

**OPERATION & MAINTENANCE MANUAL**  
POWERPACK

**CHRISTMAS PUMP STATION NO. A2**

**HARRIMAN, TN**

SIEMENS WATER TECHNOLOGIES  
PROJECT NUMBER - 5429  
CUSTOMER PURCHASE ORDER NUMBER - 24953BA

**NOVEMBER 25, 2009**

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## Project Summary and Functional Description

SO# 5429 – Harriman, TN – Christmas Pump Station

REVISION	1.0	1.1	1.2	1.3	1.4
DATE	8/09	10/09	11/09		
PURPOSE	For Approval	Issued for Construction	As Shipped		
ISSUED BY	VDS	VDS	VDS		
CHECKED BY					
CLIENT APPROVAL					

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Item	Qty.	Description
A	1	<p>Christmas Pump Station No. A-2 NEMA 1 gasketed Cutler Hammer Motor Control Center that will operate on 480 volt, 3 phase, 4 wire, 60 HZ incoming service.</p> <p>To Include:</p> <ul style="list-style-type: none"> <li>1 200 amp main breaker</li> <li>1 IQ 260 power quality meter with transducer</li> <li>1 3-phase voltage monitor</li> <li>1 TVSS surge protector with circuit breaker</li> <li>1 20 amp unit heater feeder breaker</li> <li>2 15 HP wastewater pump circuit breakers, variable speed drives with 3-contactor bypass, lights, switches and elapsed time meters</li> <li>1 ½ HP sump pump circuit breaker, x-line motor starter, lights, switch and elapsed time meter</li> <li>1 18 circuit lighting panel</li> <li>1 15 Kva lighting panel transformer</li> </ul>
B	1	<p>Christmas Pump Station No. A-2 Control Panel that will monitor the wetwell level and provide controls for two variable speed drives in a pump-down mode of operation. This panel will operate on 120 volt, 1 phase, 2 wire, 60 HZ from MCC panel board.</p> <p>To Include:</p> <ul style="list-style-type: none"> <li>1 NEMA 1 gasketed enclosure with back panel</li> <li>1 120 VAC control power circuit breaker</li> <li>1 Surge protector</li> <li>1 Uninterruptable power supply</li> <li>1 Model OI3000 operator interface module with interconnecting cable</li> <li>1 "Alarm Silence" pushbutton for the customers remote horn</li> <li>1 15 VDC power supply</li> <li>1 12VDC/24VDC converter</li> <li>1 Model IS2-2 intrinsically safe transducer barrier</li> <li>1 Model LC2000 logic controller with the following I/O <ul style="list-style-type: none"> <li>1 - Analog input</li> <li>3 - Analog outputs</li> <li>10 - Digital inputs</li> <li>4 - Digital outputs</li> </ul> </li> <li>1 Model IS6 redundant float switch intrinsically safe barrier</li> <li>1 Model CB1T sump float switch controller</li> <li>1 Lot of output relays contacts</li> <li>1 Lot of wire numbers</li> <li>1 U. L. serialized label</li> <li>1 Model A1000i breather kit</li> </ul>

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C	1	Lot of field mounted equipment To Include: 2 Model A1000i level sensing transducer with 60' cable and lower sensing element (The second unit is a spare) 1 Model A1000i stainless steel suspension kit with 30' SS cable 2 Model S60 suspended float switches with weight and 60' cable
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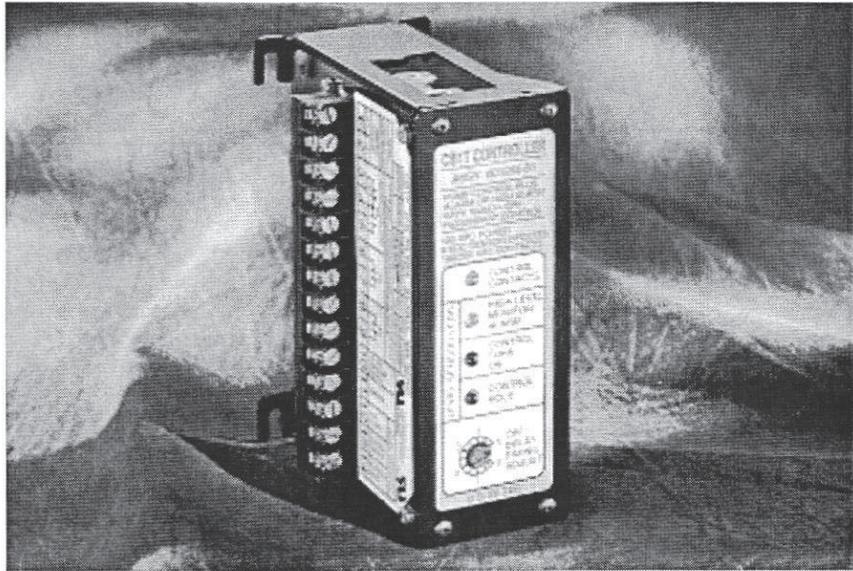




**PUBLICATION DIVIDER**

1.1

## CB1T CONTROLLER (B300)



The CB1T is a single-stage controller with high level alarm used in sewage lift stations, high-rise building sumps, storm water pumping stations, water reservoir pump control, wastewater treatment plants, and process and industrial control. It has three output relays – two for pump control (simultaneous operation) and one non-differential high level alarm output.

The CB1T can work as the primary controller with up to three float switches to control one or two pumps. It is often

used as a high level alarm device and a redundant, independent controller, using only a single-level sensor. As a back-up system for micro-processor or PLC-based control systems, the CB1T is generally independent of the primary control system as far as alarming is concerned, and its redundant control capability is wired in parallel with the control circuit outputs of the primary system, providing comprehensive back-up control.

CB1T FEATURES

---

**Pump-Down or Pump-Up**

Used with normally open or normally closed level sensors (our 9G, LS, etc.).

**Compact**

6" high x 3" wide x 4.5" deep

**Versatile**

Functions as a basic single pump control plus high level alarm or fail-safe redundant alarm/controller from a single level sensor.

**Operator Convenience**

Front panel LED's show level sensor and control output operation; 3/4-turn knob sets off-delay timing period.

**Heavy-Duty**

Load contacts rated 10 amps @ 250 VAC. Job connections are at clamp terminals accepting one or two AWG #12-20 wires.

**Easy To Use**

"Looks through" a window in a Power-pack panel or wall-mounted housing.

**Choice of Power**

120 VAC or 12 VDC

**Easy Wiring**

Low 8 VDC on sensor circuits allows open wiring.

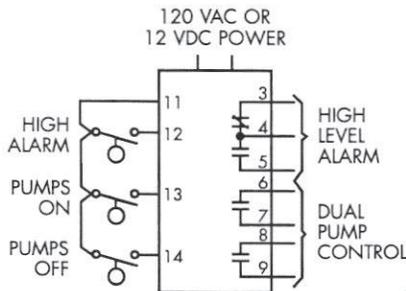
**Enclosure Options**

Available with any standard NEMA type.

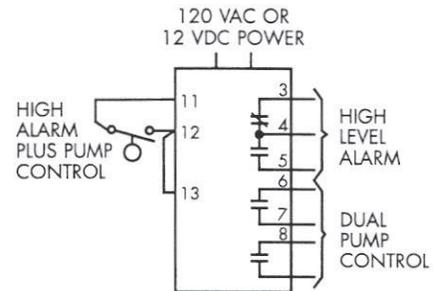


# CB1T CONTROLLER (B300)

DESCRIPTION	PART NUMBER
CB1T sump pump/redundant controller; open (no enclosure) (B300)	601280-01
Accessory: IS6 six-circuit intrinsic safety module	601316-02



*CB1T Control providing "pump-down" differential control (of two N.O. circuits in unison) plus high level alarm (SPDT) using three N.O. float switches.*



*CB1T Control providing high level alarm plus redundant duplex (in unison) "pump-down" (timed OFF. . . up to 5 minutes) operation of two pump control circuits.*

**THE B300 FAMILY**

The CB family of products provides a cost-effective, reliable means of using float switches or control logic inputs to control pumps, valves and alarms. Each unit is UL-approved and can be used as a component of an Industrial Control Panel requiring UL508 or 913 compliance. These controllers are offered either as basic control systems or built into Powerpack™ panels specifically designed to meet exacting job requirements.

The CB family of controllers is supplied with on-board transient protection and 12 VDC power supply. The controllers provide a low-voltage DC output (<8 VDC) to the discrete level sensors. If intrinsic safety is required, the CB controller can be used in conjunction with an IS6 Intrinsic Safety Barrier. The on-board 12 VDC supply is capable of powering the IS6.

