SIDE Side Mounting Bracket**

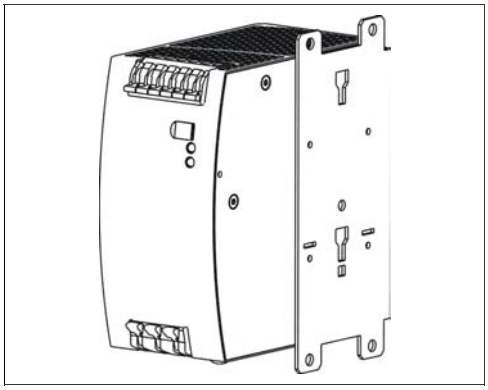
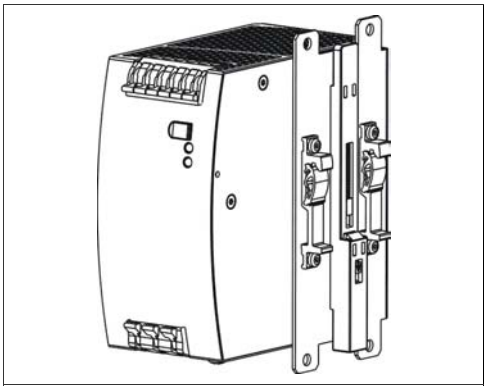


Fig. 24-4 **Side Mounting with DIN-rail brackets**



25. APPLICATION NOTES

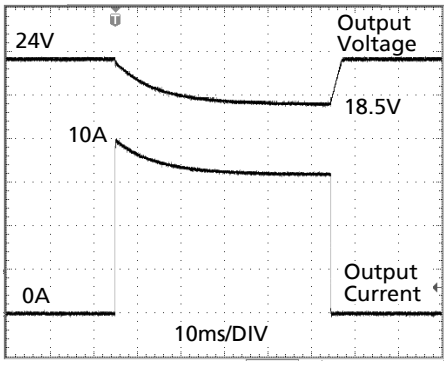
25.1. PEAK CURRENT CAPABILITY

Solenoids, contactors and pneumatic modules often have a steady state coil and a pick-up coil. The inrush current demand of the pick-up coil is several times higher than the steady state current and usually exceeds the nominal output current (including the PowerBoost) The same situation applies, when starting a capacitive load.

Branch circuits are often protected with circuit breakers or fuses. In case of a short or an overload in the branch circuit, the fuse needs a certain amount of over-current to trip or to blow. The peak current capability ensures the safe operation of subsequent circuit breakers.

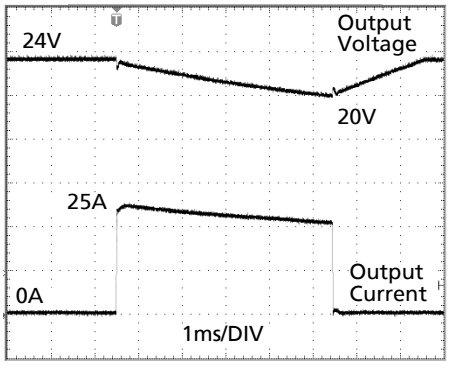
Assuming the input voltage is turned on before such an event, the built-in large sized output capacitors inside the power supply can deliver extra current. Discharging this capacitor causes a voltage dip on the output. The following two examples show typical voltage dips:

Fig. 25-1 **Peak load 10A for 50ms, typ.**



Peak load 10A (resistive) for 50ms
Output voltage dips from 24V to 18.5V.

Fig. 25-2 **Peak load 25A for 5ms, typ.**



Peak load 25A (resistive) for 5ms
Output voltage dips from 24V to 20V.

25.2. CHARGING OF BATTERIES

The power supply shall not be used to charge batteries. Choose Q-Series for charging batteries.

25.3. BACK-FEEDING LOADS

Loads such as decelerating motors and inductors can feed voltage back to the power supply. This feature is also called return voltage immunity or resistance against Back- E.M.F. (Electro Magnetic Force).

This power supply is resistant and does not show malfunctioning when a load feeds back voltage to the power supply. It does not matter, whether the power supply is on or off.

The maximum allowed feed back voltage is 35Vdc. The absorbing energy can be calculated according to the built-in large sized output capacitor which is specified in chapter 8.

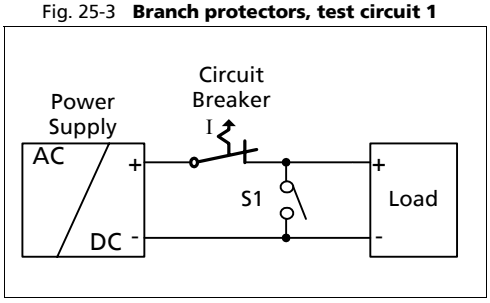
25.4. OUTPUT CIRCUIT BREAKERS

Standard miniature circuit breakers (MCBs) can be used for branch protection. Ensure that the MCB is rated for DC voltage, too. The following tests show which circuit breakers the power supply typically trips.

Circuit breakers have huge tolerances in their tripping behavior. Therefore, these typical tests can only be used as a recommendation or for comparing two different power supplies. Furthermore, the loop impedance has a major influence on whether a breaker trips or not. Two tests were performed, representing typical situations:

Test 1: Short circuit with S1 on the power supply end of the cable (loop impedance approx. 20mOhm)

Fig. 25-3 **Branch protectors, test circuit 1**



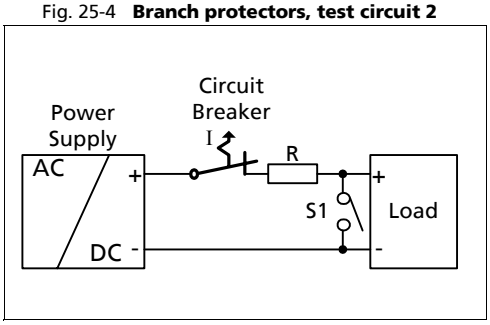
Parameters:
Input voltage: 230Vac, load current: 0A

The following circuit breaker tripped during the test:

A- or **Z**- Characteristic::	equal or smaller 8A
B- Characteristic:	no tripping ≥ 6A no breaker available < 6A
C- Characteristic:	equal or smaller 4A

Test 2: Short circuit with S1 on the load end (additional impedance included; represents longer load wire length).

Fig. 25-4 **Branch protectors, test circuit 2**



Parameters:
Input voltage: 230Vac, load current: 0A

The following circuit breaker tripped during the test:

A- or **Z**- Characteristic::	≤ 6A and R= 180mOhm
B- Characteristic:	no tripping ≥ 6A no breaker available < 6A
C- Characteristic:	≤ 3A and R= 270mOhm

What does this resistance mean in wire length?

	0.5mm²	0.7mm²	1.0mm²	1.5mm²	2.5mm²	4.0mm²
180mOhm	5.0m	7.0m	10m	15m	25m	40m
270mOhm	7.5m	10.5m	15m	23m	38m	60m

Example:
Which wire gauge must be used to trip a C-Characteristic circuit breaker with a rating of 3A? The load wire length is 21m.

Answer: A 3A C-Characteristic circuit breaker requires a loop impedance of less than 270mOhm (test results). The wire length table shows that up to 23m wire with a cross section of 1.5mm² are below 270mOhm. A wire not smaller than 1.5mm² shall be used.

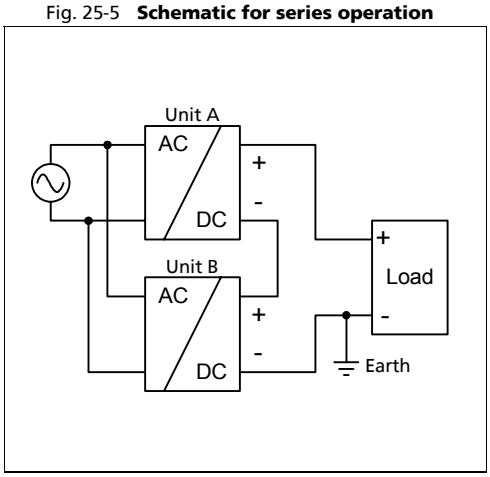
25.5. INDUCTIVE AND CAPACITIVE LOADS

The unit is designed to supply any kind of load, including unlimited capacitive and inductive loads.

25.6. SERIES OPERATION

The power supply can be put in series to increase the output voltage.

Fig. 25-5 **Schematic for series operation**



Instructions for use in series:

a) It is possible to connect as many units in series as needed, providing the sum of the output voltage does not exceed 150Vdc.
b) Voltages with a potential above 60Vdc are not SELV any more and can be dangerous. Such voltages must be installed with a protection against touching.
c) For serial operation use power supplies of the same type.
d) Earthing of the output is required when the sum of the output voltage is above 60Vdc.
e) Keep an installation clearance of 15mm (left/right) between two power supplies and avoid installing the power supplies on top of each other.

Note: Avoid return voltage (e.g. from a decelerating motor or battery) which is applied to the output terminals.

25.7. PARALLEL USE TO INCREASE OUTPUT POWER

The power supply shall not be used in parallel to increase the output power.

25.8. PARALLEL USE FOR 1+1 REDUNDANCY

Power supplies can be paralleled for 1+1 redundancy to gain a higher system availability. Redundant systems require a certain amount of extra power to support the load in case one power supply unit fails. The simplest way is to put two C-Series power supplies in parallel. In case one power supply unit fails, the other one is automatically able to support the load current without any interruption. This simple way to build a redundant system has two major disadvantages:

- The faulty power supply can not be recognized. The green LED will still be on since it is reverse-powered from the other power supply.
- It does not cover failures such as an internal short circuit in the secondary side of the power supply. In such a - virtually nearly impossible - case, the defective unit becomes a load for the other power supplies and the output voltage can not be maintained any more.

This can only be avoided by utilizing decoupling diodes which are included in the decoupling module YR2.DIODE or redundancy module YRM2.DIODE.

Recommendations for building redundant power systems:

a) Use separate input fuses for each power supply.
b) Monitor the individual power supply units. A DC-ok lamp and a DC-ok contact is included in the redundancy module YRM2.DIODE. This feature reports a faulty unit.
c) When possible, connect each power supply to different phases or circuits.

25.9. EXTERNAL INPUT PROTECTION

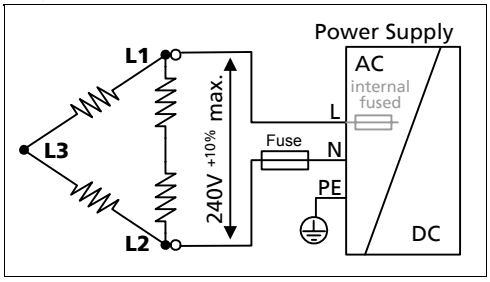
The unit is tested and approved for branch circuits up to 20A. External protection is only required if the supplying branch has an ampacity greater than this. In some countries local regulations might apply. Check also local codes and local requirements.

If an external fuse is necessary or utilized, a minimum value is required to avoid undesired tripping of the fuse.

		B-Characteristic	C-Characteristic
Ampacity	max.	20A	20A
	min.	10A	6A

25.10. OPERATION ON TWO PHASES

Fig. 25-6 **Schematic for two phase operation**



Instructions for two phase operation:

a) A phase to phase connection is allowed as long as the supplying voltage is below 240V$^{+10\%}$.

b) Use a fuse or a circuit breaker to protect the N input. The N input is internally not protected and is in this case connected to a hot wire.

Appropriate fuses or circuit breakers are specified in section 25.9 "External Input Protection".

25.11. USE IN A TIGHTLY SEALED ENCLOSURE

When the power supply is installed in a tightly sealed enclosure, the temperature inside the enclosure will be higher than outside. The inside temperature defines the ambient temperature for the power supply.

Results from such an installation:

Power supply is placed in the middle of the box, no other heat producer inside the box

Enclosure:	Rittal Type IP66 Box PK 9516 100, plastic, 110x180x165mm
Load:	24V, 4A; (=80%) load is placed outside the box
Input:	230Vac
Temperature inside the box:	44.3°C (in the middle of the right side of the power supply with a distance of 2cm)
Temperature outside the box:	23.3°C
Temperature rise:	21K

25.12. MOUNTING ORIENTATIONS

Mounting orientations other than input terminals on the bottom and output on the top require a reduction in continuous output power or a limitation in the max. allowed ambient temperature. The amount of reduction influences the lifetime expectancy of the power supply. Therefore, two different derating curves for continuous operation can be found below:

Curve A1 Recommended output current.
Curve A2 Max allowed output current (results approx. in half the lifetime expectancy of A1).

Fig. 25-7
Mounting Orientation A
Standard Orientation

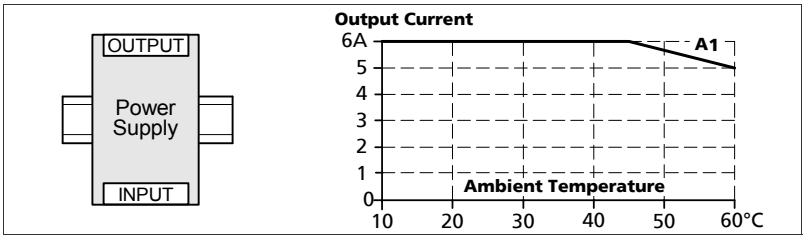


Fig. 25-8
Mounting Orientation B
(Upside down)

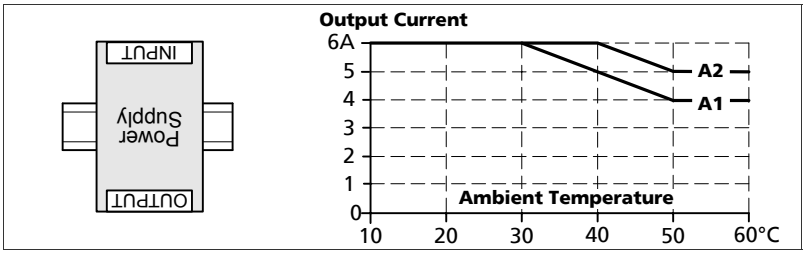


Fig. 25-9
Mounting Orientation C
(Table-top mounting)

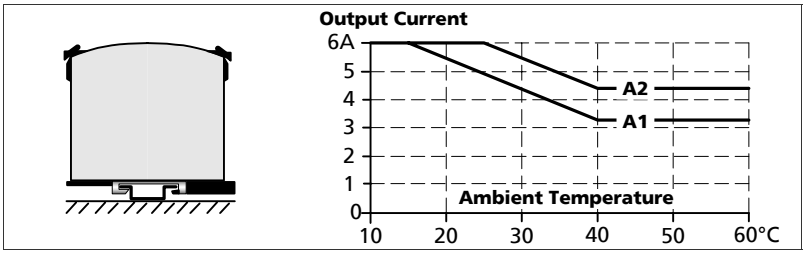


Fig. 25-10
Mounting Orientation D
(Horizontal cw)

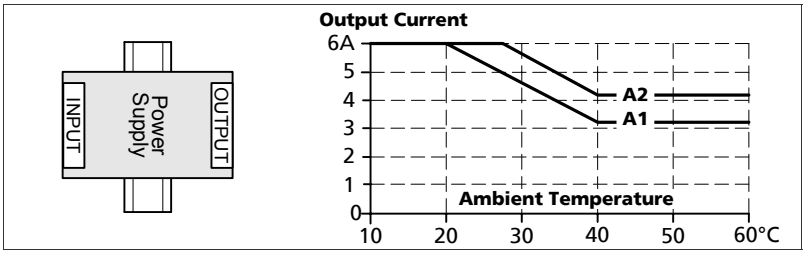
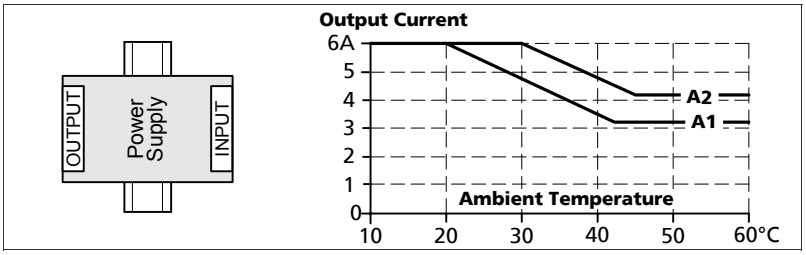
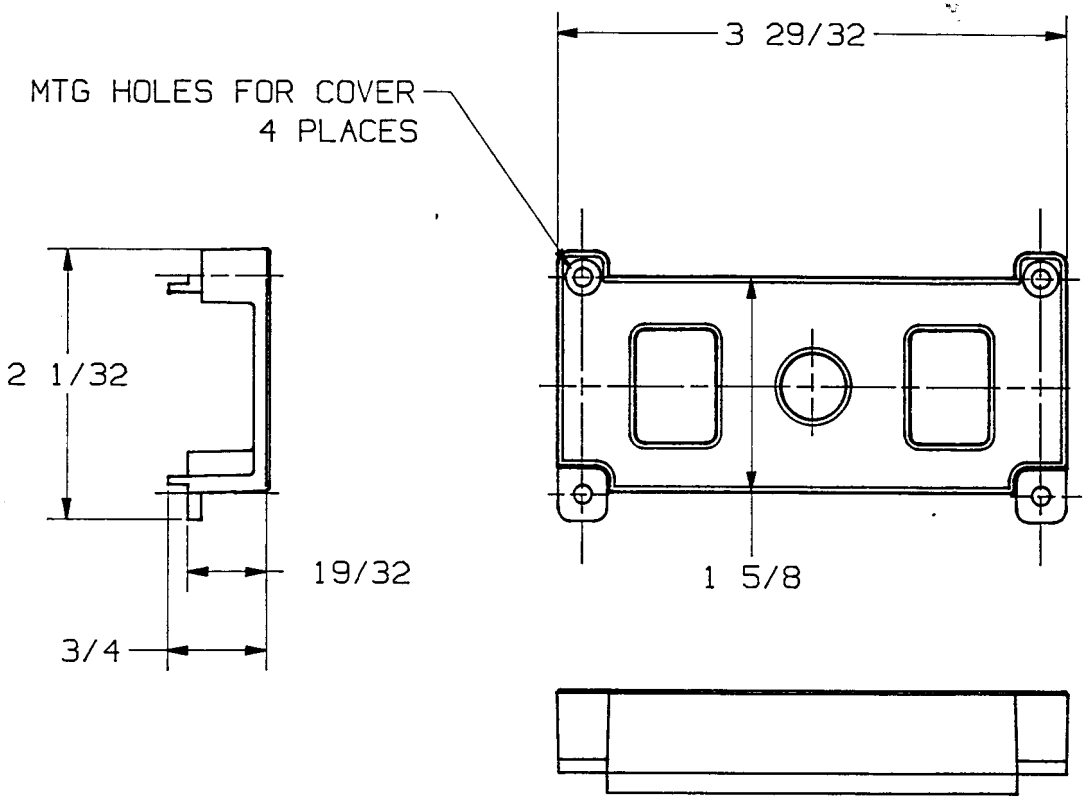