**COMPLETE CONTROL CAPABILITIES**

USFilter Control Systems offers a single, high-quality source for everything from simple level sensors to telemetry systems to complex system control engineering and software. Based in St. Paul, Minnesota, USFilter Control Systems is part of United States Filter Corporation, the leading global provider of industrial, municipal and residential water and wastewater treatment systems, products and services. As a major manufacturer/integrator with an extensive selection of specialized product lines in the areas of SCADA and telemetry, power equipment integration, automation and measurement, USFilter Control Systems is uniquely positioned to provide cost-effective, comprehensive solutions for water, wastewater, and process control and telemetry applications.



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# Model CB1T Pump and Alarm Controller with Timed-Off Redundant Control Mode

The CB1T is used in ...

- \* Sewage Lift Stations
  - \* High Rise Building Sumps
  - \* Storm Water Pumping Stations
  - \* Water Reservoir Pump Control
  - \* Wastewater Treatment Plants
  - \* Process & Industrial Control

... to provide reliable primary/redundant pump, valve and alarm operation.

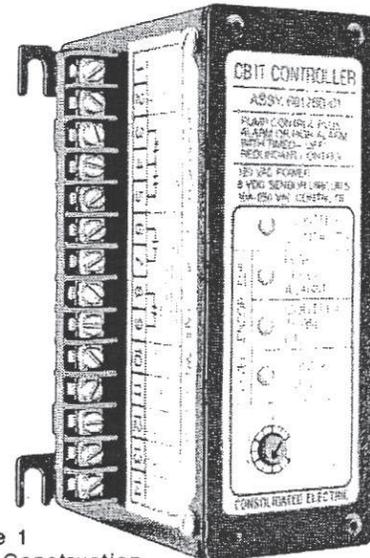


Figure 1  
Open Construction

The CB1T Controller works with one or more float switches or similar control devices to provide;

- \* Differential-level automatic operation of a pump or pumps; dual SPST-NO contacts operating in unison; from two sensors.
- \* Non-differential abnormal-level alarm relay contacts output; SPDT; from a single level sensor input.

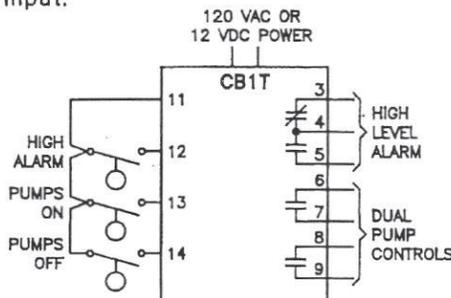


Figure 2  
Pump Control plus High Alarm

- \* Redundant single/dual pump control responding to a single level sensor and providing high level alarm relay output when the sensor is level-activated and pump control during that time and for a 0 to 5 minute adjustable time after the high level sensor lowers.

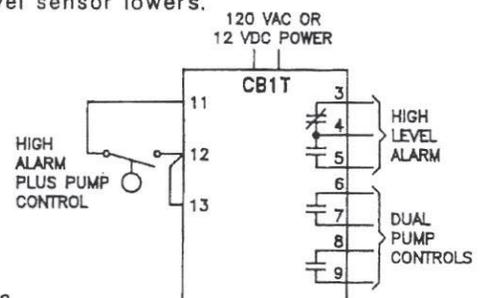


Figure 3  
High Alarm plus Redundant Pump Control

## CB1T Application & Function

The CB1T is used in single pump control applications for its differential-level control and its non-differential high level alarm operation.

It is also often used as a high level alarm device and a redundant, independent control capability; using only a single level sensor. As such, it is generally

independent or the primary control system as far as alarming is concerned and its redundant control capability is wired in parallel with the control circuit outputs of the primary system.

The single level sensor alarm/redundant-control use of the CB1T is a practical, cost-effective and easy-to-implement answer to the pressing need for reliable performance in the vital service of

municipal sewage pumping.

It is easy to justify the installation of a single level sensor as an independent device in a sewage lift station wet well if it contributes, as this system does, to the reliable performance of the station. One might be willing to install something considerably more expensive in key stations but with the CB1T and a single float switch, the equipment ... continued on page 4 ...

## CB1T Features

### PUMP-DOWN OR PUMP-UP

Used with normally-open or normally-closed level sensors; (CECO 9G, LS, etc.)

### COMPACT

6" high, 3" wide, 4-1/2" deep

### VERSATILE

Functions as a Basic Single Pump Control plus High Level Alarm or Fail-Safe Redundant Alarm/ Controller from a Single Level Sensor

### OPERATOR CONVENIENCE

Front Panel LEDs show level sensor and control output operation; 3/4-turn knob sets off-delay timing period

### HEAVY-DUTY

Load Contacts rated 10 Amps @ 250 VAC Job connections are at clamp terminals accepting one or two AWG #12-20 wires

### EASY TO USE

"Looks through" a window in a Powerpack panel or wall-mounted housing

### CHOICE OF POWER

120 VAC or 12 VDC

### FAMILY MEMBER

The small brother of the B300 - CB Family; CB1T, CB2A and CB234 Controllers as well as the CMC line of snap-track-mounting units

### UNDERWRITERS LAB

Built to UL508 Industrial Control Panel Standards; can be furnished by Consolidated in a UL508 Industrial Control Panel

### EASY WIRING

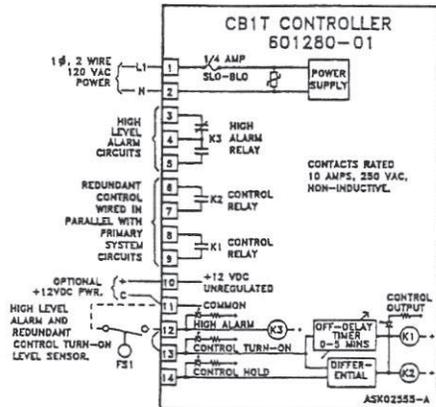
Low 8 VDC on sensor circuits allows open wiring

### INTRINSICALLY-SAFE OPTION

Used with the IS4 Module for sensor operation in hazardous areas

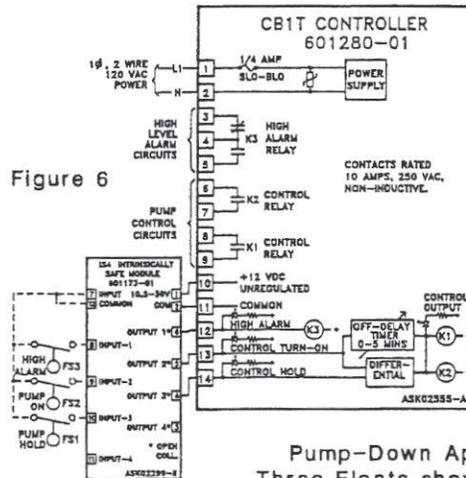
### ENCLOSURE OPTIONS

Available with any standard NEMA type

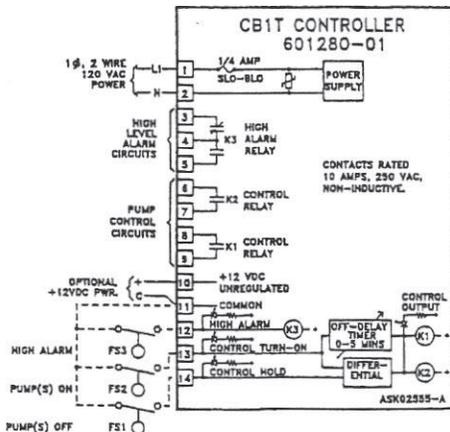


Pump-Down Application: Single Float High Alarm with Redundant Control; Timed-Off.

Figure 4

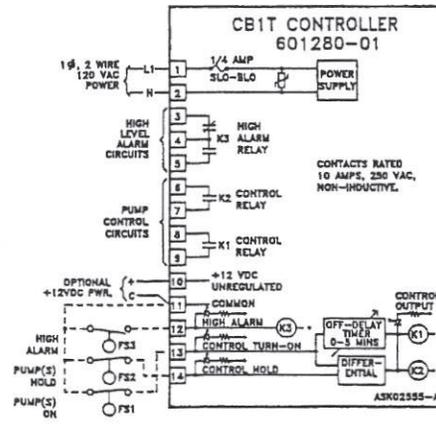


Pump-Down Application: Three Floats shown with a B400, IS4 Intrinsically-Safe Barrier Module for use in a Hazardous Wet Well.