Fig. 25-11
Mounting Orientation E
(Horizontal ccw)



Power Distribution Block Safety Cover, Ferraz Shawmut, 08570

REV	DESCRIPTION	DATE	APPD
01	REVISED AND REDRAWN PER ECO 89-021	8/16/89	



COPY

P/N 08570

NOTES UNLESS OTHERWISE SPECIFIED
- ALL DIMENSIONS ARE IN INCHES
- STAMP OR ETCH DWG. NO. ON PART
- REMOVE ALL BURRS AND SHARP EDGES
- TOLERANCES: XXXX±.0005; XXX±.005; XX±.01; X±.04; ANGLES ±0°30'
FRACTIONS ±1/32

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ASSY DWG USED ON		REF OR SIM DWG	

MATERIAL

FINISH

SIGNATURES	DATE
DRWN G Williams	8/8/89
CHKD [illegible]	8/30/89
ENGD	
APPD D Pangone	8/16/89

GOULD SHAWMUT
GOULD SHAWMUT
P. O. BOX 729
MARBLE FALLS, TX 78654

PRODUCT INFO

TITLE
COVER, PDB
MEDIUM SEGMENTED

DWG NO	REV
27B0060	01

SCALE	FILE NO	SHEET
NONE		1 OF 1

Control Transformer, Hammond PH1500MQMJ

Hammond Power Solutions Inc.

HPS IMPERATOR®
Industrial Control Transformers c/w Factory Installed Fuse Kits Installation Instructions

Patent Pending **Literature Code: PHFK1**

Thank you for purchasing your ***HPS IMPERATOR®*** industrial control transformer. This ***HPS IMPERATOR®*** machine tool rated industrial control transformer is supplied with factory installed primary and secondary fuse kits. This instruction sheet provides important information on the installation of this transformer, so please take the time to read before attempting to install this control transformer.

If you have any questions regarding the HPS Imperator series of industrial control transformers or are having any difficulty with your installation, please contact HPS customer service or technical support in the U.S. at 1-866-705-4684 or in Canada at 1-888-798-8882.

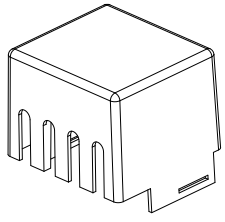
Important Installation Notes:

1) **ALL FACTORY INSTALLED FUSE KITS ARE PRE-WIRED AT THE TRANSFORMERS HIGHEST PRIMARY VOLTAGE AND THE LOWEST SECONDARY VOLTAGE. To hook-up at a different primary or seconday voltage, please refer to the PHWD1 wiring instruction sheet included with the transformer.**
2) **Torque all terminal screws between 12 to 14 inch-lbs.**
3) **For all bare wire connections, the recommended wire size range is: 18 AWG to 14 AWG for solid wire and 14 AWG for stranded.**
4) **A ring or spade connector must be used if using a wire size outside the range listed above.**
5) **Ensure mounting screws used for installation (screws not supplied), are properly sized for transformer weight and mounting application.**
6) **For connection details, please refer to wiring instructions supplied with your *HPS IMPERATOR™* machine tool industrial control transformer.**
7) **Primary and secondary fuse kits are currently not suitable for *branch circuit* applications!**

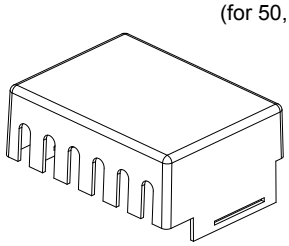
If finger safe applications are required, HPS also has available optional finger guard kits. These kits (see example drawing below) are ordered separately. Please see the tables below for the correct finger guard part number. You will require one finger guard for each primary or secondary side you wish to protect (2 per transformer).

Optional Fused Finger Guard Kits

Kit P/N	Applicable P/N Suffix's	Applicable VA Size
FGF1	AJ, AR, MQMJ, MEMX, QR, SP, PG, PP	50
FGF2	MBMH, MGJ, MLI	50
FGF2	All	75
FGF2	All (excluding PH100MBMH)	100
FG3	MBMH	100
FG3	All	150
FG3	AJ, AR, MQMJ, MEMX, QR, SP, PG, PP	250
FG4	MBMH, MGJ, MLI	250
FG4	All	350, 500
FG4	AJ, AR, MQMJ, QR, SP, PP	750
FG5	MBMH, MEMX, MGJ, MLI, PG	750
FG5	All	1000, 1500
N/A	All	2000 to 5000



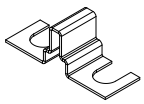
Finger Guard
(for 50, 75 and 100VA)



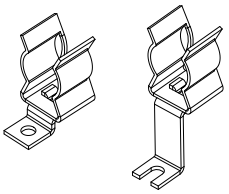
Finger Guard
(for 150VA to 1500VA)

Note: Maximum allowable current rating on all primary or secondary fuse kits is 30 Amps.

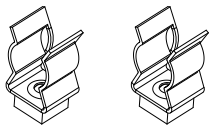
Accessory Sample Identifier Drawings



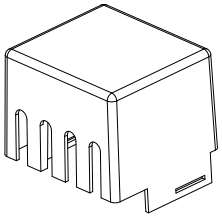
Voltage Link



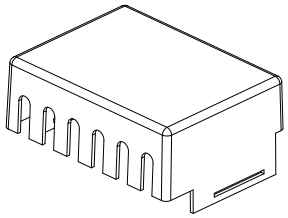
Fuse Clips
(for 50, 75 and 100VA)



Fuse Clips
(for 150VA to 1500VA)

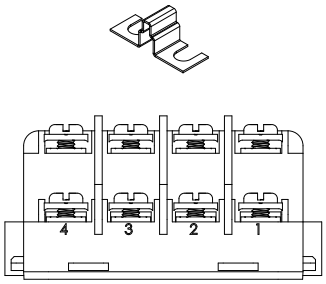


Finger Guard
(for 50, 75 and 100VA)

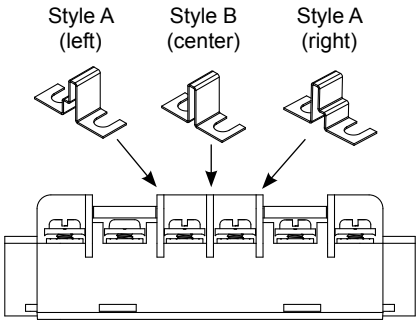


Finger Guard
(for 150VA to 1500VA)

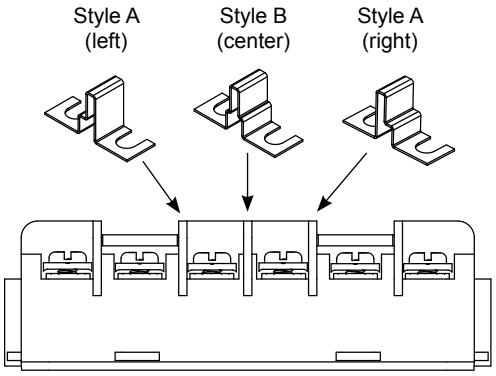
Sample Assembly Drawings for Voltage Link Installation



For units from 50VA to 100VA, the voltage links supplied can be installed between any two primary or secondary terminal bays. Please refer to PHWD1 instruction sheet included with your transformer for connection for details.

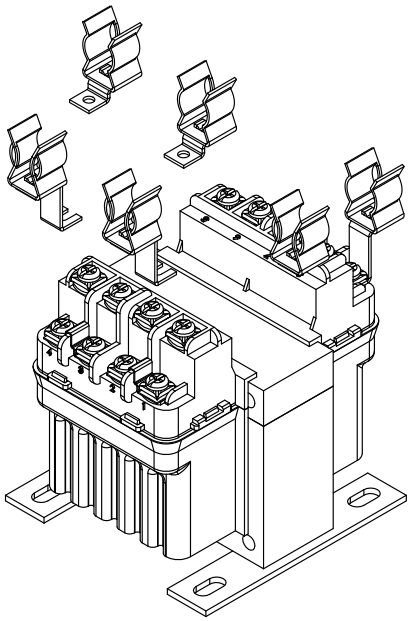


For units from 150VA to 250VA, the voltage links supplied must be installed between the primary or secondary terminal bays as indicated above Please refer to PHWD1 instruction sheet included with you transformer for connection details.

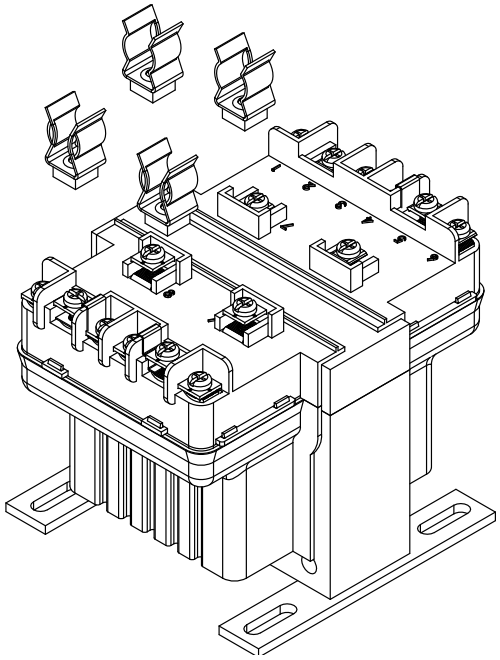


For units from 350VA to 1500VA, the voltage links supplied must be installed between the primary or secondary terminal bays as indicated above Please refer to PHWD1 instruction sheet included with you transformer for connection details.

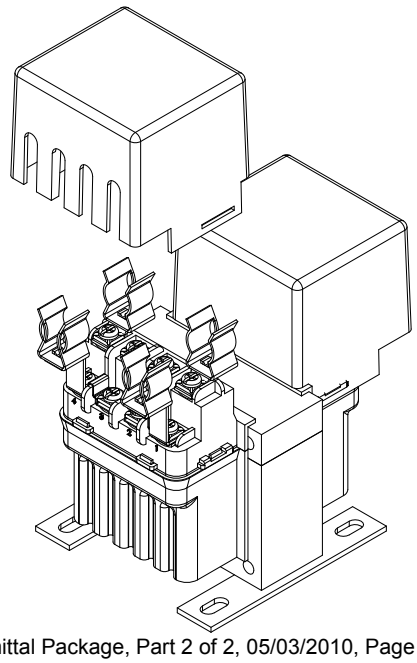
Sample Assembly Drawing for Fuse Clip Installation (for 50, 75 and 100VA)



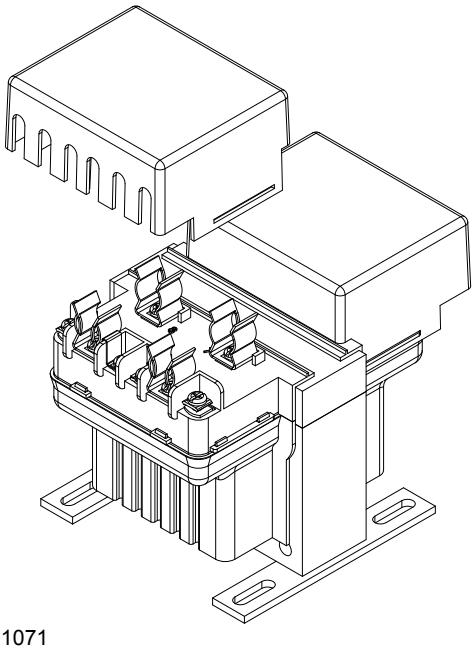
Sample Assembly Drawing for Fuse Clip Installation (for 150VA to 1500VA)



Sample Assembly Drawing for Finger Guard Installation (for 50, 75 and 100VA)



Sample Assembly Drawing for Finger Guard Installation (for 150VA to 1500VA)



Issue Date: November 2007 Revision #: 0

HPS Imperator™
Frequently Asked Questions

1. **What is a Control Transformer?**

A control transformer is a isolation transformer designed to provide a high degree of secondary voltage stability (regulation) during a brief period of overload condition (also referred to as ***"inrush current"***). Control transformers are also known as *Machine Tool Transformers, Industrial Control Transformers or Control Power Transformers.*

2. **What is the difference between "molded" and "encapsulated"?**

There is no major difference between the terms "molded" and "encapsulated". Both terms are used frequently in the control industry. When HPS uses the term "molded" it refers to a control transformer that has a cover (cup) over the coils and is then filled with a resin material. A control transformer with its coils exposed, but having just a molded terminal block should not be considered a molded control transformer.

3. **What is the difference between the new Imperator style versus the old PH and PT molded style?**

The HPS Imperator's unique terminal block design (patent pending) has 8 terminations per side, allowing for quick and easy installation of standard secondary or optional primary fuse clips. It utilizes custom serrated terminals, in combination with standard SEMS washer screws, allowing a bare wire without crimp-ons to be inserted. The HPS Imperator has 11 standard voltage groups, a VA range from 50VA to 5000VA and is available with standard secondary and optional primary fuse kits.

4. **How do I know if I am ordering the new Imperator style versus the old PH, PT molded style?**

All old PH and PT transformer part numbers are automatically cross-referenced in the HPS system to the new HPS Imperator. Old style (PH, PT) control transformers may be ordered (if stock available) by specifying with customer service the desire to have the old style units. Old style (PH, PT) units are only available while quantities last, as HPS will no longer be building these old style units. Otherwise, any PH control transformers will be shipped as the new Imperator transformer.

5. **What accessories are available on the HPS Imperator line?**

The HPS Imperator series of machine tool industrial control transformers are supplied with standard secondary fuse kits or optional accessories such as primary fuse kits and finger guards.

6. **What makes the HPS Imperator so innovative?**

The HPS Imperator's unique terminal block design (patent pending) allows for the quick and easy installation of standard secondary or optional primary 13/32"x 1 1/2" midget/type CC fuse clips on every unit. This is the simplest and most inexpensive fusing installation provided on any industrial control transformer in the market today.

7. **The HPS Imperator only has a cULus approval, is this approved for Canada?**

Yes, cULus is a UL approval for the HPS Imperator as a Machine Tool Industrial Control Transformer for the US and Canada. UL approved marks for Canada are officially accepted by regulatory authorities in all the provinces and territories of Canada including the Federal Government. For further information please go to www.ul.com/marks_labels/mark/index.html or www.ulc.ca/downloads/mark_acceptance_booklet.pdf

8. **When installing accessories, what tools are required?**

The terminations and fuse clips will require either a #2 slotted or Philips screwdriver to install the screws. The finger guards do not require a tool for installation. A detailed instruction sheet is provided with accessory kits to make installation easy.

9. **What size fuses does HPS recommend for the HPS Imperator?**

Due to application considerations, HPS provides recommendations for overcurrent protection for North American standards (UL and CSA). Tables for primary and secondary recommendations for overcurrent protection can be found on pages 47 and 48 in Section One of the HPS Catalog (HTP-08). Note: HPS does not supply fuses.

10. **Are HPS fuse clips midget or type CC rejection style?**
The HPS Imperator Industrial Control Transformer utilizes a custom designed midget/type CC fuse clip. These fuse clips accept both midget and type CC rejection style fuses, but do not incorporate the rejection style feature. This feature provides customers the flexibility of utilizing either midget or type CC fuses.

11. **The finger guards that are supplied with the kits, are they designed for the primary or secondary side?**
They are designed for the secondary side because of the higher current.

12. **What is the difference between a voltage link and a jumper lead?**
A voltage link function is similar to that of a jumper lead. It provides a connection between two separate termination points. A voltage link is a small piece of formed metal that has two spade like receptacles which when installed properly, are positioned under the SEMS washer and screw or fuse clip (depending on the installation requirement).
A jumper lead wire is a short piece of insulated wire, which usually has two crimp on spade connectors on either end. The installation of this is similar to that of a voltage link.

13. **What does the molded numbers on the terminal block mean?**
The unique terminal block design (patent pending) features terminal connection numbers that correspond to the nameplate and wiring diagrams, making connecting the HPS Imperator quick and simple.

14. **Does the HPS Imperator overall dimensions and mounting dimensions match other competitor's products?**
The HPS Imperator is replacing the old style PH, PT, and SL lines and was also designed to compete against no less than 8 major North American competitors. All three of the old HPS lines as well as the 8 major competitors all have different mounting and overall dimensions. When finalizing the designs for the HPS Imperator, the overall dimensions were designed as small as possible, keeping in mind that HPS has incorporated a terminal block that features 8 terminations per side as opposed to 4 terminations per side. In designing the mounting feet/plates of the HPS Imperator line, we made certain to address two issues:
1. Mounting feet/plates and dimensions are as small as possible for each unit.
2. Mounting holes/slots are always accessible with a screw driver.

15. **Why is there multiple voltage ratios listed for each group in the Catalog and Imperator brochure?**
In a control transformer, the relationship of primary to secondary turns that affects voltage change is referred to as the "ratio of a transformer". The number of turns in each of the primary and secondary coils determines the ratio. The system voltage to which the unit is connected determines the input voltage for the primary winding, the output voltage of the transformer (the voltage the load requires) is determined by the ratio of the secondary winding to the primary winding. By varying the input voltage, the inherent voltage ratio will reduce the secondary voltage accordingly. For example, Group A has a 600V primary to a 120 x 240V secondary. By reducing the primary voltage to 575V, the secondary voltage (due to the transformers voltage ratio) will be reduced to 115 x 230V. Note: at no time should a transformer be operated at voltages higher than nameplate unless the taps are provided.

16. **There are 11 standard voltages listed in the Catalog and Imperator brochure, are those the only voltages manufactured?**
No, HPS has the capability to manufacture any voltage or VA size upon request. Please contact your HPS customer service representative for special order requests.

17. **Where can I get more information on the HPS Imperator line?**
Detailed information on the HPS Imperator line can be found in the HPS Catalog (HTP-08), the HPS Imperator Brochure (ENCCON), and on our website (www.hammondpowersolutions.com). The catalog and brochure can be found on our website or by contacting HPS directly.

19. **What is the UL file number for the HPS Imperator?**
The UL file number for the HPS Imperator is E50394.

In Canada: 595 Southgate Drive, Guelph, Ontario, N1G3W6 519-822-2441
In USA: 1100 Lake Street, Baraboo, WI, 53913-2866 608-356-3921

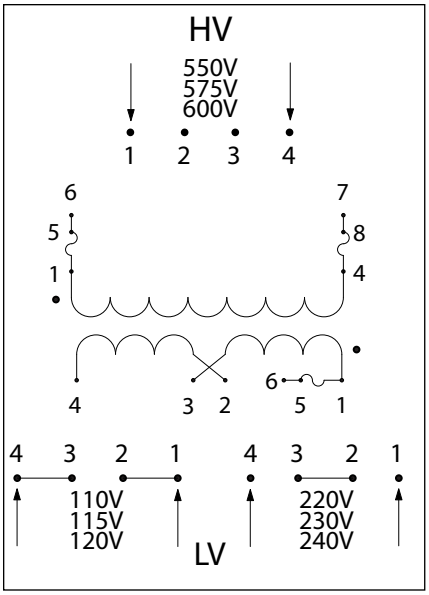
Hammond Power Solutions Inc.

HPS IMPERATOR® Industrial Control Transformer Wiring Diagrams

Literature Code: PHWD1

The ***HPS IMPERATOR®*** series of machine tool industrial molded control transformers are available in many standard offerings. This wiring hook-up instruction sheet refers to all standard ***HPS IMPERATOR®*** series part number suffixes. (Note: standard secondary fuse kits (not installed) supplied with each transformer unless otherwise indicated; field insatlled primary fuse kits sold separately; fuses not available from HPS.)
If you have any questions regarding these wiring diagrams or are having any difficulty correctly installing our transformers, please contact HPS customer service or technical support in the U.S. at 1-866-705-4684 or in Canada at 1-888-798-8882.

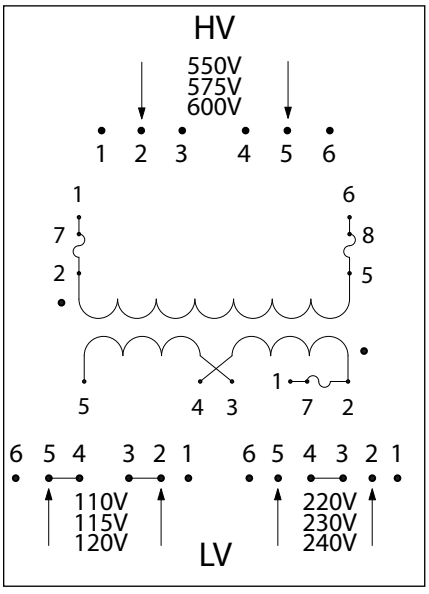
HPS IMPERATOR® Series - Wiring Schematic Drawings



PH***AJ Schematic for 50, 75 and 100VA Units

High Voltage (HV) (Primary Volts)			Install Supplied Jumpers/ Links Between Terminals	Supply Lines Connect To	Install Fuse Clips To
600	575	550	None	1, 4	Unfused
600	575	550	None	6, 7	1-5, 4-8

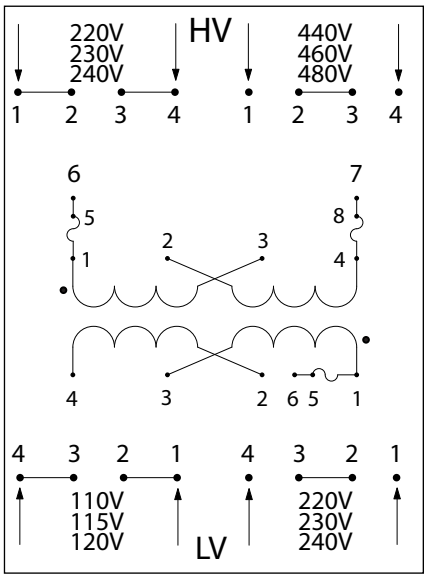
Low Voltage (LV) (Secondary Volts)			Install Supplied Links Between Terminals	Load Lines Connect To	Install Fuse Clips To
120	115	110	3-4, 1-2	1, 4	Unfused
240	230	220	2-3	1, 4	Unfused
120	115	110	3-4, 1-2	4, 6	1-5
240	230	220	2-3	4, 6	1-5



PH***AJ Schematic for 150VA to 1500VA Units

High Voltage (HV) (Primary Volts)			Install Supplied Jumpers/ Links Between Terminals	Supply Lines Connect To	Install Fuse Clips To
600	575	550	None	2, 5	Unfused
600	575	550	None	1, 6	2-7, 5-8

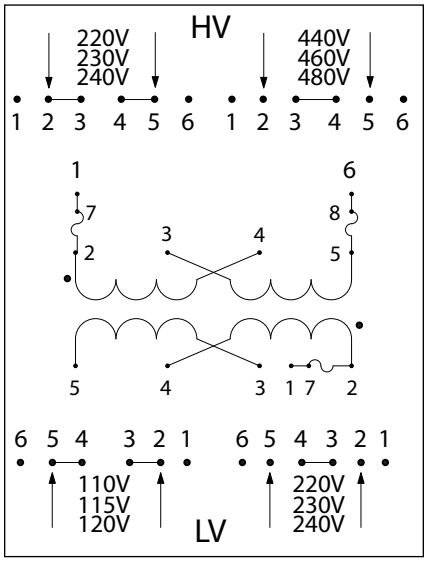
Low Voltage (LV) (Secondary Volts)			Install Supplied Links Between Terminals	Load Lines Connect To	Install Fuse Clips To
120	115	110	4-5, 2-3	2, 5	Unfused
240	230	220	3-4	2, 5	Unfused
120	115	110	4-5, 2-3	1, 5	2-7
240	230	220	3-4	1, 5	2-7



PH***MQMJ Schematic for 50, 75 and 100VA Units

High Voltage (HV) (Primary Volts)			Install Supplied Links Between Terminals	Supply Lines Connect To	Install Fuse Clips To
240	230	220	1-2, 3-4	1, 4	Unfused
480	460	440	2-3	1, 4	Unfused
240	230	220	1-2, 3-4	6, 7	1-5, 4-8
480	460	440	2-3	6, 7	1-5, 4-8

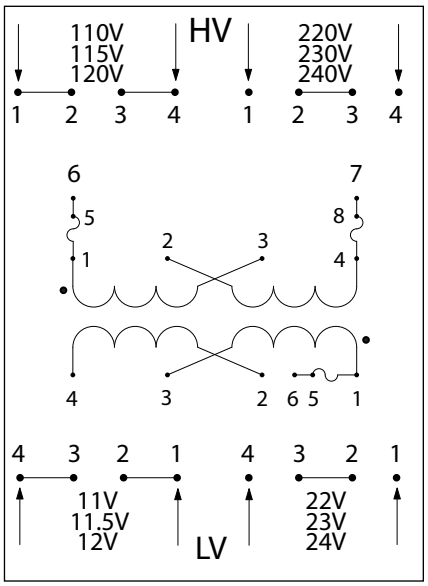
Low Voltage (LV) (Secondary Volts)			Install Supplied Links Between Terminals	Load Lines Connect To	Install Fuse Clips To
120	115	110	3-4, 1-2	1, 4	Unfused
240	230	220	2-3	1, 4	Unfused
120	115	110	3-4, 1-2	4, 6	1-5
240	230	220	2-3	4, 6	1-5



PH***MQMJ Schematic for 150VA to 1500VA Units

High Voltage (HV) (Primary Volts)			Install Supplied Links Between Terminals	Supply Lines Connect To	Install Fuse Clips To
240	230	220	2-3, 4-5	2, 5	Unfused
480	460	440	3-4	2, 5	Unfused
240	230	220	2-3, 4-5	1, 6	2-7, 5-8
480	460	440	3-4	1, 6	2-7, 5-8

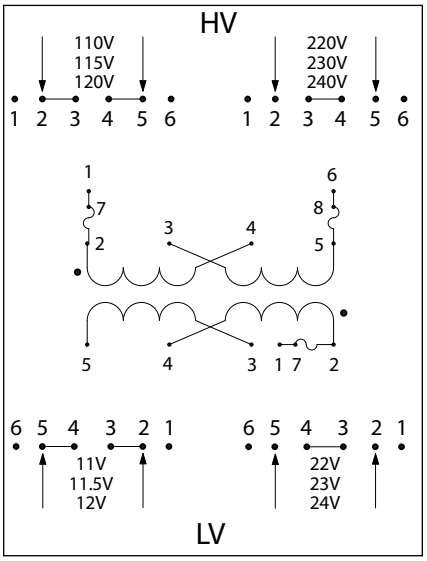
Low Voltage (LV) (Secondary Volts)			Install Supplied Links Between Terminals	Load Lines Connect To	Install Fuse Clips To
120	115	110	4-5, 2-3	2, 5	Unfused
240	230	220	3-4	2, 5	Unfused
120	115	110	4-5, 2-3	1, 5	2-7
240	230	220	3-4	1, 5	2-7



PH***PG Schematic for 50, 75 and 100VA Units

High Voltage (HV) (Primary Volts)			Install Supplied Links Between Terminals	Supply Lines Connect To	Install Fuse Clips To
120	115	110	1-2, 3-4	1, 4	Unfused
240	230	220	2-3	1, 4	Unfused
120	115	110	1-2, 3-4	6, 7	1-5, 4-8
240	230	220	2-3	6, 7	1-5, 4-8

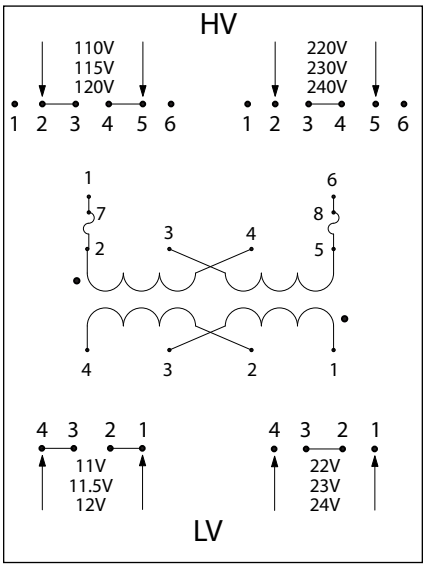
Low Voltage (LV) (Secondary Volts)			Install Supplied Links Between Terminals	Load Lines Connect To	Install Fuse Clips To
12	11.5	11	3-4, 1-2	1, 4	Unfused
24	23	22	2-3	1, 4	Unfused
12	11.5	11	3-4, 1-2	4, 6	1-5
24	23	22	2-3	4, 6	1-5



PH***PG Schematic for 150VA to 500VA Units

High Voltage (HV) (Primary Volts)			Install Supplied Links Between Terminals	Supply Lines Connect To	Install Fuse Clips To
120	115	110	2-3, 4-5	2, 5	Unfused
240	230	220	3-4	2, 5	Unfused
120	115	110	2-3, 4-5	1, 6	2-7, 5-8
240	230	220	3-4	1, 6	2-7, 5-8

Low Voltage (LV) (Secondary Volts)			Install Supplied Links Between Terminals	Load Lines Connect To	Install Fuse Clips To
12	11.5	11	4-5, 2-3	2, 5	Unfused
24	23	22	3-4	2, 5	Unfused
12	11.5	11	4-5, 2-3	1, 5	2-7
24	23	22	3-4	1, 5	2-7

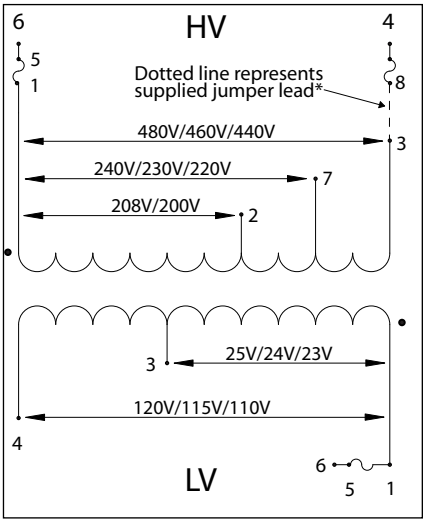


PH***PG Schematic for 750VA and 1000VA Units

High Voltage (HV) (Primary Volts)			Install Supplied Links Between Terminals	Supply Lines Connect To	Install Fuse Clips To
120	115	110	2-3, 4-5	2, 5	Unfused
240	230	220	3-4	2, 5	Unfused
120	115	110	2-3, 4-5	1, 6	2-7, 5-8
240	230	220	3-4	1, 6	2-7, 5-8

Low Voltage (LV) (Secondary Volts)			Install Supplied Links Between Terminals	Load Lines Connect To	Install Fuse Clips To
12	11.5	11	3-4, 1-2	1, 4	Unfused
24	23	22	2-3	1, 4	Unfused

Note: secondary fuse clips not available on PH750PG or PH1000PG.

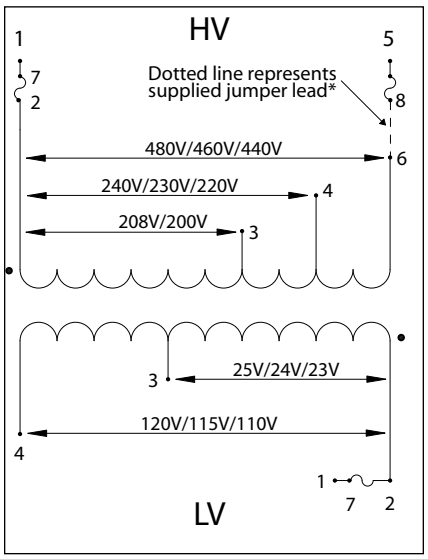


PH***MLI Schematic for 50, 75 and 100VA Units

High Voltage (HV) (Primary Volts)			Install Supplied Jumpers Between Terminals	Supply Lines Connect To	Install Fuse Clips To
480	460	440	None	1, 3	Unfused
240	230	220	None	1, 7	Unfused
	208	200	None	1, 2	Unfused
480	460	440	3-8	6, 4	1-5, 4-8
240	230	220	8-7	6, 4	1-5, 4-8
	208	200	2-8	6, 4	1-5, 4-8

Low Voltage (LV) (Secondary Volts)			Install Supplied Jumpers Between Terminals	Load Lines Connect To	Install Fuse Clips To
120	115	110	None	1, 4	Unfused
25	24	23	None	1, 3	Unfused
120	115	110	None	4, 6	1-5
25	24	23	None	3, 6	1-5

*This primary fuse jumper is supplied with the primary fuse kit only.