Pump-Down Application: Three Floats giving Differential Level Control plus High Alarm

Figure 5



Pump-Up Application: Three Floats giving Differential Level Control plus High Alarm

Figure 7

## Basic-Pump and Alarm Controller Specification

A complete level-responsive automatic pump and alarm control system shall be supplied and placed in successful operation under this specification. It shall use direct-acting float switches and a Bulletin B300, Model CB1T Controller all as manufactured by Consolidated Electric Company of St. Paul, MN 55107 USA.

The Controller shall be designed to UL508 Industrial Control Panel standards and be suited for operation on either 120 VAC or 12 VDC. The normal 120 VAC line connection shall be fused and furnished with transient protection, an isolation transformer and a 12 VDC power supply.

The Controller shall provide connection for up to three (3) level-responsive float switches. Each float circuit input shall have an indicating LED showing its operation and shall be Controller-powered at 8 VDC. A fourth LED shall show the operation of the control contact outputs.

The four LEDs on the face of the Controller shall be;

- Control Contacts (ON)
- High Level Alarm (ON)
- Control Turn On (ON)
- Control Hold (ON)

In addition, a 0 to 5 minute Off-Delay Timing Adjustment shall be located on the face of the Controller for convenient adjustment of an optional Alarm/Redundant-Control capability. This back-up operating mode shall be implemented with a wire jumper on the terminal block. The redundant mode shall allow the use of a single level-sensor as a high level alarm sensing device and a redundant control mode of operation with pump operation during a high alarm period and also during an off-delay timing period after the high level float switch has lowered (following a high level condition).

The Controller shall provide ON/OFF, level-differential control of one or two pumps (simultaneous operation of two form A (SPST-NO) contacts) as well as High Level Alarm transfer of a form C (SPDT) contact on a non-differential basis when the high level sensor is operated by an abnormally-high level condition.

The load contacts of the Controller shall be rated to handle NEMA magnetic motor starter control circuits (through "Hand-Off-Auto" 3-position selector switches) and be rated at 10 amps at up to 240 VAC. All job connections shall be made at clamp/barrier type terminals each accepting up to two AWG #12-20 wires.

The Controller shall be a standard catalog product of a manufacturer regularly engaged in automatic control systems and it shall be fully integrated in the specific motor control equipment package and NEMA type enclosure as specified for this project. It shall be accompanied with all necessary drawings and instructions for its successful installation and operation.

NOTE: In addition to the above specification, call for the necessary quantity of the level sensors selected on page 4 and also stipulate which sensor mounting means is desired.

## Redundant High Alarm/ Pump Control Specification

An independent high level alarm and redundant control capability with features as hereinafter listed shall be provided in addition to the specified primary control system. It shall be powered by a 120 VAC circuit breaker (other than the one powering the primary system) and use one or more direct-acting level-responsive float switches as described.

The independent alarm/control panel equipment shall be designed to UL508 Industrial Control Panel standards and shall incorporate a 120 VAC input transformer with transient protection, a fused primary and a DC power supply with limited 12 VDC to supply the level sensing float circuit(s). The control shall be used here with a single high level float switch arranged in the wet well at a higher elevation than the normal operating range of the primary control and alarm. The float switch shall be mounted in the wet pit in accordance with manufacturers instructions or as shown on the plans. The front face of the Controller shall incorporate a High Level Alarm LED, a Control Turn-On LED, a Control Hold LED, a Control Contacts LED and a time adjustment with a 0 to 5 minute range.

Upon the occurrence of a high level condition sensed by the high alarm float, the High Level Alarm red LED shall light, a form C SPDT alarm output contact circuit shall transfer to operate the specified alarm devices and two (2) form A, normally-open, redundant control (10 amp/240 VAC) circuits shall close to provide redundant pump operation. These control circuits shall be wired in parallel with the primary control system two-wire control circuits to provide a redundant capability. As the level recedes from the high level float, the alarm contact shall return to its normal state; however, the redundant control contacts are to continue to operate during the time period setting of the off-delay timer. After that time interval (which is to commence following the lowering of the high level float) the control relay contacts are to re-open.

The Control Turn-On and Control Hold LEDs and circuitry allow two additional floats to be used with the CB1T to provide differential-level automatic control in addition to the High Level Alarm capability. When the differential level pump control is in use, the High Level Alarm circuitry is not generally connected to activate the control circuits in the redundant mode here described.

The redundant control/alarm capability shall be completely integrated in the specified control panel and system as described and in accordance with all applicable codes and job requirements.

The logic/relay assembly and level-sensing means to perform the described functions shall be a Bulletin B300, Model CB1T Controller and floats as manufactured by Consolidated Electric Company of St. Paul, Minnesota 55107 USA.

NOTE: In addition to the above specification, call for the necessary quantity of the level sensors selected on page 4 and also stipulate which sensor mounting means is desired.

## Liquid Level Sensor(s) and Mounting Specs

(LS) Each float shall have molded polyethylene body, internal redundant polyurethane foam flotation, potted switch/cable connections and fine-stranded AWG #18 cable with heavy-duty synthetic rubber jacket in lengths as required to run unspliced to the control panel.

(9G) Each level sensor shall be a stainless steel float flexibly supported by a three-conductor neoprene jacketed cable and having a mercury switch inside. The float and mounting hardware shall be constructed of Type 316 stainless steel and the float shall be 5-1/2" in diameter. The mercury switch shall be connected across two conductors of the neoprene jacketed type SO, #14 AWG cable, potted in epoxy (to prevent moisture wicking down the cable and shorting out the switch) and shall be inserted, with the end of the cable and neoprene jacketing into the stainless steel tube where it shall be held in place by dual circular crimp. The cord shall be fine stranded made especially for underwater and heavy flexing service and shall be furnished with an additional neoprene jacket from the float to the point where the cable is held in place by a stationary clamp tube.

Select LS or 9G

### (A) PIPE MOUNTING OF SENSORS

The Contractor shall furnish, install and wire the float switches as shown on the drawings. The float switches shall be mounted to a 1" pipe utilizing all stainless steel float switch mounting hardware. The 1" pipe shall be attached to the wall of the well with two (aluminum) (stainless steel) pipe mounting clamps located near the top of the pipe.

### (B) CABLE/ANCHOR MOUNTING OF SENSORS

The Contractor shall furnish, install and wire the float switches as shown on the drawings. The float switches shall be mounted to a stainless steel cable/weight kit utilizing all stainless steel float switch mounting hardware for suspension in the wet well. The stainless steel cable/weight assembly shall be suspended from an eyelet in the top slab of the wet well.

Select One of Three

### (C) INDIVIDUAL SUSPENSION OF LS SENSORS USING WEIGHT KITS

The Contractor shall furnish, install and wire the float switches as shown on the drawings. The float switches shall be individually suspended in the wet well with weight kits. The float switch cables shall be suspended from a cable rack mounted to the top slab of the wet well.

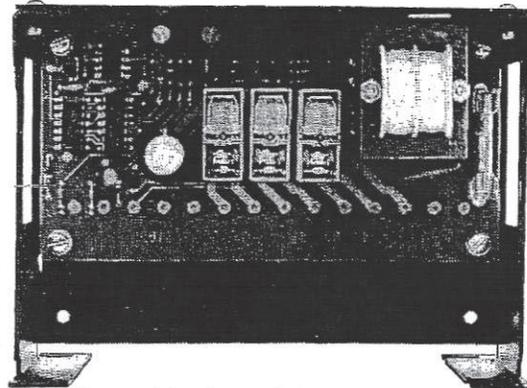
## CB1T Application & Function (continued)

in the wet well is both economical and simple enough to avoid the appearance of a lack of confidence in the primary system.

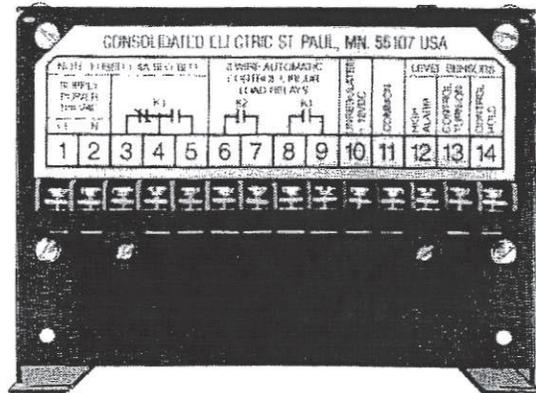
The providing of redundant control capability does not reflect adversely on the primary control but rather addresses responsibly the fact that some eventual failure or misoperation of some part of the primary control system is likely to occur and the CB1T with its associated sensor and connections is an economical and effective answer to the need for "fail-safe" performance.