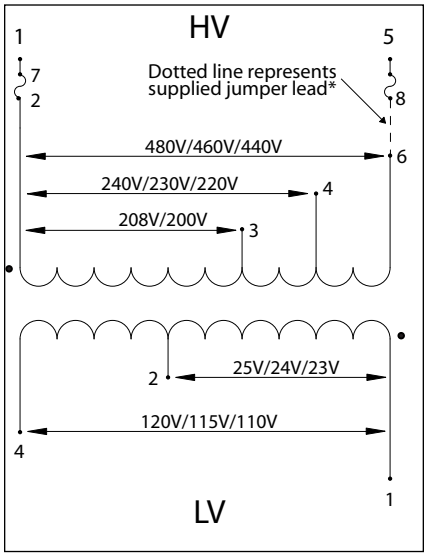


PH***MLI Schematic for 150VA to 500VA Units

High Voltage (HV) (Primary Volts)			Install Supplied Jumpers Between Terminals	Supply Lines Connect To	Install Fuse Clips To
480	460	440	None	2, 6	Unfused
240	230	220	None	2, 4	Unfused
	208	200	None	2, 3	Unfused
480	460	440	8-6	1, 5	2-7, 5-8
240	230	220	4-8	1, 5	2-7, 5-8
	208	200	3-8	1, 5	2-7, 5-8

Low Voltage (LV) (Secondary Volts)			Install Supplied Jumpers Between Terminals	Load Lines Connect To	Install Fuse Clips To
120	115	110	None	2, 4	Unfused
25	24	23	None	2, 3	Unfused
120	115	110	None	1, 4	2-7
25	24	23	None	1, 3	2-7

*This primary fuse jumper is supplied with the primary fuse kit only.



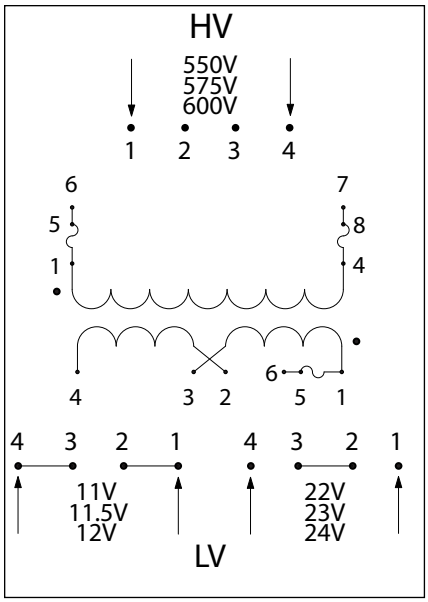
PH***MLI Schematic for 750VA and 1000VA Units

High Voltage (HV) (Primary Volts)			Install Supplied Jumpers Between Terminals	Supply Lines Connect To	Install Fuse Clips To
480	460	440	None	2, 6	Unfused
240	230	220	None	2, 4	Unfused
	208	200	None	2, 3	Unfused
480	460	440	8-6	1, 5	2-7, 5-8
240	230	220	4-8	1, 5	2-7, 5-8
	208	200	3-8	1, 5	2-7, 5-8

Low Voltage (LV) (Secondary Volts)			Install Supplied Jumpers Between Terminals	Load Lines Connect To	Install Fuse Clips To
120	115	110	None	1, 4	Unfused
25	24	23	None	1, 2	Unfused

Note: secondary fuse clips for 24V tap not available on the PH750MLI or PH1000MLI units.

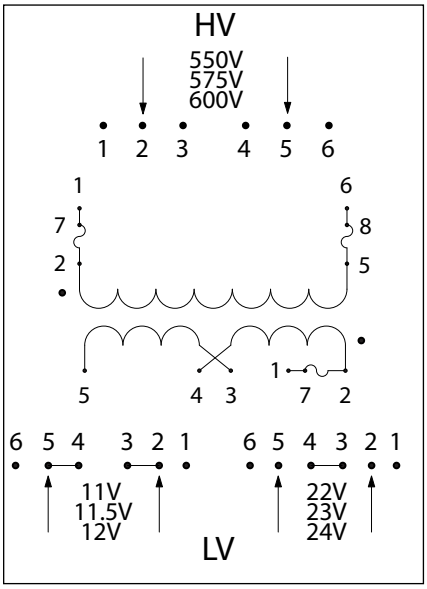
*This primary fuse jumper is supplied with the primary fuse kit only.



PH***AR Schematic for 50, 75 and 100VA Units

High Voltage (HV) (Primary Volts)			Install Supplied Jumpers/ Links Between Terminals	Supply Lines Connect To	Install Fuse Clips To
600	575	550	None	1, 4	Unfused
600	575	550	None	6, 7	1-5, 4-8

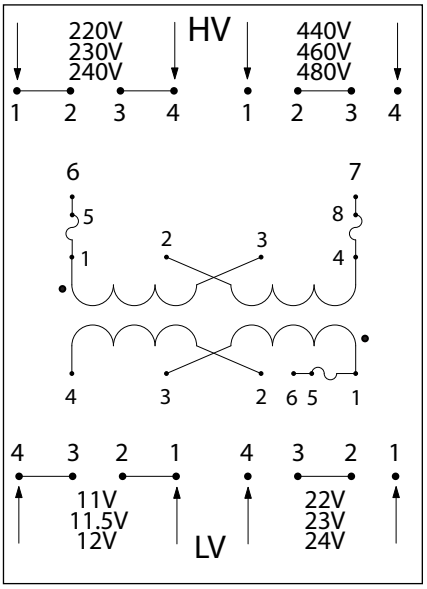
Low Voltage (LV) (Secondary Volts)			Install Supplied Links Between Terminals	Load Lines Connect To	Install Fuse Clips To
12	11.5	11	3-4, 1-2	1, 4	Unfused
24	23	22	2-3	1, 4	Unfused
12	11.5	11	3-4, 1-2	4, 6	1-5
24	23	22	2-3	4, 6	1-5



PH***AR Schematic for 150VA to 500VA Units

High Voltage (HV) (Primary Volts)			Install Supplied Jumpers/ Links Between Terminals	Supply Lines Connect To	Install Fuse Clips To
600	575	550	None	2, 5	Unfused
600	575	550	None	1, 6	2-7, 5-8

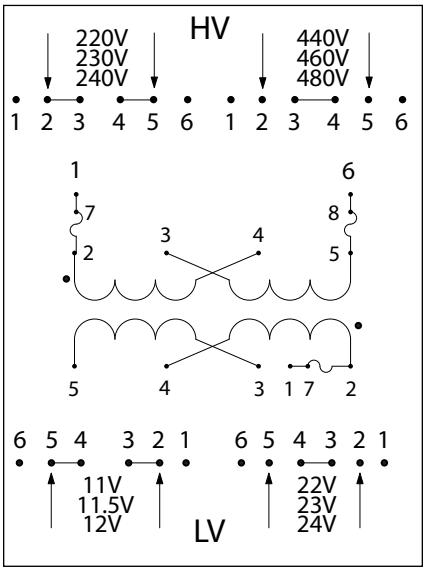
Low Voltage (LV) (Secondary Volts)			Install Supplied Links Between Terminals	Load Lines Connect To	Install Fuse Clips To
12	11.5	11	4-5, 2-3	2, 5	Unfused
24	23	22	3-4	2, 5	Unfused
12	11.5	11	4-5, 2-3	1, 5	2-7
24	23	22	3-4	1, 5	2-7



PH***QR Schematic for 50, 75 and 100VA Units

High Voltage (HV) (Primary Volts)			Install Supplied Links Between Terminals	Supply Lines Connect To	Install Fuse Clips To
240	230	220	1-2, 3-4	1, 4	Unfused
480	460	440	2-3	1, 4	Unfused
240	230	220	1-2, 3-4	6, 7	1-5, 4-8
480	460	440	2-3	6, 7	1-5, 4-8

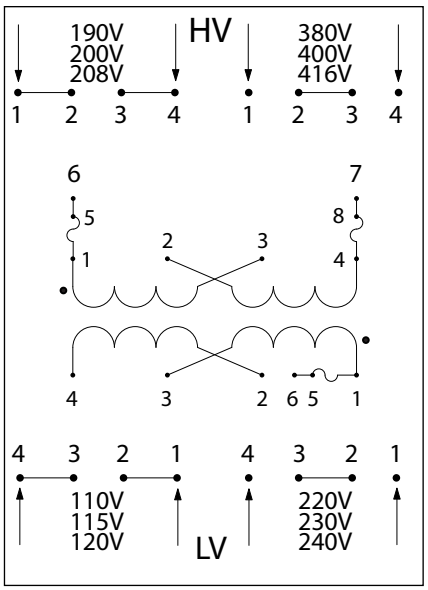
Low Voltage (LV) (Secondary Volts)			Install Supplied Links Between Terminals	Load Lines Connect To	Install Fuse Clips To
12	11.5	11	3-4, 1-2	1, 4	Unfused
24	23	22	2-3	1, 4	Unfused
12	11.5	11	3-4, 1-2	4, 6	1-5
24	23	22	2-3	4, 6	1-5



PH***QR Schematic for 150VA to 500VA Units

High Voltage (HV) (Primary Volts)			Install Supplied Links Between Terminals	Supply Lines Connect To	Install Fuse Clips To
240	230	220	2-3, 4-5	2, 5	Unfused
480	460	440	3-4	2, 5	Unfused
240	230	220	2-3, 4-5	1, 6	2-7, 5-8
480	460	440	3-4	1, 6	2-7, 5-8

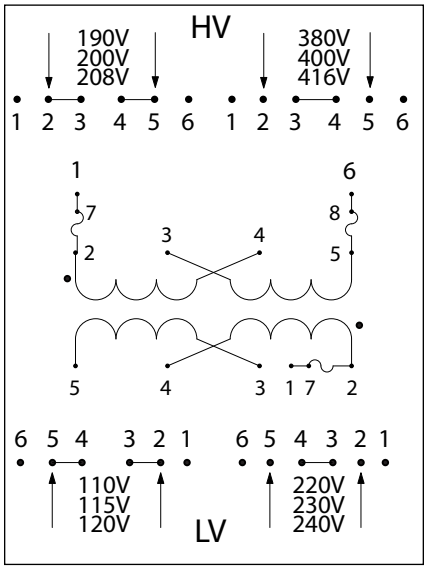
Low Voltage (LV) (Secondary Volts)			Install Supplied Links Between Terminals	Load Lines Connect To	Install Fuse Clips To
12	11.5	11	4-5, 2-3	2, 5	Unfused
24	23	22	3-4	2, 5	Unfused
12	11.5	11	4-5, 2-3	1, 5	2-7
24	23	22	3-4	1, 5	2-7



PH***SP Schematic for 50, 75 and 100VA Units

High Voltage (HV) (Primary Volts)			Install Supplied Links Between Terminals	Supply Lines Connect To	Install Fuse Clips To
208	200	190	1-2, 3-4	1, 4	Unfused
416	400	380	2-3	1, 4	Unfused
208	200	190	1-2, 3-4	6, 7	1-5, 4-8
416	400	380	2-3	6, 7	1-5, 4-8

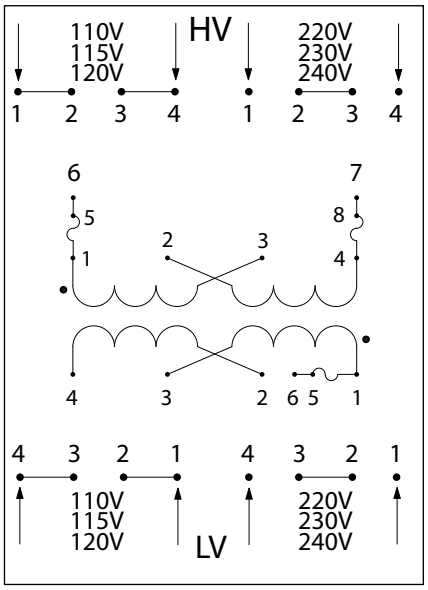
Low Voltage (LV) (Secondary Volts)			Install Supplied Links Between Terminals	Load Lines Connect To	Install Fuse Clips To
120	115	110	3-4, 1-2	1, 4	Unfused
240	230	220	2-3	1, 4	Unfused
120	115	110	3-4, 1-2	4, 6	1-5
240	230	220	2-3	4, 6	1-5



PH***SP Schematic for 150VA to 1000VA Units

High Voltage (HV) (Primary Volts)			Install Supplied Links Between Terminals	Supply Lines Connect To	Install Fuse Clips To
208	200	190	2-3, 4-5	2, 5	Unfused
416	400	380	3-4	2, 5	Unfused
208	200	190	2-3, 4-5	1, 6	2-7, 5-8
416	400	380	3-4	1, 6	2-7, 5-8

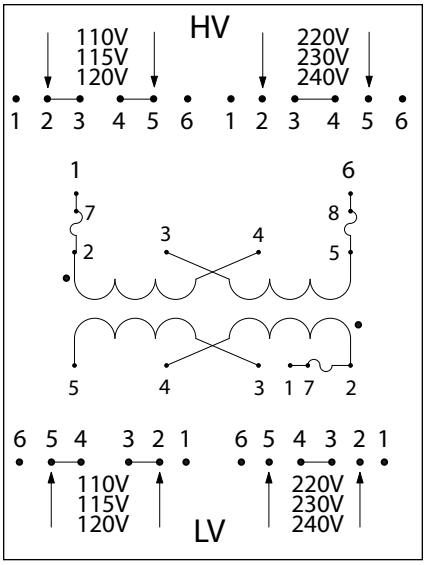
Low Voltage (LV) (Secondary Volts)			Install Supplied Links Between Terminals	Load Lines Connect To	Install Fuse Clips To
120	115	110	4-5, 2-3	2, 5	Unfused
240	230	220	3-4	2, 5	Unfused
120	115	110	4-5, 2-3	1, 5	2-7
240	230	220	3-4	1, 5	2-7



PH***PP Schematic for 50, 75 and 100VA Units

High Voltage (HV) (Primary Volts)			Install Supplied Links Between Terminals	Supply Lines Connect To	Install Fuse Clips To
120	115	110	1-2, 3-4	1, 4	Unfused
240	230	220	2-3	1, 4	Unfused
120	115	110	1-2, 3-4	6, 7	1-5, 4-8
240	230	220	2-3	6, 7	1-5, 4-8

Low Voltage (LV) (Secondary Volts)			Install Supplied Links Between Terminals	Load Lines Connect To	Install Fuse Clips To
120	115	110	3-4, 1-2	1, 4	Unfused
240	230	220	2-3	1, 4	Unfused
120	115	110	3-4, 1-2	4, 6	1-5
240	230	220	2-3	4, 6	1-5

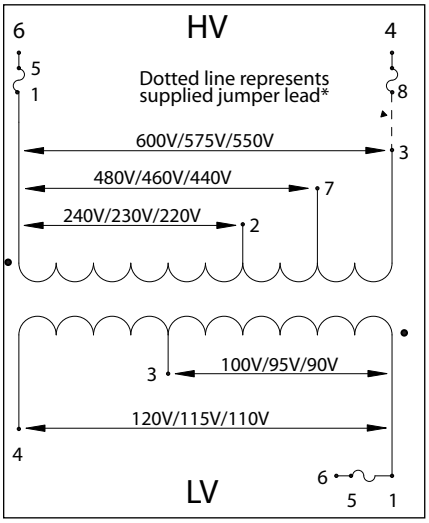


PH***PP Schematic for 150VA to 1500VA Units

High Voltage (HV) (Primary Volts)			Install Supplied Links Between Terminals	Supply Lines Connect To	Install Fuse Clips To
120	115	110	2-3, 4-5	2, 5	Unfused
240	230	220	3-4	2, 5	Unfused
120	115	110	2-3, 4-5	1, 6	2-7, 5-8
240	230	220	3-4	1, 6	2-7, 5-8

Low Voltage (LV) (Secondary Volts)			Install Supplied Links Between Terminals	Load Lines Connect To	Install Fuse Clips To
120	115	110	4-5, 2-3	2, 5	Unfused
240	230	220	3-4	2, 5	Unfused
120	115	110	4-5, 2-3	1, 5	2-7
240	230	220	3-4	1, 5	2-7

PH***MBMH Schematic for 50 and 75VA Units

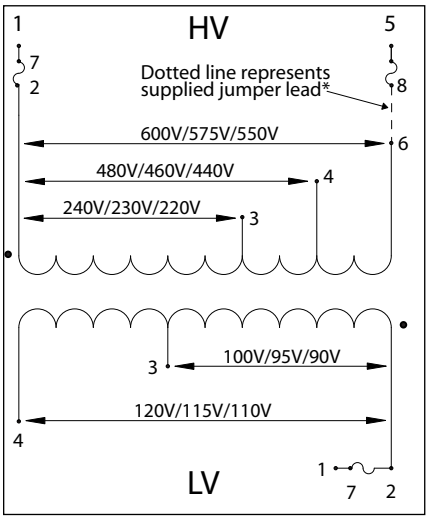


High Voltage (HV) (Primary Volts)			Install Supplied Jumpers Between Terminals	Supply Lines Connect To	Install Fuse Clips To
600	575	550	None	1, 3	Unfused
480	460	440	None	1, 7	Unfused
240	230	220	None	1, 2	Unfused
600	575	550	3-8	6, 4	1-5, 4-8
480	460	440	8-7	6, 4	1-5, 4-8
240	230	220	2-8	6, 4	1-5, 4-8

Low Voltage (LV) (Secondary Volts)			Install Supplied Jumpers/ Links Between Terminals	Load Lines Connect To	Install Fuse Clips To
120	115	110	None	1, 4	Unfused
100	95	90	None	1, 3	Unfused
120	115	110	None	4, 6	1-5
100	95	90	None	3, 6	1-5

*This primary fuse jumper is supplied with the primary fuse kit only.

PH***MBMH Schematic for 100VA to 1500VA Units

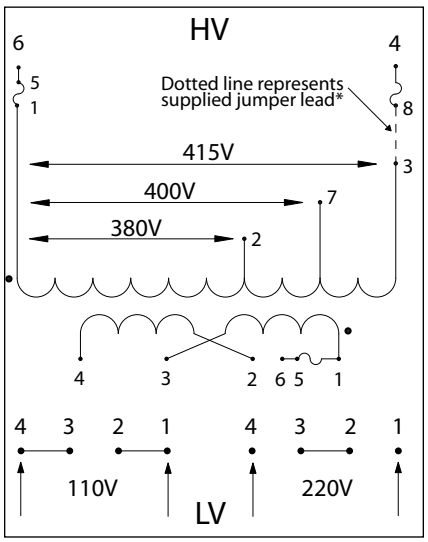


High Voltage (HV) (Primary Volts)			Install Supplied Jumpers Between Terminals	Supply Lines Connect To	Install Fuse Clips To
600	575	550	None	2, 6	Unfused
480	460	440	None	2, 4	Unfused
240	230	220	None	2, 3	Unfused
600	575	550	8-6	1, 5	2-7, 5-8
480	460	440	4-8	1, 5	2-7, 5-8
240	230	220	3-8	1, 5	2-7, 5-8

Low Voltage (LV) (Secondary Volts)			Install Supplied Jumpers/ Links Between Terminals	Load Lines Connect To	Install Fuse Clips To
120	115	110	None	2, 4	Unfused
100	95	90	None	2, 3	Unfused
120	115	110	None	1, 4	2-7
100	95	90	None	1, 3	2-7

*This primary fuse jumper is supplied with the primary fuse kit only.

PH***MEMX Schematic for 50, 75 and 100VA Units

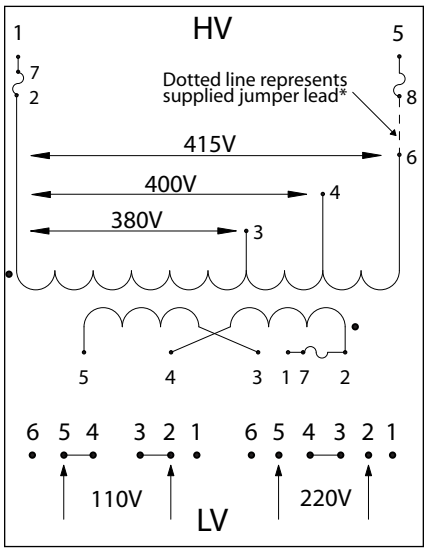


High Voltage (HV) (Primary Volts)	Install Supplied Jumpers Between Terminals	Supply Lines Connect To	Install Fuse Clips To
415	None	1, 3	Unfused
400	None	1, 7	Unfused
380	None	1, 2	Unfused
415	3-8	6, 4	1-5, 4-8
400	8-7	6, 4	1-5, 4-8
380	2-8	6, 4	1-5, 4-8

Low Voltage (LV) (Secondary Volts)	Install Supplied Links Between Terminals	Load Lines Connect To	Install Fuse Clips To
110	3-4, 1-2	1, 4	Unfused
220	2-3	1, 4	Unfused
110	3-4, 1-2	4, 6	1-5
220	2-3	4, 6	1-5

*This primary fuse jumper is supplied with the primary fuse kit only.

PH***MEMX Schematic for 150VA to 1000VA Units

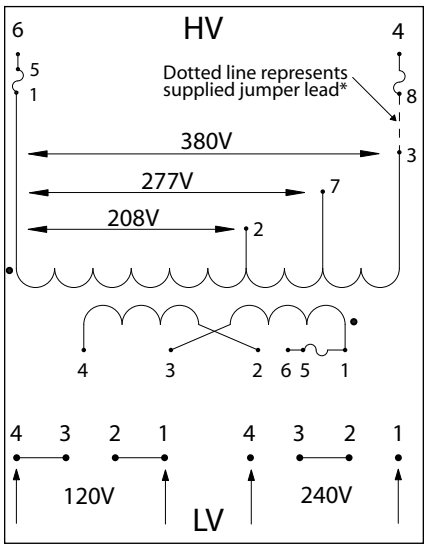


High Voltage (HV) (Primary Volts)	Install Supplied Jumpers Between Terminals	Supply Lines Connect To	Install Fuse Clips To
415	None	2, 6	Unfused
400	None	2, 4	Unfused
380	None	2, 3	Unfused
415	8-6	1, 5	2-7, 5-8
400	4-8	1, 5	2-7, 5-8
380	3-8	1, 5	2-7, 5-8

Low Voltage (LV) (Secondary Volts)	Install Supplied Links Between Terminals	Load Lines Connect To	Install Fuse Clips To
110	4-5, 2-3	2, 5	Unfused
220	3-4	2, 5	Unfused
110	4-5, 2-3	1, 5	2-7
220	3-4	1, 5	2-7

*This primary fuse jumper is supplied with the primary fuse kit only.

PH***MGJ Schematic for 50, 75 and 100VA Units

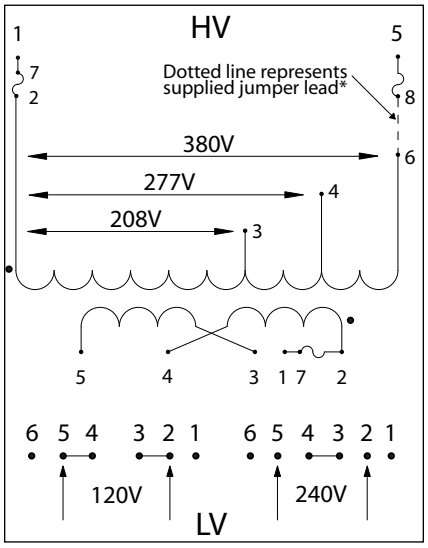


High Voltage (HV) (Primary Volts)	Install Supplied Jumpers Between Terminals	Supply Lines Connect To	Install Fuse Clips To
380	None	1, 3	Unfused
277	None	1, 7	Unfused
208	None	1, 2	Unfused
380	3-8	6, 4	1-5, 4-8
277	8-7	6, 4	1-5, 4-8
208	2-8	6, 4	1-5, 4-8

Low Voltage (LV) (Secondary Volts)	Install Supplied Links Between Terminals	Load Lines Connect To	Install Fuse Clips To
120	3-4, 1-2	1, 4	Unfused
240	2-3	1, 4	Unfused
120	3-4, 1-2	4, 6	1-5
240	2-3	4, 6	1-5

*This primary fuse jumper is supplied with the primary fuse kit only.

PH***MGJ Schematic for 150VA to 1000VA Units



High Voltage (HV) (Primary Volts)	Install Supplied Jumpers Between Terminals	Supply Lines Connect To	Install Fuse Clips To
380	None	2, 6	Unfused
277	None	2, 4	Unfused
208	None	2, 3	Unfused
380	8-6	1, 5	2-7, 5-8
277	4-8	1, 5	2-7, 5-8
208	3-8	1, 5	2-7, 5-8

Low Voltage (LV) (Secondary Volts)	Install Supplied Links Between Terminals	Load Lines Connect To	Install Fuse Clips To
120	4-5, 2-3	2, 5	Unfused
240	3-4	2, 5	Unfused
120	4-5, 2-3	1, 5	2-7
240	3-4	1, 5	2-7

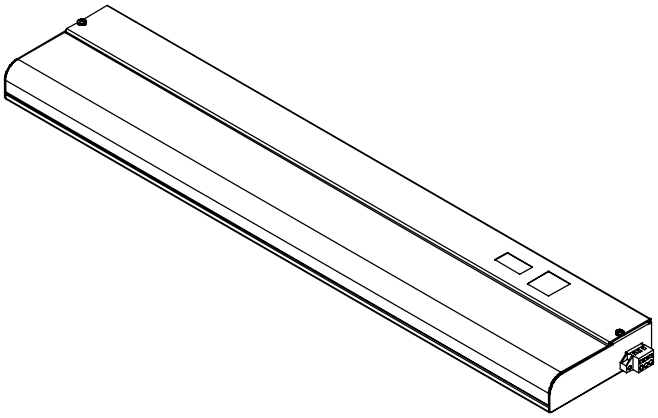
*This primary fuse jumper is supplied with the primary fuse kit only.

Fluorescent Light, Hoffman ALF16D24R

Hoffman®

A Pentair Company

Fluorescent Lighting Package
Paquet Fluorescent D'Éclairage
Paquete Fluorescente De la Iluminación



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P/N 87568937 87569108

⚠ WARNING ⚠ AVERTISSEMENT ⚠ PRECAUCION

- To avoid electric shock and equipment damage, disconnect any power supplies to the enclosure before installing the light.
- The fluorescent lighting package must be properly grounded.
- The fluorescent lighting package is not designed for use in hazardous or wet locations.
- To avoid electric shock, do not energize any circuits before all internal and external electrical and mechanical clearances are checked to assure that all assembled equipment functions safely and properly.

- Pour éviter la décharge électrique et les dommages aux équipments, débranchez toutes les alimentations d'énergie à la clôture avant d'installer la lumière.
- Les paquets fluorescents d'éclairage doivent être correctement fondus.
- Ces paquets fluorescents d'éclairage ne sont pas conçus pour l'usage dans des endroits dangereux ou humides.
- Pour éviter la décharge électrique, n'activez aucun circuit avant que des dégagements électriques et mécaniques tout internes et externes soient vérifiés pour s'assurer que tout l'équipement assemblé fonctionne sans risque et correctement.

- Para evitar descarga eléctrica y daño de equipo, desconecte cualquier fuente de alimentación al recinto antes de instalar la luz.
- Los paquetes fluorescentes de la iluminación deben ser puestos a tierra correctamente.
- Estos paquetes fluorescentes de la iluminación no se diseñan para el uso en localizaciones peligrosas o mojadas.
- Para evitar descarga eléctrica, no energice ninguna circuitos antes de que las separaciones eléctricas y mecánicas todo internas y externas se comprueben para asegurar que funcione todo el equipo montado con seguridad y correctamente.

INTRODUCTION

1. Before installing fluorescent fixture, read these instructions carefully. Failure to follow these instructions could damage the product or cause a hazardous condition.
2. The fluorescent light package is designed to operate on single phase power and at the voltage and frequency listed on the product label only.

INTRODUCTION

1. Avant d'installer le montage fluorescent, lisez ces instructions soigneusement. Le manque de suivre ces instructions a pu endommager le produit ou causer un état dangereux.
2. Des paquets légers fluorescents sont conçus pour opérer la puissance monophasé et à la tension et à la fréquence énumérées sur l'étiquette de produit seulement.

INTRODUCCIÓN

1. Antes de instalar el accesorio fluorescente, lea estas instrucciones cuidadosamente. La falta de seguir estas instrucciones podía dañar el producto o causar una condición peligrosa.
2. Los paquetes ligeros fluorescentes se diseñan para funcionar encendido energía la monofásico y en el voltaje y frecuencia enumerada en la etiqueta del producto solamente.

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GENERAL SAFETY INFORMATION

1. Route supply wires away from door hinge, sharp edges, etc.
2. Use only preheat type lamps as listed in table under “Lamp Type”. (except where noted)
3. Keep lens in place to prevent accidental breakage of the fluorescent lamp.

L’INFORMATION GÉNÉRALE DE SÛRETÉ

1. Conduisez les fils d’approvisionnement loin de la charnière de porte, des bords pointus, etc..
2. L’utilisation préchauffent seulement des lampes de type comme énuméré dans la table sous le ”type de lampe”. (excepté où remarquable)
3. Gardez l’objectif en place pour empêcher la rupture accidentelle de la lampe fluorescente.

INFORMACIÓN GENERAL DE SEGURIDAD

1. Encamine los alambres de la fuente lejos de la bisagra de la puerta, de los bordes agudos, del etc.
2. El uso precalienta solamente las lámparas del tipo según lo enumerado en tabla bajo ”tipo de la lámpara”. (excepto donde observado)
3. Mantenga la lente lugar para prevenir la fractura accidental de la lámpara fluorescente.

Cat. No.	Lamp Type	Recommended Nominal Lamp Length
ALF16D12R	F8T5/CW	12
ALF16M12R	F8T5/CW	12
ALF16D18R	F15T8/CW	18
ALF16M18R	F15T8/CW	18
ALF25D18R	F15T8/CW	18
ALF25M18R	F15T8/CW	18
ALF16D24R	F18T8/CW	24
ALF16M24R	F18T8/CW	24
ALF16M48R	F34T12/CW/RS/ES	48

Lamp Type Designation Example: F34T12/CW/RS/ES
Exemple De Désignation De Type De Lampe: F34T12/CW/RS/ES
Ejemplo De la Designación Del Tipo De la Lámpara: F34T12/CW/RS/ES

F: Flourescent
34: Rated Nominal Wattage (Puissance en watts Nominale Évaluée / Vatiaje Nominal Clasificado)
T: Indicates Shape (Indique La Forme / Indica Forma)
12: Diameter in Eighths of an Inch (Diamètre dans Eighths de pouce / Diámetro en Eighths de una pulgada)
CW: Color (Couleur / Color)
RS: Rapid Start Lamp (Lampe Rapide De Début / Lámpara Rápida Del Comienzo)
ES: Energy Saving (Économie D’Énergie / Ahorro De la Energía)

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WIRING

1. All wiring must comply with applicable national and local eletrical codes; all authorities have jurisdiction.
2. Connect the fluorescent fixture to a power supply consistent with the voltage and frequency information found on the product label.
3. Be sure the fluorescent fixture ground terminal is connected to a proper earth ground source. Intermittent operation indicates a probable lack of earth ground.
4. In some cases it may be advantageous to connect wire leads to terminal block on lighting fixture before installing.

CÂBLAGE

1. Tout le câblage doit être conforme aux codes eletrical nationaux et locaux applicables; toutes les autorités ont la juridiction.
2. Reliez le montage fluorescent à une alimentation d'énergie conformée à la tension et à l'information de fréquence trouvées sur l'étiquette de produit.
3. Soyez sûr que la borne au sol de montage fluorescent est reliée à une source appropriée de groun de la terre. L'opération intermittente indique un manque probable de au sol de la terre.
4. Dans certains cas il peut être avantageux de relier le fil mène au TB sur le montage d'éclairage avant l'installation.

CABLEADO

1. Todo el cableado debe conformarse con códigos eletrical nacionales y locales aplicables; todas las autoridades tienen jurisdicción.
2. Conecte el accesorio fluorescente con una fuente de alimentación constante con el voltaje y la información de la frecuencia encontrados en la etiqueta del producto.
3. Sea seguro que el terminal de tierra del accesorio fluorescente está conectado con una fuente apropiada del groun de la tierra. La operación intermitente indica una carencia probable de la tierra de la tierra.
4. En algunos casos puede ser ventajoso conectar el alambre conduce al bloque de terminales en accesorio de la iluminación antes de instalar.

MAINTENANCE

1. Replacement lamps must be the type indicated in the table.

ENTRETIEN

1. Les lampes de rechange doivent être le type indiqué dans la table.

MANTENIMIENTO

1. Las lámparas del reemplazo deben ser el tipo indicado en la tabla.

This accessory maintains UL/CSA Type 12,4,4X when installed per these instructions.
This accessory is covered by UL file E61997 and CSA file LR42186.

Cet accessoire maintient UL/CSA Type 12,4,4X une fois installé par ces instructions.
Cet accessoire est couvert par le dossier E61997 d'UL et le dossier LR42186 de CSA.

Este accessorio mantiene el Tipo 12,4,4X de UL/CSA cuando está instalado por estas instrucciones.
Este accessorio es cubierto por el archivo E61997 de UL y el archivo LR42186 de CSA.