The CB1T is the smallest of the B300 - CB Family of automatic pump controllers; 6" long, 3" wide, and 4-1/2" deep. All job connections are at barrier/clamp type terminals each able to accept one or two AWG #14-20 wires. The CB1T can be supplied in a variety of NEMA enclosure types to cope with a range of application environments. It operates on 120 VAC power or can alternately be operated on 12 VDC. The sensor circuits are Controller-powered at 8 VDC.

Indicating LEDs show the operation of each level sensor circuit and the control relays. The off-delay timer adjustment is easily operated and viewed on the front of the unit.

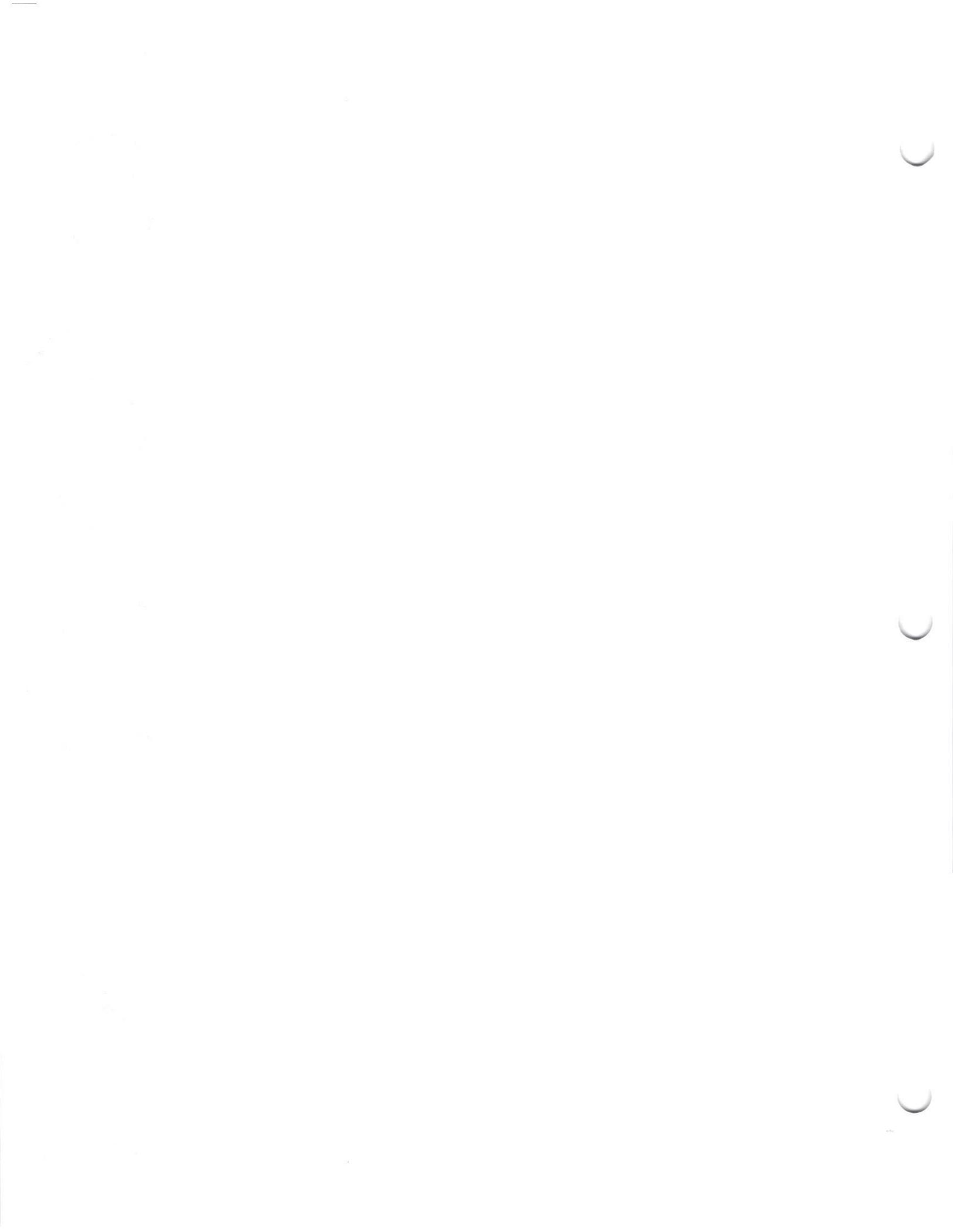


Open side view of CB1T Controller



Terminal side of CB1T Controller



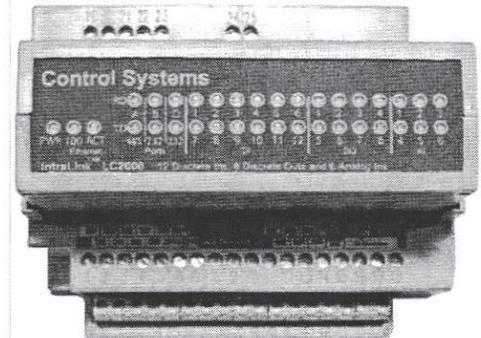


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Applicable standards and certifications:



European Directives



Marine & Offshore



US Emissions

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## **STATEMENT OF LIMITED WARRANTY**

The limited warranty applicable to the IntraLink products is set forth in Siemens Water Technologies standard terms of sale, that are made applicable to the purchase of these products.

### **INSTALLATION AND HAZARDOUS AREA WARNINGS**

These products should not be used to replace proper safety interlocking. No software-based device (or any other solid-state device) should be designed to be responsible for the maintenance of consequential equipment or personnel safety. In particular, Siemens Water Technologies disclaims any responsibility for damages, either direct or consequential, that result from the use of this equipment in any application.

All power, input and output (I/O) wiring must be in accordance with Class I, Division 2 wiring methods and in accordance with the authority having jurisdiction.

**WARNING – EXPLOSION HAZARD – SUBSTITUTION OF COMPONENTS MAY IMPAIR SUITABILITY FOR CLASS 1, DIVISION 2.**

**WARNING – EXPLOSION HAZARD – WHEN IN HAZARDOUS LOCATIONS, DISCONNECT POWER BEFORE REPLACING OR WIRING MODULES.**

**WARNING – EXPLOSION HAZARD – DO NOT DISCONNECT EQUIPMENT UNLESS POWER HAS BEEN SWITCHED OFF OR THE AREA IS KNOWN TO BE NON-HAZARDOUS.**

<p><b>Note:</b> All information in this document applies to the <b>LC2000</b>, except where otherwise noted. Refer to the IntraLink Toolbox software online help system for detailed product specifications and configuration settings.</p>
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Last Revision: December 2008

## **Section 1 Overview**

The LC2000 combines on-board I/O with a state of the art logic controller. The LC2000 was developed specifically for smaller remote applications in the water and wastewater industry. This innovative controller combines robust technologies and an open architecture to produce a cost competitive, feature rich solution that is ideal for use in remote control applications. The LC2000 includes a high performance CPU, multiple RS232 ports, an RS485 port, an Ethernet port, and 26 points of on-board I/O (both discrete and analog). An optional, user-friendly operator interface may be added to provide a window into the process. The local operator interface uses both text and graphics to allow an operator to view process data, change setpoints, view/acknowledge alarms, view alarm history and view historical trends

### **I/O overview**

The LC2000's on-board I/O includes 12 discrete inputs, 8 discrete outputs, and 6 analog inputs. I/O can be expanded up to 250 points using the Ethernet I/O family of modules. The Ethernet I/O modules can be connected to the LC2000 via its Ethernet port or via its RS485 port.