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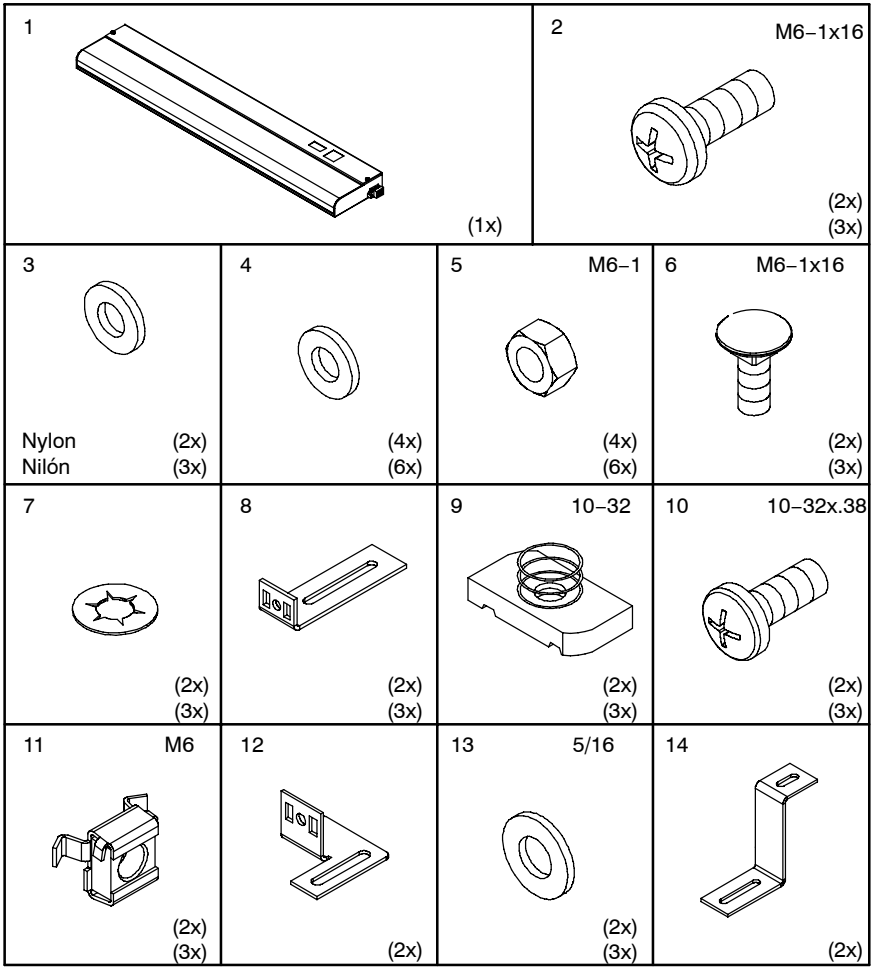

Cat. No.	D Inches	mm	Kit Items Articles De Kit Artículos Del Kit
ALF16D12R	6.125	156	1,2,3,4,5,6,7,8,9,10,11,12,13,14
ALF16M12R	6.125	156	1,2,3,4,5,6,7,8,9,10,11,13
ALF16D18R	11.938	303	1,2,3,4,5,6,7,8,9,10,11,12,13,14
ALF16M18R	11.938	303	1,2,3,4,5,6,7,8,9,10,11,13
ALF25D18R	11.938	303	1,2,3,4,5,6,7,8,9,10,11,12,13,14
ALF25M18R	11.938	303	1,2,3,4,5,6,7,8,9,10,11,13
ALF16D24R	17.938	456	1,2,3,4,5,6,7,8,9,10,11,12,13,14
ALF16M24R	17.938	456	1,2,3,4,5,6,7,8,9,10,11,13
ALF16M48R	45.734	1162	1,2,3,4,5,6,7,8,9,10,11,13

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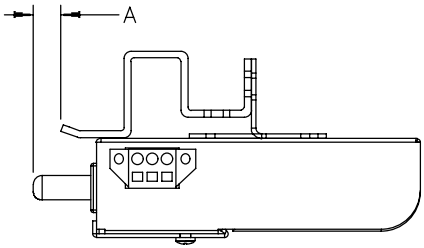
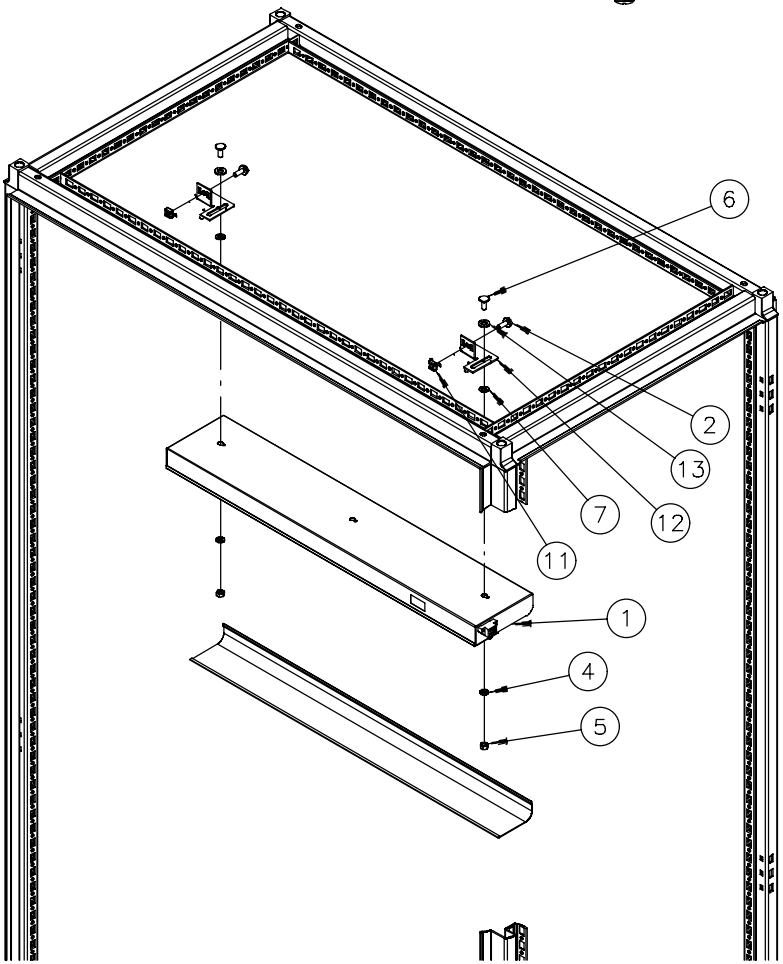
PROLINE® Flange Mounting (Door Switch)
Support De Bride de PROLINE® (Commutateur De Porte)
Montaje Del Reborde de PROLINE® (Interruptor De la Puerta)

A = 0 with door bar (avec la barre de porte / con la barra de la puerta)

A = .5 without door bar (sans barre de porte / sin la barra de la puerta





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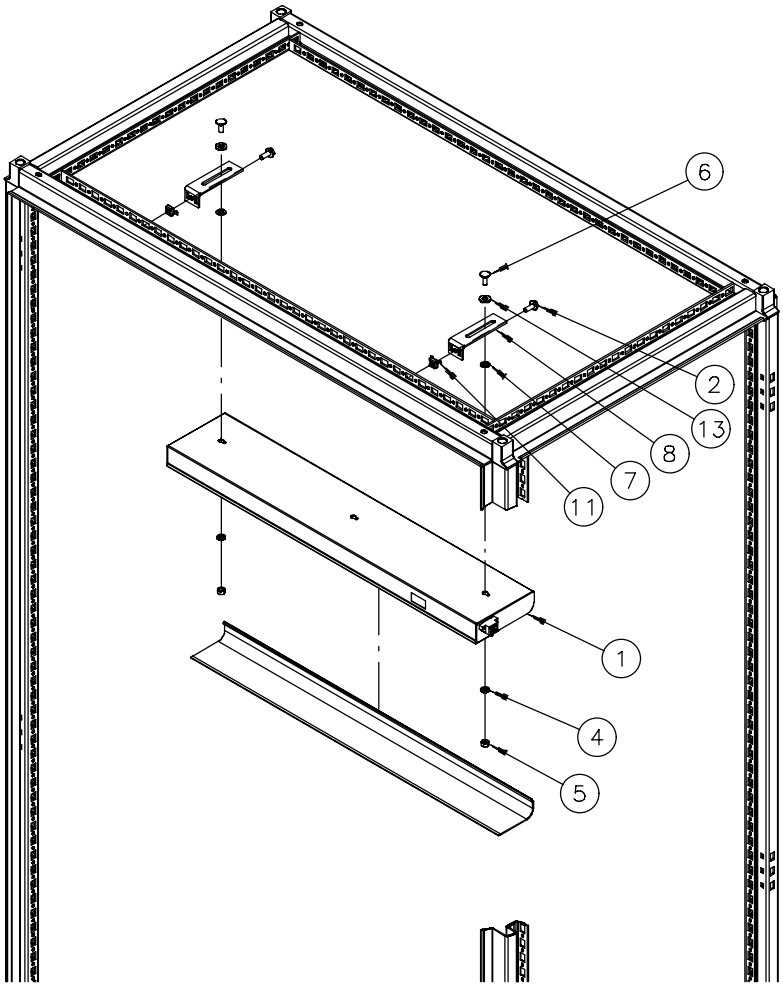
PROLINE® Frame Mounting (Manual Switch)
Support D'Armature PROLINE® (Commutateur Manuel)
Montaje Del Marco PROLINE® (Interruptor Manual)



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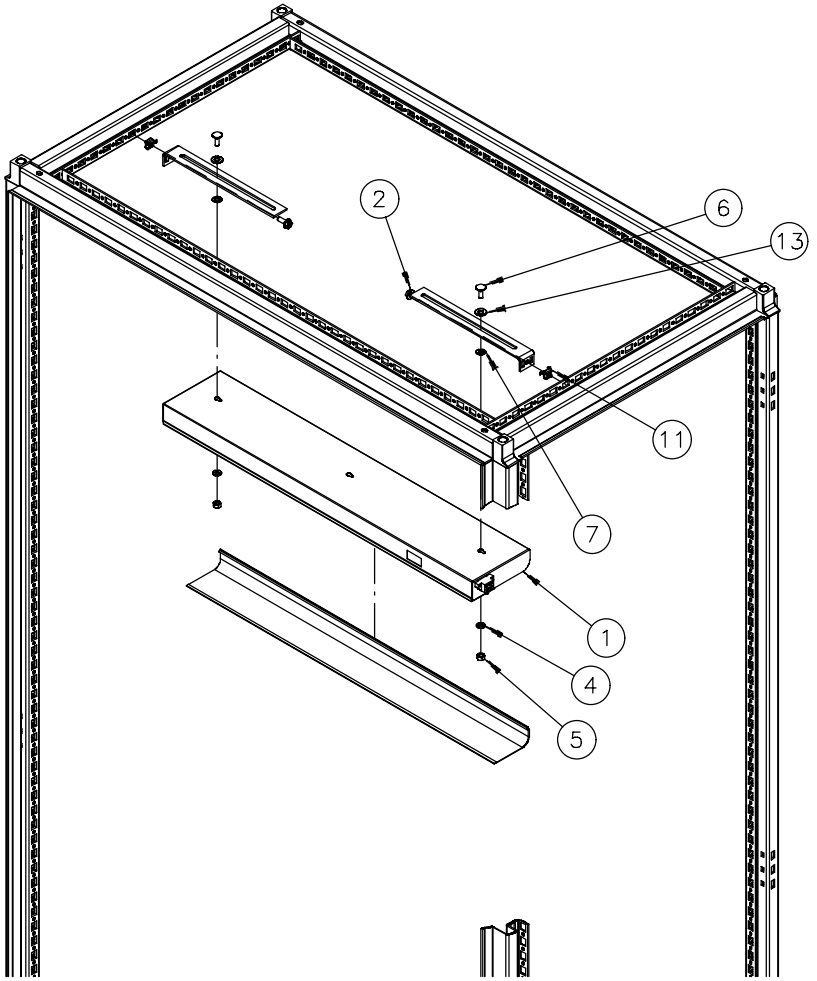
Optional PROLINE® Frame Side−To−Side Mounting
(use when disconnect device is installed)
Support side−To−Side de vue facultative de PROLINE®
(utilisation quand le dispositif de débranchement est installé)
Montaje side−To−Side del capítulo opcional de PROLINE®
(uso cuando el dispositivo de la desconexión está instalado)



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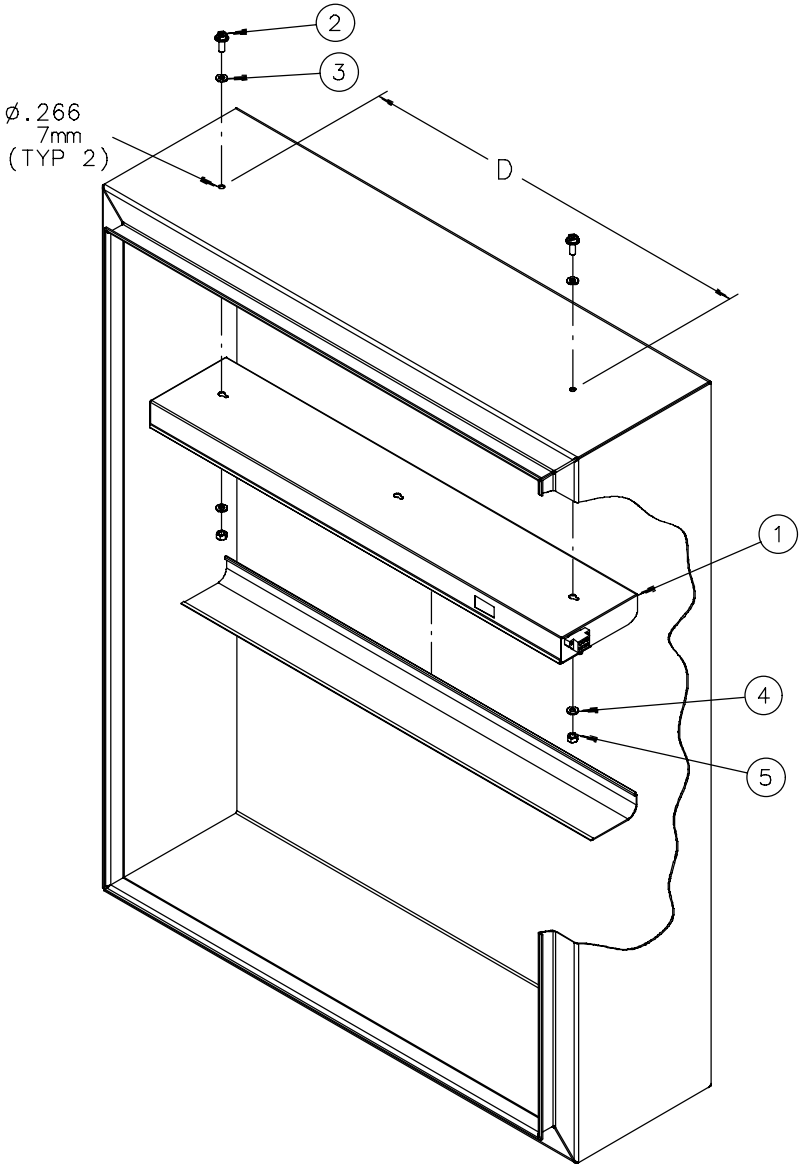
Enclosure Top Mounting
Bâti De Dessus De Clôture
Montaje De la Tapa Del Recinto



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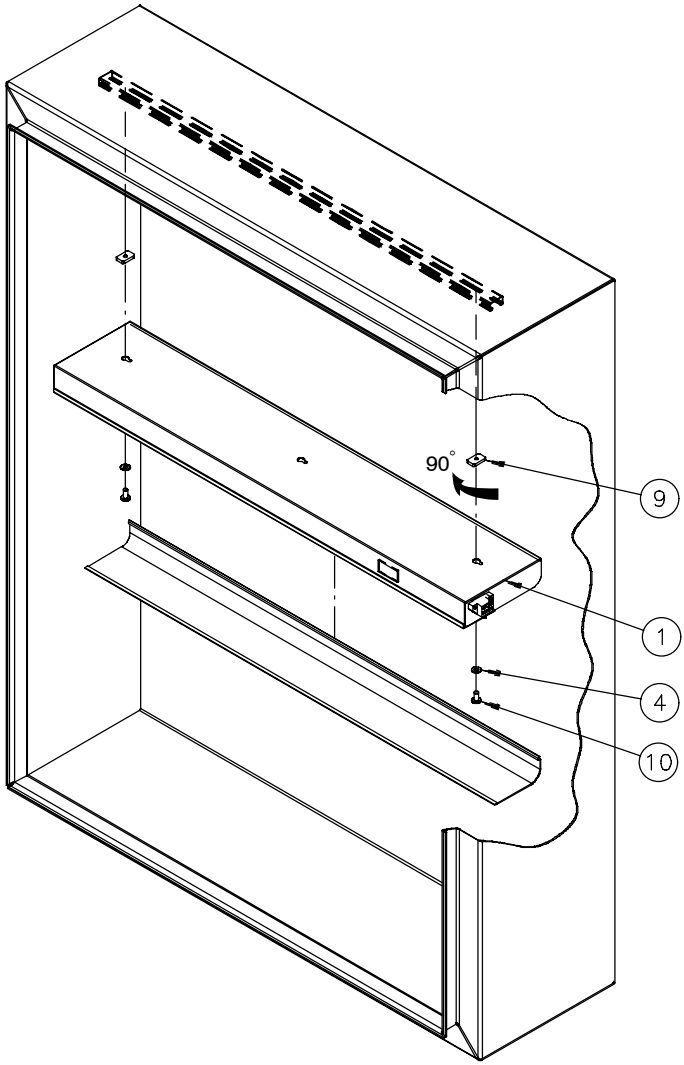
Enclosure Channel Mounting (rocker switch)
Bâti De la Manche De Clôture (commutateur de culbuteur)
Montaje Del Canal Del Recinto (interruptor de eje de balancín)



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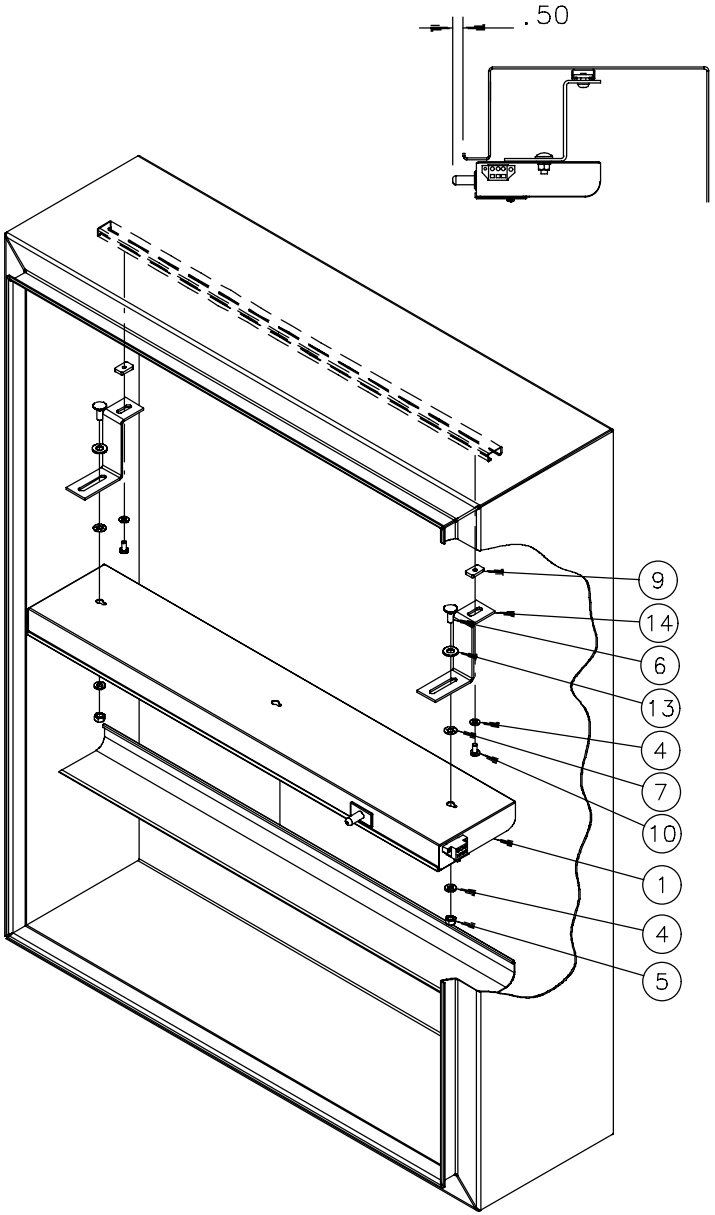
Enclosure Channel Mounting (plunger switch)
Bâti De la Manche De Clôture (commutateur de plongeur)
Montaje Del Canal Del Recinto (interruptor del émbolo)



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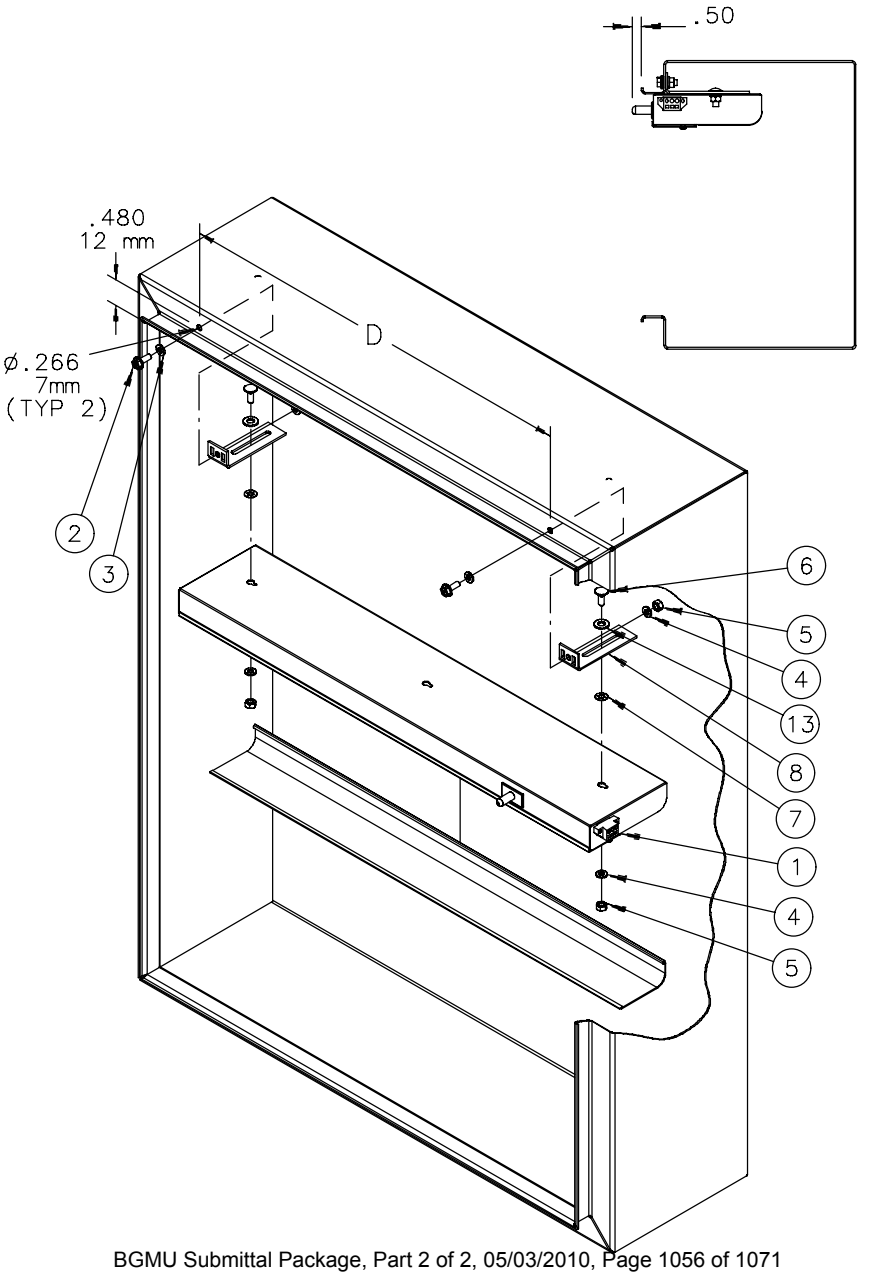
Enclosure Flange Mounting
Bâti De Bride De Clôture
Montaje Del Reborde Del Recinto



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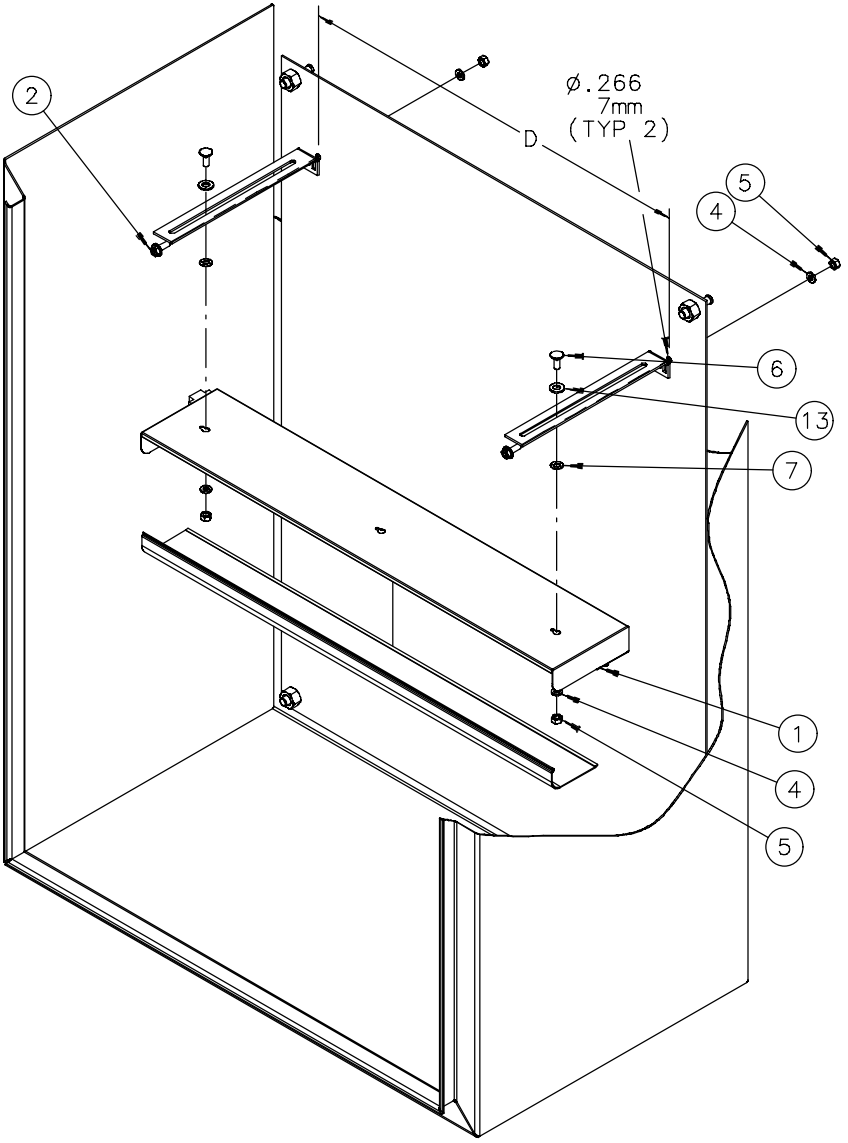
Optional Panel Mounting
Support Facultatif De Panneau
Montaje Opcional Del Panel



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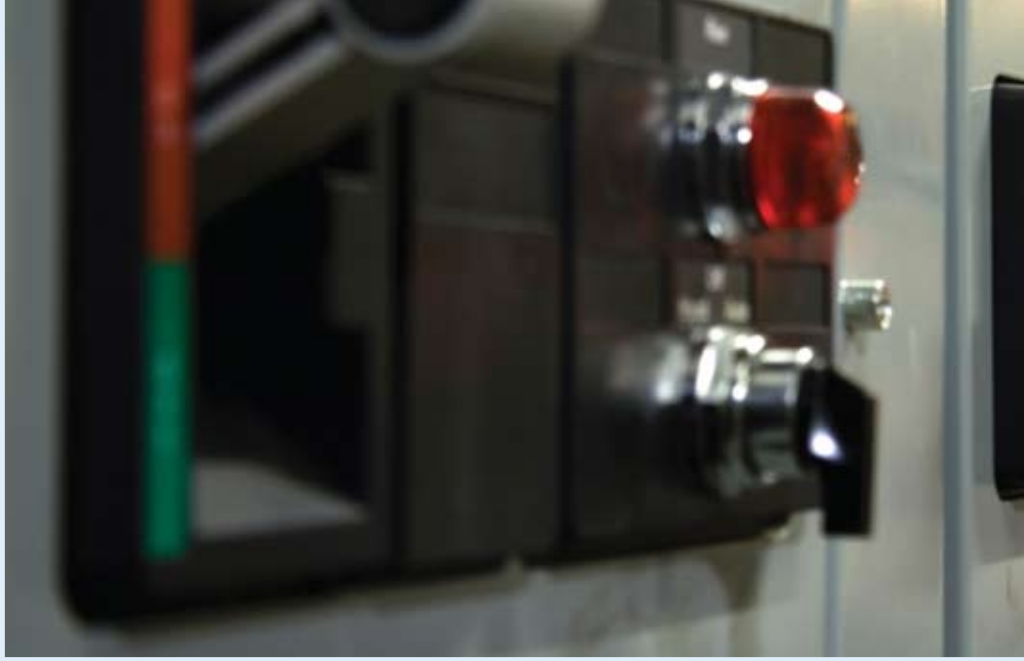
Fuse Holder, Ferraz Shawmut, USCC21

ULTRASAFE™ Fuse Holders

The safety evolution continues.

Ferraz Shawmut



The Revolutionary Advantages

Ferraz Shawmut continues to lead the safety evolution with even more improvements to our popular ULTRASAFE fuse holders. Renowned throughout the industry for their forward-thinking design, ULTRASAFE fuse holders deliver more than "finger-safe" protection, they deliver the features both installers and end users demand. Features like lockout/tagout compliance, the simplicity of DIN rail mounting, and at-a-glance open-fuse indication.

In addition, our new US14 and US22 series holders feature microswitch capabilities for remote indication. And for quick and easy panel layout adjustments, many models include an innovative DIN rail latch adapter. Simply unlatch, slide the holder to the new position, and relock. With ULTRASAFE, ease-of-use — and safety — come built right in.

"... they deliver the features both installers and end users demand."

Easy panel layout adjustments

Need to make room for another fuse holder or component? Simply unlatch the DIN rail adapter, slide the holder to the desired position, and relock.

Totally modular

Use single or multiple poles. Or add poles in the field using a pin assembly kit to form any number of poles. Either way, you have maximum application flexibility.

Flick-of-the-finger changeouts

A permanently attached, pivoting fuse door simplifies and speeds fuse extraction. No tools or accessories needed.

DIN rail mounting

Integral design allows for quick and easy installations on 35mm DIN rail. And our Class CC and Midget holders take up 15% less space than traditional holders.

At-a-glance open-fuse indication

A long-lasting, neon indicator light helps you identify the down circuit fast. So you can clear the problem, replace the fuse, and get back on-line fast.

Simplified wire terminations

Pressure plate terminals arrive backed out and ready to wire. Just insert the wire, tighten and go.

Runs cool

Our vented design provides adequate airflow around our US3J, US6J, US14 and US22 holders at all times.

UL/CSA compliance

USCC, US3J and US6J, models are UL Listed and CSA certified for branch circuit protection. USM US14 and US22 models are UL Recognized and CSA Certified for supplementary and high speed protection.

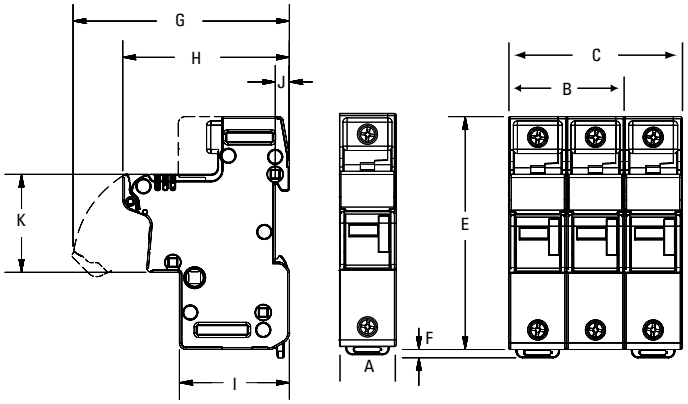
European acceptance

All ULTRASAFE fuse holders have a CE Mark for acceptance throughout the European community.

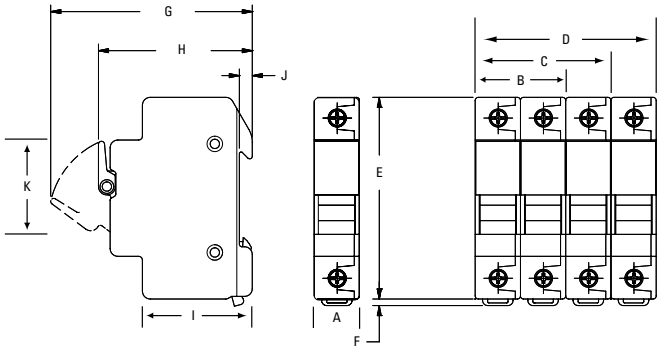
Lockout/tagout compliance

US3J, US6J, US14 and US22 fuse holders provide a lockable extraction door to meet OSHA requirements and prevent personnel from accidentally energizing equipment that is off-line for repairs or maintenance.