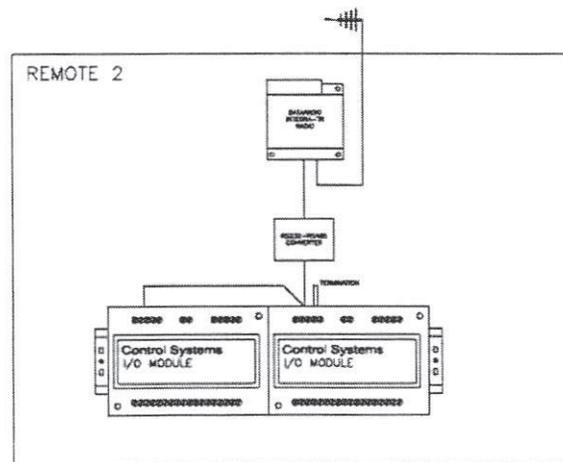
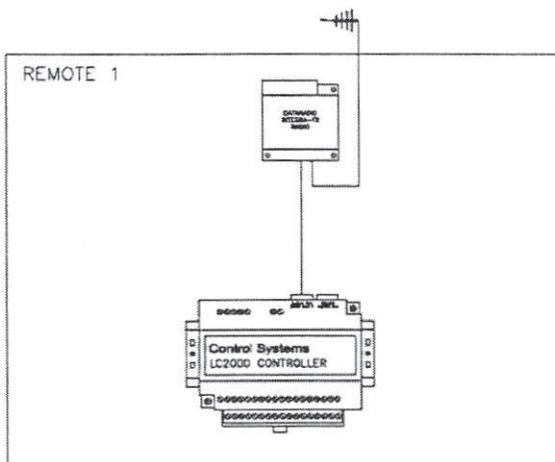
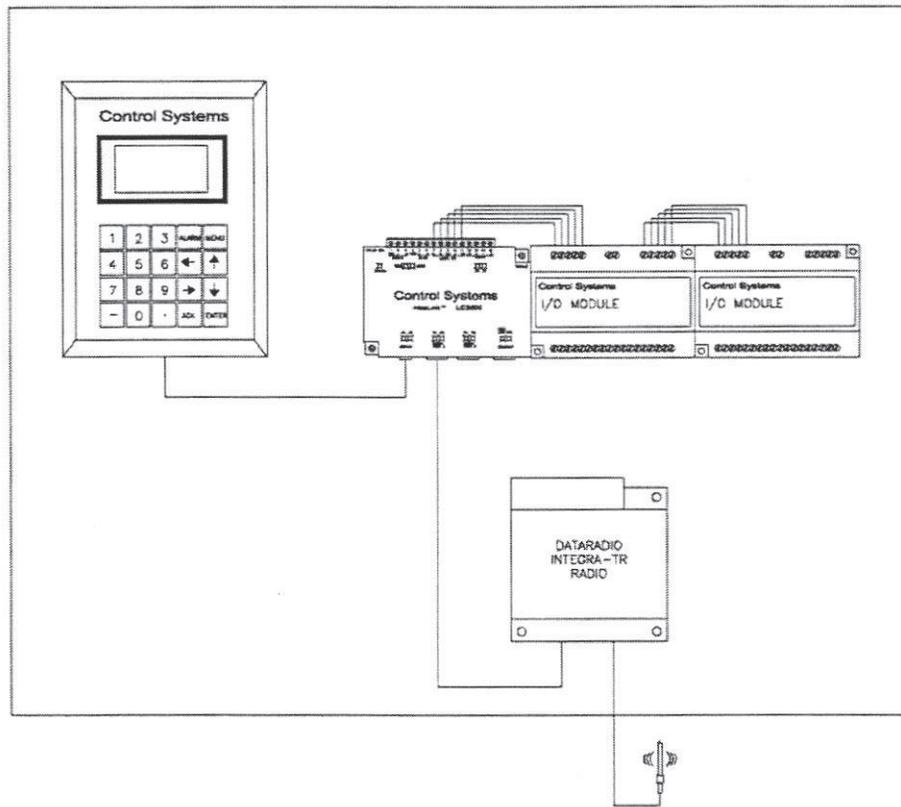
### **Operator Interface Overview**

The OI3000 (optional) is 128 x 64 pixel, backlit, graphical display coupled with an ergonomic 20 key keypad. The operator interface allows the user to view process data, change setpoints, view/acknowledge alarms, view alarm history and view historical trends. Together with a door switch, the OI3000/LC2000 can provide an effective intrusion detection system. The OI3000 is connected to the LC2000 through serial port D. The operator interface is configured using IntraLink Toolbox software. Please refer to the OI3000 Users Manual and IntraLink Toolbox On-line Help for more details.

### **IntraLink Toolbox Overview**

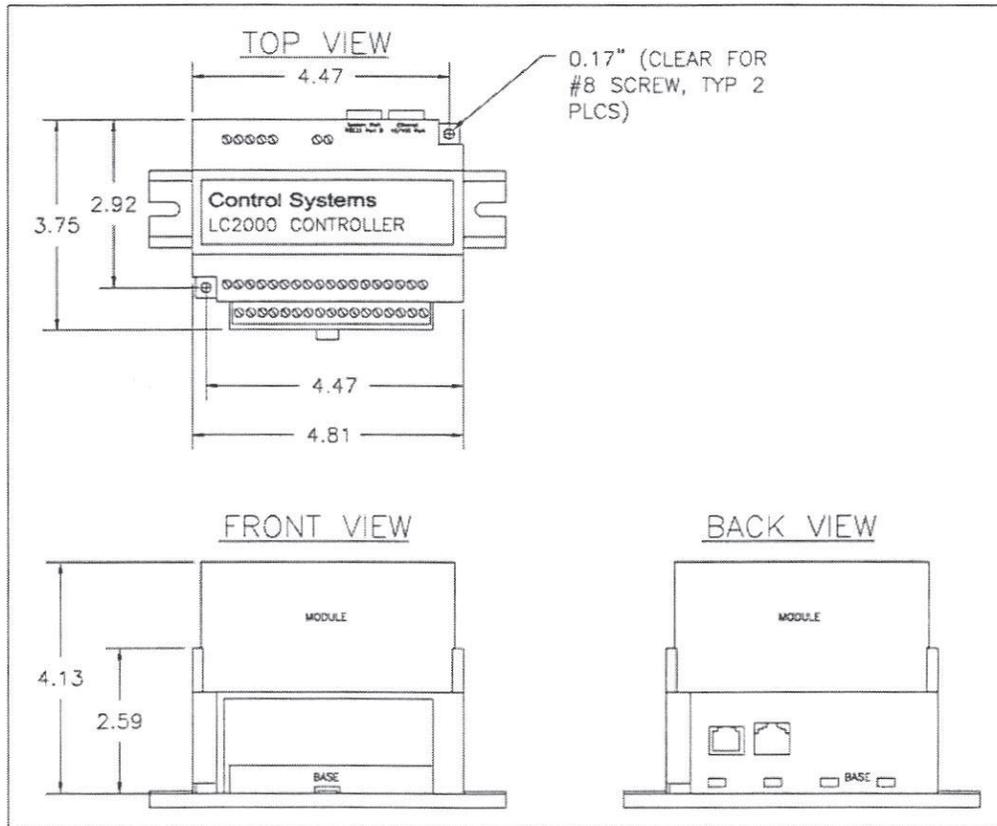
IntraLink Toolbox software is used to program, configure, and troubleshoot LC2000 and LC3000 systems. The software runs a PC with current Windows operating systems. IntraLink Toolbox allows the users to create stations, configure I/O (both Panel I/O and Ethernet I/O), setup communications, configure the OI3000 display, configure alarms, configure trends, and program a control strategy. ISaGRAF is an industry standard IEC 61131-3 compliant programming language used to implement control algorithms in the LC2000. ISaGRAF supports all five IEC 61131-3 languages including ladder logic and function blocks. IntraLink Toolbox contains specialized water and wastewater function blocks enabling consistently implemented, advanced control strategies. IntraLink Toolbox supports local connections to the LC2000 via the Ethernet or RS232 ports or remote connections via dial-up modem or network.

## Typical system diagram



## Section 2 Installation

The LC2000 controller is normally snapped onto DIN rails fastened to a sub-panel. However the LC2000 can also be surface mounted using the mounting holes located on two corners of the case.



## Section 3 Power

The LC2000 controller accepts power from an external DC power source of 10–30 VDC. Unlike the LC3000, the LC2000 does not have internal battery handling circuitry. An external battery handling device must be used to charge the battery and provide seamless transfer when line power fails.

## Section 4 On-board I/O

The LC2000 comes with integrated discrete and analog I/O on board. Wiring for the on-board I/O should be based on the wiring diagram shown in Figure 4.1. A hardware summary for each type of I/O is described below. Further details on the features available when using the on-board I/O can be found in the on-line Help system found in IntraLink Toolbox software.

### Discrete Inputs

There are twelve discrete inputs on the LC2000. These inputs may be wired for sourcing or sinking by setting the DI return jumper in the module's base. An input counting feature uses analog input registers to accumulate the number of positive transitions of each input. Positive DC voltage must be applied to an input to indicate an ON condition. All channels are referenced to a common return or supply, which is connected to the negative side (ground) or positive side (DC+) of the DC power source. One wire from each sourcing field input should be bussed together and connected to terminal 17 (DC+). One wire from each sinking field input should be bussed together and connected to terminal 18 (DC GND). Refer to the wiring diagram, Figure 4.1. Set the DI return jumper inside the wiring base to match the wiring configuration of the inputs (sinking or sourcing).