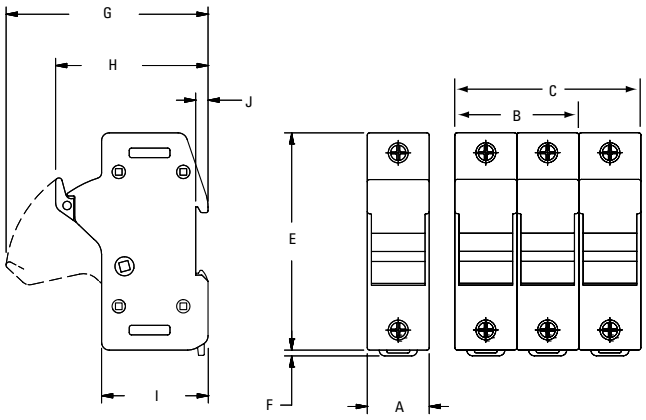
US14/22



Class CC & Midget



Class J



ULTRASAFE Series Nomenclature

Description — Fuse Holders	For Use With 14 x 55mm Fuses	For Use With 22 x 58mm Fuses	For Use With Class CC Fuses	For Use With Midget Fuses	For Use With 30AJ Fuses	For Use With 60AJ Fuses
1 Pole	US141	US221	USCC1	USM1	US3J1	US6J1
1 Pole with Indicator	US141I	US221I	USCC1I	USM1I	US3J1I	US6J1I
1 Pole with Indicator 12 - 24VDC	—	—	USCC1I-DC24	USM1I-DC24	—	—
1 Pole with Indicator 20 - 24VDC	—	—	—	USM1I-DC24P	—	—
1 Pole with Indicator 35 - 48VDC	—	—	USCC1I-DC48	USM1I-DC48	—	—
1 Pole with Microswitch	US141M	US221M	—	—	—	—
1 Pole with Microswitch & Indicator	US141MI	US221MI	—	—	—	—
2 Pole	US142	US222	USCC2	USM2	US3J2	US6J2
2 Pole with Indicator	US142I	US222I	USCC2I	USM2I	US3J2I	US6J2I
2 Pole with Microswitch	US142M	US222M	—	—	—	—
2 Pole with Microswitch & Indicator	US142MI	US222MI	—	—	—	—
3 Pole	US143	US223	USCC3	USM3	US3J3	US6J3
3 Pole with Indicator	US143I	US223I	USCC3I	USM3I	US3J3I	US6J3I
3 Pole with Microswitch	US143M	US223M	—	—	—	—
3 Pole with Microswitch & Indicator	US143MI	US223MI	—	—	—	—
3 Pole with 2 Microswitches	US143M2	US223M2	—	—	—	—
3 Pole with 2 Microswitches & Indicator	US143M2I	US223M2I	—	—	—	—
3 Pole with a Fourth Neutral Pole	—	—	USCC3N	USM3N	—	—
3 Pole with Indicators and a Fourth Neutral Pole	—	—	USCC3IN	USM3IN	—	—
4 Pole	—	—	USCC4	USM4	—	—
4 Pole with Indicator	—	—	USCC4I	USM4I	—	—
1 Pole with Integral Neutral Link	US14N	US22N	—	USN	US3JN	US6JN

Accessories for Assembling Multiple Poles	US14 Series	US22 Series	USCC Series	USM Series	US3J Series	US6J Series
Multi-Pole Assembly Kit	US14PAK	US22PAK	—	—	—	—
Microswitch for Single Pole	US14S1P	US22S1P	—	—	—	—
Microswitch for 3 Pole	US14S3P	US22S3P	—	—	—	—
2 Microswitches for 3 Pole	US14S3P2	US22S3P2	—	—	—	—
2 Pole Assembly Kits	—	—	USPTH2	USPTH2	US3J2PAK	US6J2PAK
3 Pole Assembly Kits	—	—	USPTH3	USPTH3	US3J3PAK	US6J3PAK
4 Pole Assembly Kits	—	—	USPTH4	USPTH4	US3J4PAK	US6J4PAK

Specifications	US14 Series	US22 Series	USCC Series	USM Series	US3J Series	US6J Series
Voltage AC	750V	750V	600V	600V	600V	600V
Special Indicator Voltage DC	—	—	24V, 48V	24V, 48V	—	—
Amperage	50A	125A	30A	30A	30A	60A
Withstand Rating (RMS Symetrical)	200,000A	200,000A	200,000A	100,000A	200,000A	200,000A
Termination Screw Type	Phillips/Slot Screw	Phillips/Slot Screw	Phillips/Slot Screw	Phillips/Slot Screw	Phillips/Slot Screw	Phillips/Slot Screw
Suggested Torque (lbs-in)	35	45	14.75	14.75	35	45
Termination Type	Pressure Plate	Pressure Plate	Pressure Plate	Pressure Plate	Pressure Plate	Pressure Plate
Wire Range (Solid/Stranded CU)	#2 - #14	#1/0 - #14	#6 - #14	#6 - #14	#2 - #14	#2 - #14
Load Break Disconnect	No	No	No	No	No	No

Agency Approvals	US14 Series	US22 Series	USCC Series	USM Series	US3J Series	US6J Series
UL 512, Guide IZLT, File E52283 (Listed)	—	—	Yes	—	Yes	Yes
UL 512, Guide IZLT2, File E52283 (Recognized)	Yes	Yes	—	Yes	—	—
CSA C22.2, Class 6225, File 32169	Yes	Yes	Yes	Yes	Yes	Yes
IEC 269	Yes	Yes	—	Yes	Yes	Yes

	US14 Series	US22 Series	USCC Series	USM Series	US3J Series	US6J Series
ULTRASAFE Fuse Holders will Accommodate the Following Ferraz Shawmut Fuses:	60gD14, A70QS, A70P, URC, URD, ASOP, A30QS, AZSX, AZy, A6g-11	60gD22, A70QS, URD	ATDR, ATMR, ATQR	ATM, OTM, TRM, ATQ, A60Q, A15QS, A13X, A25X, A25Z, A30Z-TYPE 2,	AJT, A4J, HSJ	AJT, A4J, HSJ

Your Global Resource

With products to meet every major global standard and a worldwide sales and service network, Ferraz Shawmut offers a range of solutions unmatched in the industry. Plus technical and applications support that combine our global expertise with local, customer-first service. So whatever and wherever your circuit protection needs may be, there is one company that can meet them all.

Outline Dimensions - mm (in.)

	US14 Series		US22 Series		Class CC & Midget Series		US3J Series		US6J Series	
Dimension	mm	in	mm	in	mm	in	mm	in	mm	in
A	26.5	1.04	35.0	1.38	17.5	0.69	32.5	1.28	40	1.57
B	53.0	2.09	70.0	2.76	35.0	1.38	65	2.56	80	3.15
C	79.5	3.13	105.0	4.13	52.5	2.07	97.5	3.84	120	4.72
D	—	—	—	—	70.0	2.76	—	—	—	—
E	107.0	4.21	124.0	4.88	78.0	3.07	114	4.49	122	4.80
F	3.8	0.15	3.8	0.15	2.5	0.10	3	0.12	3	0.12
G	94.0	3.70	103.0	4.06	78.0	3.07	106	4.17	115	4.43
H	76.5	3.01	76.5	3.01	59.0	2.32	80	3.15	89	3.50
I	50.5	1.99	50.5	1.99	42.5	1.67	56	2.20	62	2.44
J	6.5	0.26	6.5	0.26	5.0	0.20	6.5	0.26	6.5	0.26
K	45.0	1.77	45.0	1.77	45.0	1.77	—	—	—	—

“ . . . ease-of-use — and safety — come built right in.”

A relentless pursuit of protection for electrical components, systems—and the people who use them.

Ferraz Shawmut is an international company manufacturing the widest range of circuit protection solutions in the electrical industry. Drawing on a century of experience—and an ongoing commitment to critical research in electrical safety—we provide industrial, commercial, and OEM customers with innovative products and technical support teams to increase effectiveness, simplify applications, and enhance productivity. Learn more about our circuit protection solutions at us.ferrazshawmut.com.

For more information,
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BR-ULTRAFB-001

ATDR

THE BEST PROTECTION FOR TODAY'S SMALL MOTORS.

Amp-trap 2000® ATDR small-dimension fuses can provide IEC Type 2 "no damage" protection to your facility's increasingly sensitive branch circuit components and small motors – minimizing the risk of fault-related damage. ATDR Class CC fuses deliver the best time delay characteristics in their class with excellent cycling ability for small motor loads.

Features/Benefits

- **Time delay** for motor starting inrush currents without nuisance opening
- **Highly current limiting** for low peak let-thru current
- **Improved cycling ability** for frequent motor starts/stops without nuisance fuse opening
- **Rejection-style design** prevents replacement errors (when used with recommended fuse blocks)
- **High-visibility orange label** ensures instant recognition, simplifies replacement
- **Metal-embossed date and catalog number** for traceability and lasting identification
- **Fiberglass body** provides dimensional stability in harsh industrial settings
- **High-grade silica filler** ensures fast arc quenching and optimum current limitation

HIGHLIGHTS:

- Time Delay
- Best Choice for Small Motor Protection
- Highly Current-Limiting
- AC & DC Rated

APPLICATIONS:

- Small Motors
- Contactors
- Lighting, Heating & General Loads
- Branch Circuit Protector

Ratings

- **AC:** 1/4 to 30A 600VAC, 200kA I.R.
- **DC:** 1/4 to 30A 300VDC, 100kA I.R.

Approvals

- UL Listed to Standard 248-4 File 2137
- CSA Certified to Standard C22.2 No. 248.4
- DC Listed to UL Standard 248

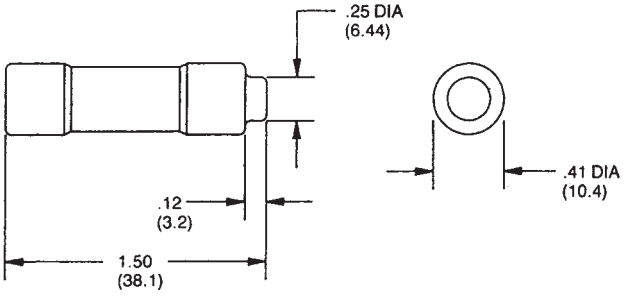
TIME DELAY/CLASS CC FUSES

ATDR

Standard Fuse Ampere Ratings, Catalog Numbers

AMPERE RATING	CATALOG NUMBER	AMPERE RATING	CATALOG NUMBER	AMPERE RATING	CATALOG NUMBER	AMPERE RATING	CATALOG NUMBER	AMPERE RATING	CATALOG NUMBER
1/4	ATDR1/4	1-1/2	ATDR1-1/2	3	ATDR3	6	ATDR6	12	ATDR12
1/2	ATDR1/2	1-6/10	ATDR1-6/10	3-2/10	ATDR3-2/10	6-1/4	ATDR6-1/4	15	ATDR15
8/10	ATDR8/10	1-8/10	ATDR1-8/10	3-1/2	ATDR3-1/2	7	ATDR7	17-1/2	ATDR17-1/2
1	ATDR1	2	ATDR2	4	ATDR4	7-1/2	ATDR7-1/2	20	ATDR20
1-1/8	ATDR1-1/8	2-1/4	ATDR2-1/4	4-1/2	ATDR4-1/2	8	ATDR8	25	ATDR25
1-1/4	ATDR1-1/4	2-1/2	ATDR2-1/2	5	ATDR5	9	ATDR9	30	ATDR30
1-4/10	ATDR1-4/10	2-8/10	ATDR2-8/10	5-6/10	ATDR5-6/10	10	ATDR10		

Dimensions



Small Motor Fuse Protection, 600 Volts AC or Less

MOTOR FULL LOAD AMPERES	ATDR RATING*	
	MINIMUM DUTY	NORMAL DUTY
.71 - .89	1-1/4	1-6/10
.90 - 1.19	1-6/10	2
1.20 - 1.34	2	2-1/2
1.35 - 1.79	2-1/2	3
1.80 - 2.25	3	4
2.26 - 2.69	4	5
2.70 - 2.90	4	6
2.91 - 3.20	5	6
3.21 - 3.75	5	7
3.76 - 4.50	6	8
4.51 - 5.34	8	10
5.35 - 5.69	10	12
5.70 - 6.70	12	12
6.71 - 7.79	12	15
7.80 - 8.88	15	17-1/2
8.89 - 11.1	17-1/2	20
11.2 - 13.3	20	25
13.4 - 15.2	25	30

* The National Electrical Code allows time-delay Class CC fuses to be sized at up to 400% (maximum) of motor F.L.A. if needed.

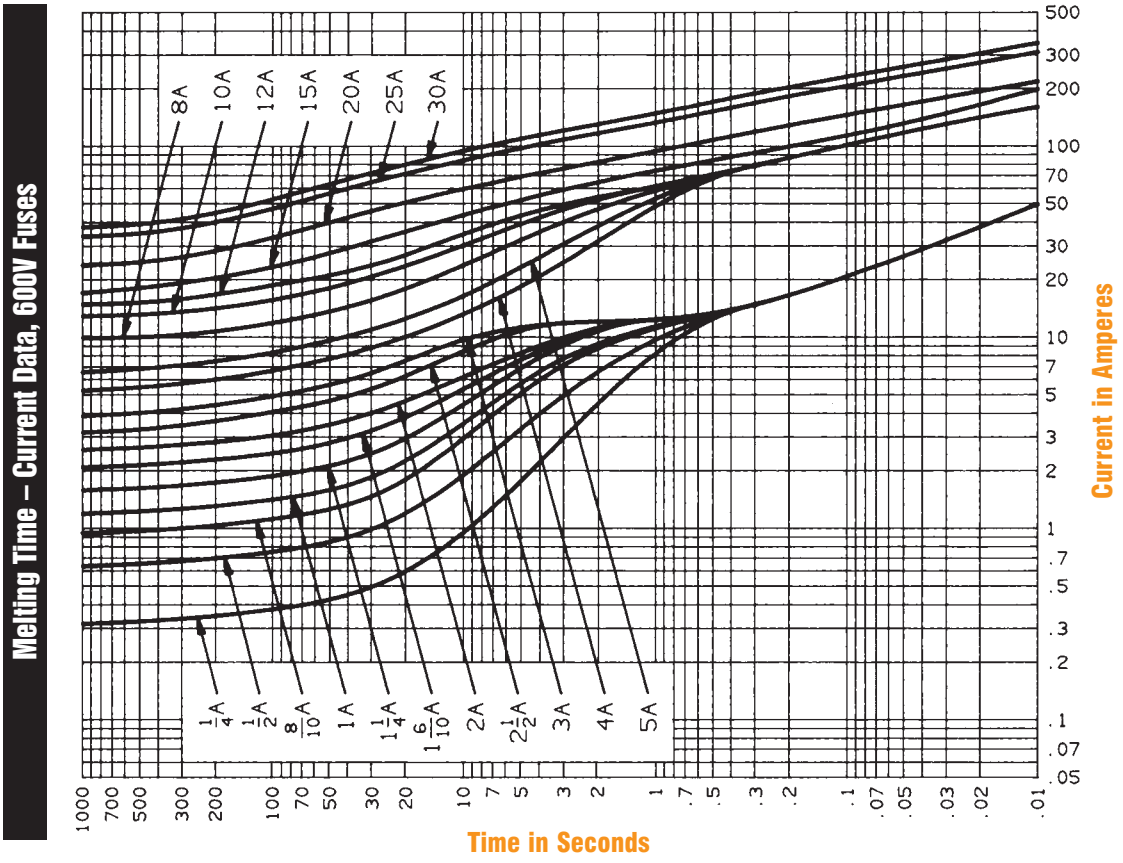
Recommended Fuse Blocks for Class CC Fuses

Number of Poles	CATALOG NUMBER			
	ULTRASAFE™ Indicating Fuse Holder	Screw Connector w/ Double Quick Connects	Pressure Plate Connector w/ Double Quick Connects	Copper Box Connector
ADDER		30310R	30320R	30350R
1	USCC1I	30311R	30321R	30351R
2	USCC2I	30312R	30322R	30352R
3	USCC3I	30313R	30323R	30353R

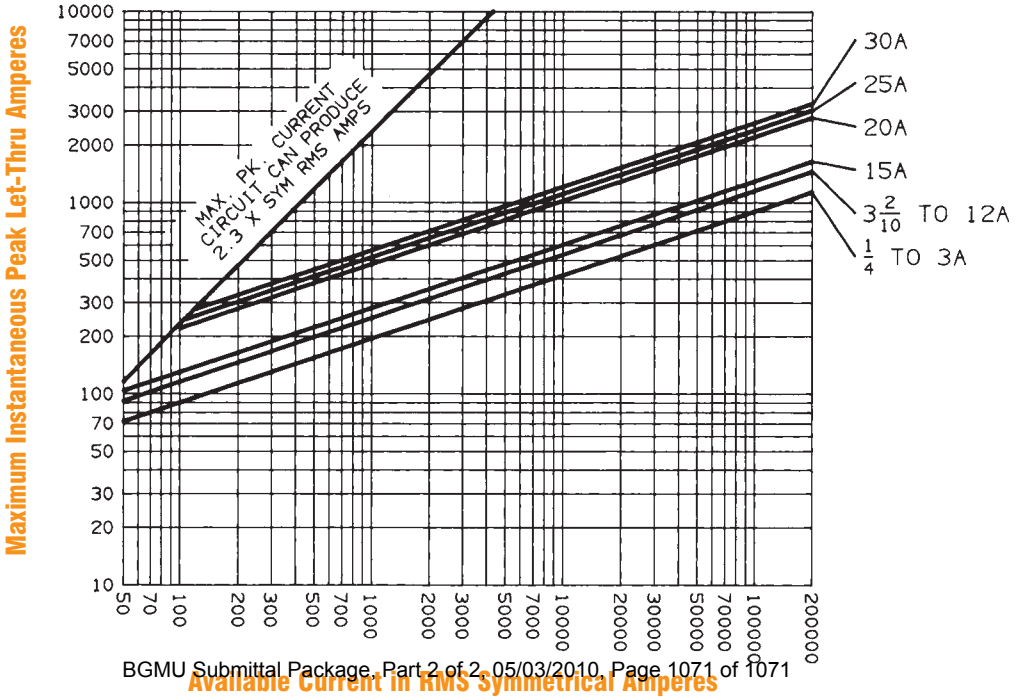
TIME DELAY/CLASS CC FUSES

A

ATDR1/4 to 30



Peak Let-Thru Current Data – ATDR1/4 to 30, 600 Volts AC



Schnell, Kristi

From: Mike McCawley [MMcCawley@therma-flite.com]
Sent: Thursday, July 22, 2010 11:55 AM
To: Schnell, Kristi
Cc: Robert Nickerson
Subject: Therma Flite Submittal - Part 2

Kristi,

Section H of the TFL 5412 Part 2 of 2 Submittal Package is just a summary page, it contains a list of the items below Section H.

Section N – Analog Output Module 1756-OFC6I and Section M – Analog Input Module 1756-IA16 share the same User Manual.

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