### Discrete Outputs

There are 8 discrete outputs integrated on the LC2000. The discrete output channels each provide up to 1 Amp DC to power the relay or other loads. A single terminal is provided for each output channel. All outputs are powered from the DC power terminal. All channels are referenced to a common return, which is connected to the negative side (ground) of the DC power source.

### Analog Inputs

There are six 4-20 mA analog inputs on the LC2000. The inputs provide 16 bits of resolution for precision analog measurements. A single input terminal is provided for each measurement channel. Care must be taken to provide a suitable ground and/or isolation for these single ended input circuits. Precision 100 ohm current shunts, beneath the hinged access door in the wiring base, pass current and maintain loop integrity, even if the plug-in logic module is removed. Each analog channel has built in current protection circuitry, such that each channel open circuits before any circuit damage will occur.

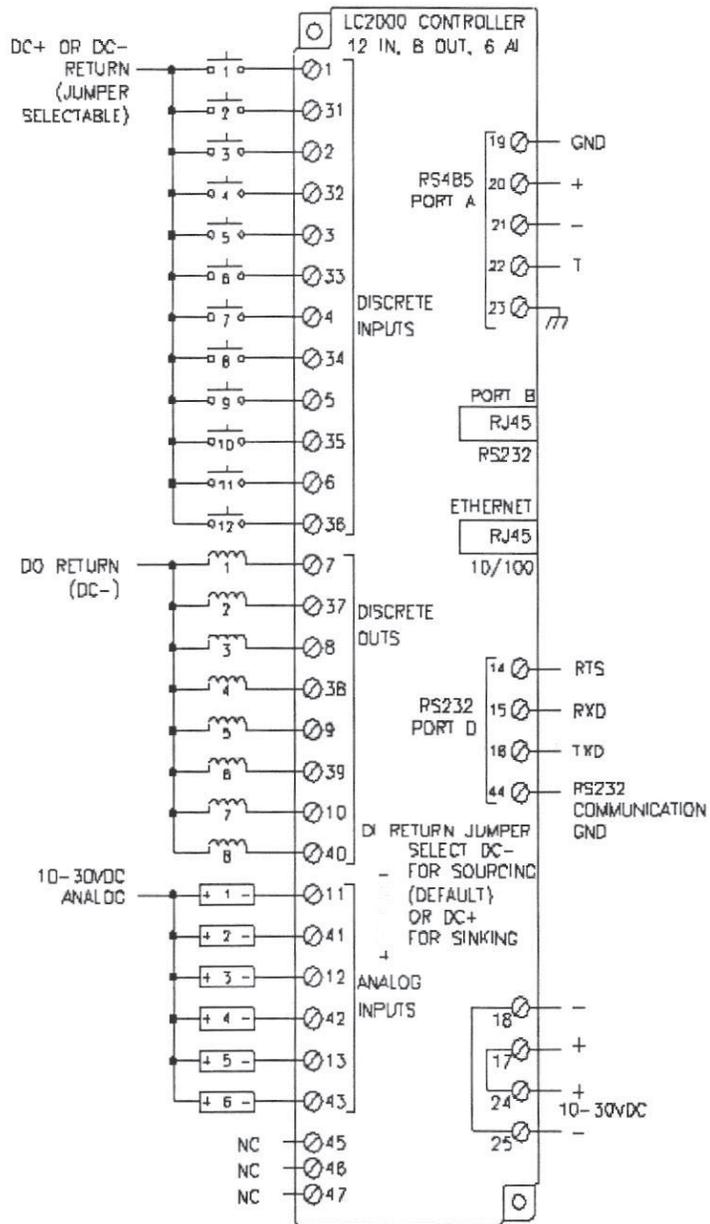


Figure 4.1 – LC2000 Wiring Diagram

## Section 5 Communications

The LC2000 controller has 4 communication ports:

- RS485 Port
- RS232 Port D (Display port)
- RS232 Port A
- Ethernet Port

### RS485 Port

This port provides an RS485 (2-wire, half duplex) connection to Ethernet I/O modules, RTU I/O modules, and other equipment. Four terminals (signal GND, 485+, 485-, termination) are provided. Generally + is connected to + and – to – between units. However, since there are no standards for RS485 terminal designations, + may need to be connected to – and – to + in some cases. No damage will result if you connect incorrectly. It is highly recommended that signal ground be connected to an appropriate ground (if available) between all RS485 units. Make sure to use a good quality communication cable with three conductors (twisted is preferred) plus a shield. To prevent ground loops, the shield should be connected to chassis ground on only one end of any cable run.

**Note:** If you have existing wiring that has only two conductors and a shield, you can use the shield to connect the signal grounds between stations. This is not optimal (especially for long cable runs) but should work in most situations.

The LC2000 has RS485 termination components (150 ohm resistor and 0.1 uF capacitor connected in series) already inside. To terminate your RS485 network tie the “T” terminal to the RS485- terminal. Use the same type and size conductor as that used for the RS485 – connection. It is recommended that both end stations of your RS485 network be terminated. Avoid terminating more than two stations.

On a RS485 2-wire network, a pair of bias resistors (1K ohm typically) acting upon the transmit/receive wire may be required. If bias resistors are not present, the receive inputs on some RS485 devices may react to noise on the floating wires. The bias resistors will force the transmit/receive lines to a known (non-floating) state when none of the RS485 devices are transmitting data. Some RS485 devices have bias resistors built in, which can be enabled through DIP-switches or jumper settings. Make sure there is only one pair of bias resistors acting upon the network. If your network is entirely made up of IntraLink family of devices, then bias resistors are not necessary.

**Display Port (Port D)**

The display port on the LC2000 is normally used to connect to the OI3000 Operator Interface. However, if an OI3000 is not used, this port may be used as a general communications port. This port is a four wire RS232 port providing RTS, RX, TX, and GND. If the port is being used to connect an OI3000, DC+ (terminal 17) is used and RTS (terminal 14) is not used. Refer to the Communications Port Diagram on the following page for exact pin out details. Refer to the OI3000 Users Manual for more details on the operator interface.

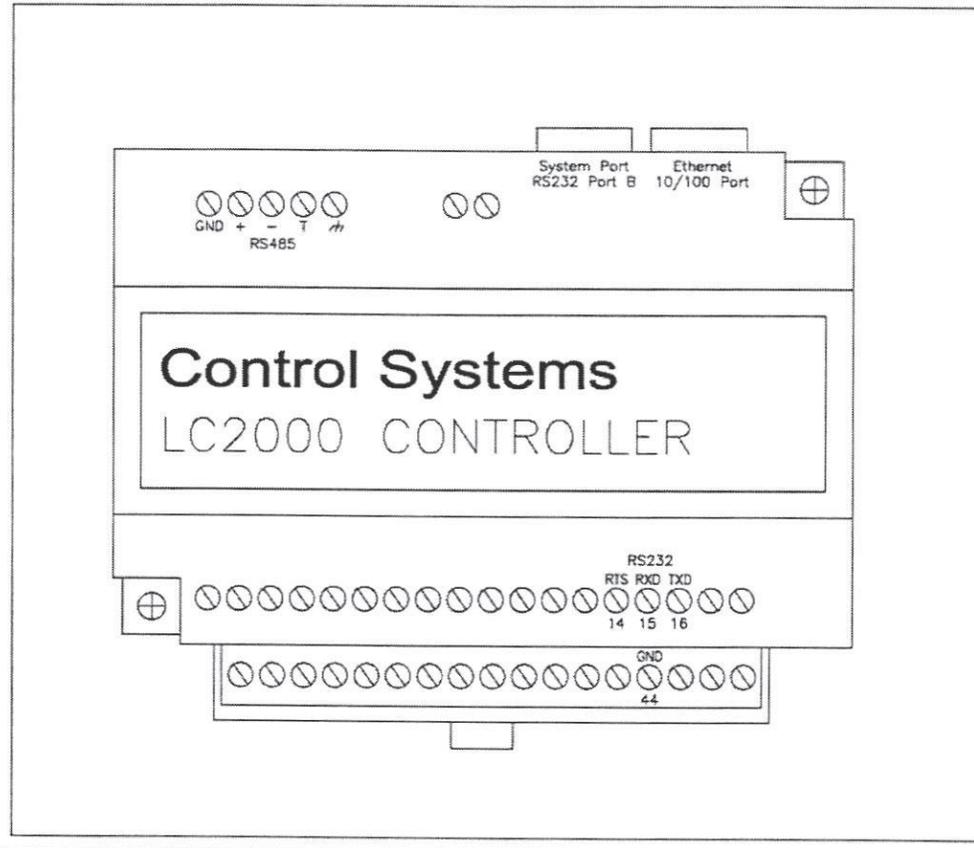
**RS232 Port B**

RS232 port B interface is a RJ45 female connector. This port may be used as a programming port or as a means to connect to a radio or modem. The pin-outs follow the EIA/TIA 561 standard (See Communications Port Details Diagram for pin outs). The ports are generally used in conjunction with a DB9 (or DB25) to RJ-45F adaptor and an RJ-45 male to RJ-45 male straight-through wired patch cable to make a connection between the LC2000 and another communication device.

**Ethernet Port**

The Ethernet port is a 10/100BaseT, auto-detecting and auto-crossover Ethernet port. This means the port will auto-detect speed and will work with either a straight-through or cross-wired Ethernet cable. A standard shielded RJ-45 female connector is provided. Refer to the Communications Port Diagram on the following page for pin-out details. The port has a fixed, unique MAC address. The port's IP address is viewable through the OI3000 Operator Interface and can be set with IntraLink Toolbox software. Refer to IntraLink Toolbox software on-line help for details.

## Communication Port Details



### **Port B, RJ45 Female (RS232 DTE):**

- Pin 1: RI/DSR (in)
- Pin 2: DCD (in)
- Pin 3: DTR (out)
- Pin 4: GND
- Pin 5: RXD (in)
- Pin 6: TXD (out)
- Pin 7: CTS (in)
- Pin 8: RTS (out)

### **Ethernet, RJ45 Female (10T/100T Auto uplink):**

- Pin 1: TX+
- Pin 2: TX-
- Pin 3: RX+
- Pin 6: RX-

## Section 6 Technical Specifications

Here are the technical specifications for the L2000 controller.

<b>General Details</b>	
Microprocessor	Industrial PowerPC (32 bit data bus)
Operating System	Embedded Linux
Number of unique stations addresses	16,000 (IntraLink Open) or 247 (Modbus)
Dynamic memory (for program execution, dynamic variables, dynamic file system etc)	16 Megabytes
Flash memory (Linux OS, program storage, file system)	16 Megabytes
Non-volatile RAM (datalogging)	512K bytes (battery backed, rechargeable Lithium)
Battery backup time/life	1 year/10 years
Real time clock resolution	10 ms
Real time clock accuracy	+/- 15 seconds per month
On board I/O	26 (12 DI, 8 DO, 6 AI)
I/O Expansion	Ethernet I/O, RTU I/O up to 256 points
Maximum virtual I/O registers	256 of each type
Datalogging	Internal datalogging
Programming Language	ISaGRAF (IEC 61131-3 compliant)
Languages supported	Ladder logic, SFC, function block, instruction list, structured text
Communication capabilities	Master, slave, peer-to-peer, report on exception, store and forward
Communication media supported	Ethernet, dial-up telephone, leased line, UHF/VHF radio, spread spectrum radio, wireless Ethernet, fiber optic and more
CPU Watchdog	CPU automatically resets if error is detected; status LED flashed error code
Communication watchdog	Settable timeout and output action (freeze or force off)
Heartbeat watchdog	Settable timeout and output action (freeze or force off)
<b>Ethernet Details</b>	
Ethernet media	10/100BaseT (auto-detecting)
Connection	RJ-45 Female (auto cross-over)
Isolation	1500 Volts RMS 1 minute (60 Hz)
Message response time (typical)	5 ms
Diagnostic LEDs	Link activity and speed
Protocols supported	TCP/IP, ARP, UDP, ICMP, DHCP, Modbus/TCP, IntraLink Open
Address	Unique MAC with static or DHCP assigned IP address

<b>Serial Port Details</b>	
Port speed	300 to 115,000 baud
RS232 Port B	RJ-45 (TD, RD, CTS, RTS, CD, DTR, DSR/RI, GND)
RS232 Port D (display port)	Screws (TD, RD, RTS, GND)
RS485 Port	Screw terminals (GND, 485+, 485-, termination) (2-wire half-duplex)
RS485 network	Up to 32 stations
RS485 distance	Up to .5 miles
Protocols (Master & Slave)	Modbus (RTU & ASCII), IntraLink Open, Microcat (9500 & 9700), PLTU, DF1, CECO
Diagnostics LED (each port)	Transmit data, Receive Data
Flow control	Hardware (RTS), software (XON/XOFF)
<b>Discrete Inputs</b>	
Guaranteed ON Voltage	9 VDC
Maximum Voltage	30 VDC
Guaranteed OFF voltage	5.0 VDC & 1.5 mA
Input Resistance	10K ohms
Input Current @ 24 V	3 mA
Filtered ON/OFF delay	25 ms (20 Hz max counting rate)
Fast ON/OFF delay	4 ms (100 Hz max counting rate)
Count rate	10 kHz on channel 1 (see above for others)
<b>Discrete Outputs</b>	
Maximum Output per Channel	1 A
Maximum Output per Module	8 A
Maximum Off-state leakage	0.05 mA
Minimum Load	1 mA
Inrush Current	5 A (100 ms surge)
Typical ON resistance	0.3 ohms
Typical ON voltage (@ 1A)	0.3 VDC
<b>Analog Inputs</b>	
A/D Resolution	16 bits
Full scale accuracy	+/- 0.1% (@ 20° C)
Span and Offset temp coefficient	+/- 50 ppm/degree C
Input impedance	100 ohm
Current protection	Self resetting fuse
DMRR	66 dB @ 50/60 Hz
<b>Environmental Details</b>	
Temperature	-40 to 70 C (-40 to 85 C storage)
Humidity	5% to 95% RH (non-condensing)
Flammability	UL 94V-0 materials
Electrical Safety	UL 508, CSA C22.2/14, EN61010-1 (IEC1010), CE
EMI emissions	FCC par 15, ICES-003, Class A; EN55022; EN61326-1; CE

EMC Immunity	EN61326-1 (EN6100-4-2,3,4,6); CE
Surge Withstand	IEEE-472 (ANSI C37.90), EN61000-4-2,4
Vibration	IEC68-2-6
Hazardous locations (Class 1, Div 2, Groups A, B, C, D)	UL 1604, CSA C22.2/213, Cenelec EN50021 Zone 2
Packaging	Lexan packaging
Mounting	DIN rail (EN50022) or direct to panel
Size	4.75"L x 3.83"W x 4.13"H
Weight	.73 lbs.

## Section 7 Troubleshooting and Service Information

### Local Diagnostics

Local diagnostics can be performed through either RS232 serial port or Ethernet, even while the LC2000 is responding to messages on other ports. IntraLink Toolbox software can be used to access internal diagnostics and display the status of I/O registers. Refer to the software's on-line help for details. The OI3000 can display a limited set of controller diagnostics. Refer to the OI3000 Users Manual for details.

### Status LED

The status LED on the LC2000 indicates its operational status

<b>ON:</b>	The LC2000 is operating properly
<b>OFF:</b>	There is no power to the LC2000 or service is required
<b>Fast Blink:</b>	This may occur when the LC2000 is being reset, or firmware is being downloaded from IntraLink Toolbox software.
<b>Slow or periodic blink:</b>	This indicates that the internal watchdog has detected a problem. Try clearing memory and reloading the project using IntraLink Toolbox software.

### LC2000 Memory

The LC2000 has non-volatile (battery free) memory for storing configuration data from IntraLink Toolbox.

The LC2000 also has battery-backed memory for storing program variables and logged data. The battery is a re-chargeable lithium cell that is kept fresh by the power circuitry on the controller. The memory retention period for an un-powered controller is at least 6 months at room temperature. The retention time will be shorter at high temperatures. The life expectancy of the lithium battery is at least 10 years.

**Product Support**

To obtain technical support or service for Control Systems products, contact your local Siemens Water Technologies, Control Systems representative. For factory support contact Siemens Water Technologies, Control Systems and ask for technical support. Our phone numbers are:

Phone: 1 (800) 224-9474  
Local: (651) 766-2700  
Fax: (651) 766-2754  
Email: [controlsystemssupport.water@siemens.com](mailto:controlsystemssupport.water@siemens.com)

Our mailing address is:

Siemens Water Technologies  
1239 Willow Lake Blvd  
Vadnais Heights, MN 55110

**Product Service**

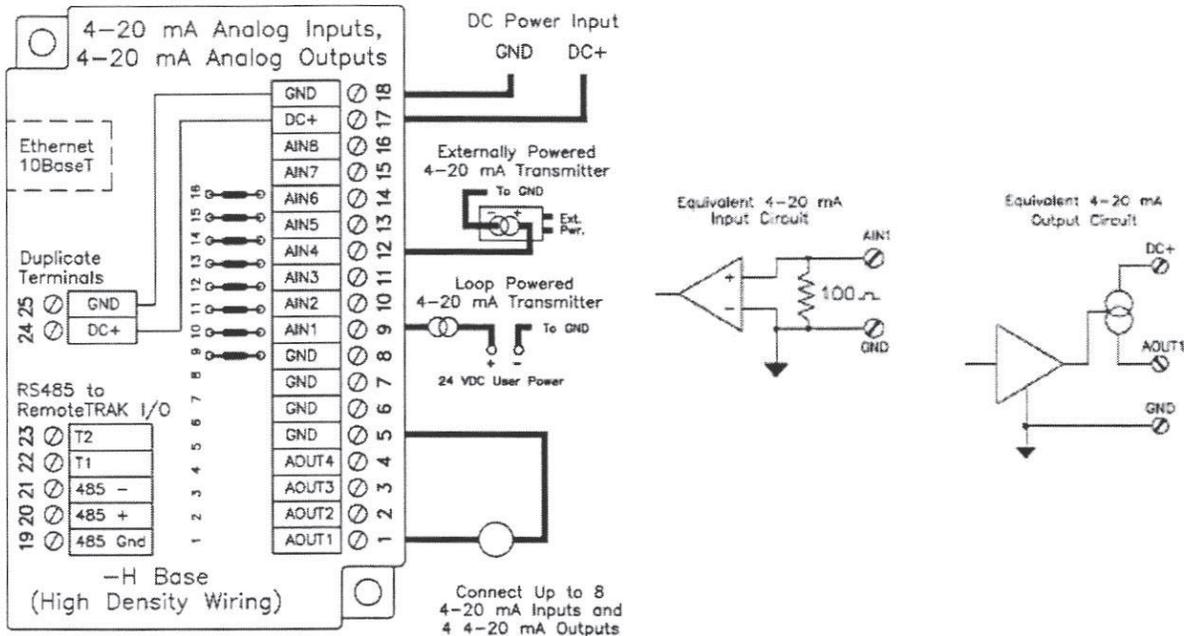
The warranty for this product was stated previously in this manual, on page 1.

For product service outside the warranty, contact your local Siemens Water Technologies representative. For more information on Control Systems parts replacement, contact the factory directly at 1-800-224-9474 and ask to speak with a customer service representative.



- When you need a mix of 4-20 mA analog inputs and outputs at the same location
- Single compact solution for small stations
- Lowest cost for small analog applications
- Input/output combination is ideal for control
- May be expanded with Remote RS485 I/O

Part Number	Description	Application
ILK-AI8AO4-BE	Analog Inputs and Outputs	IntraLink Ethernet I/O



### Electrical Specifications

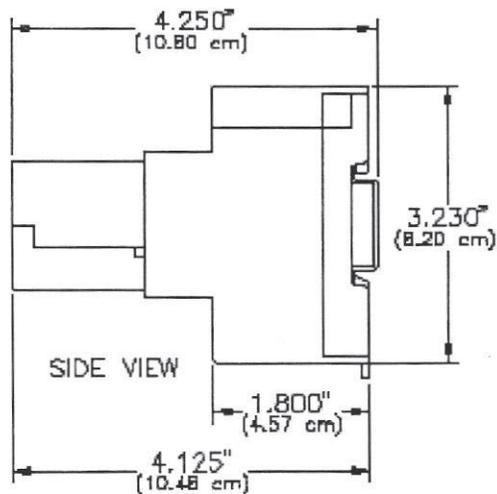
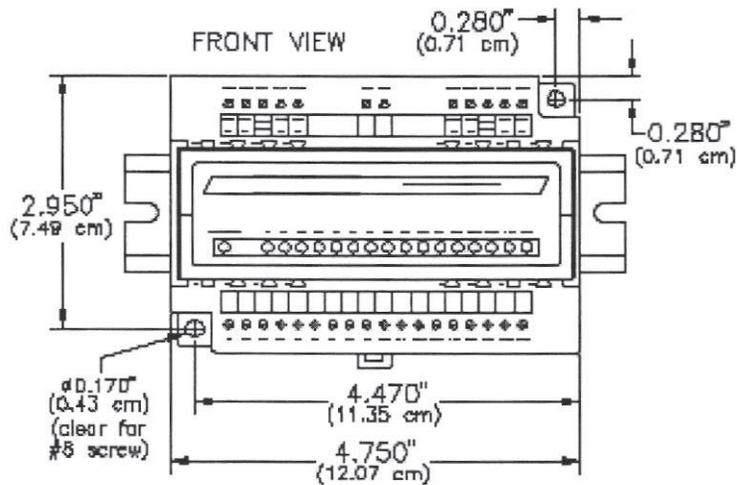
Number of analog inputs	8
Analog input range	4-20 mA
Analog input resolution	14 bits (0.01%)
Analog input characteristics	Same as ILK-AI-16-BE
Number of analog outputs	4
Output range	4-20 mA
D/A resolution	16 bits (less than 1µA)
Full scale accuracy (@20°C)	+/- 0.02%
Span and offset temp. coefficient	+/- 50 ppm per °C typical
Max. output settling time (to 0.05%)	5 mS
Required user supplied voltage	10-30 VDC
Load resistance range (@ +24 VDC supply)	0-750 Ohms
Short circuit protection	Current limiting
Fastest scan rate (all channels)	5 mS
Required supply voltage	10-30 VDC (0.75 watt typical)

Number of Ethernet I/O nodes	16,000
Ethernet port on each module	10BaseT at 10 Mbps
Protocols supported	TCP/IP and UDP/IP with Modbus or USFilter Open
Number of I/O per node	512 with RS485 expansion

Environmental Specifications

Operating temperature range	-30 to 70°C
Storage temperature range	-40 to 85°C
Humidity (non-condensing)	5 to 95%
Flammability (module plastic)	UL 94V-0 materials
Electrical safety	UL 508, CSA C22.2/14; EN61010-1 (IEC1010)
EMI emissions	FCC part 15, ICES-003, Class A; EN55022
EMC immunity	EN50082-1 (IEC801-2, 3, 4)
Surge withstand	IEEE-472 (ANSI C37.90)
Vibration	IEC68-2-6
Hazardous Locations	UL 1604, CSA C22.2/213-M1987 (Class I, Div. 2, Groups A, B, C, D)

Physical Specifications

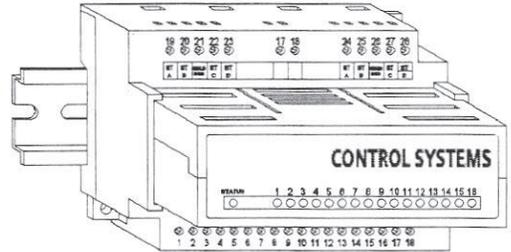




# SIEMENS

Water Technologies

## Ethernet & RTU I/O Distributed I/O Installation and Maintenance



### Contents at a Glance:

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Section 3	Discrete I/O Modules	6
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Class I, Division 2,  
Groups A, B, C, and D  
Hazardous Locations



## **STATEMENT OF LIMITED WARRANTY**

The limited warranty applicable to the Ethernet I/O products is set forth in Siemens Water Technologies standard terms of sale, that are made applicable to the purchase of these products.

### **INSTALLATION AND HAZARDOUS AREA WARNINGS**

These products should not be used to replace proper safety interlocking. No software-based device (or any other solid-state device) should ever be designed to be responsible for the maintenance of consequential equipment or personnel safety. In particular, USFilter disclaims any responsibility for damages, either direct or consequential, that result from the use of this equipment in any application.

All power, input and output (I/O) wiring must be in accordance with Class I, Division 2 wiring methods and in accordance with the authority having jurisdiction.

**WARNING – EXPLOSION HAZARD – SUBSTITUTION OF COMPONENTS MAY IMPAIR SUITABILITY FOR CLASS I, DIVISION 2.**

**WARNING – EXPLOSION HAZARD – WHEN IN HAZARDOUS LOCATIONS, DISCONNECT POWER BEFORE REPLACING OR WIRING MODULES.**

**WARNING – EXPLOSION HAZARD – DO NOT DISCONNECT EQUIPMENT UNLESS POWER HAS BEEN SWITCHED OFF OR THE AREA IS KNOWN TO BE NONHAZARDOUS.**

**Note:** All information in this document applies to Ethernet I/O modules, except where otherwise noted. Refer to the IntraLink Toolbox software online help systems for detailed product specifications and configuration settings.

## Section 1

### Overview

### General Specifications

### DC Power Overview

## General Information

This manual will help you install and maintain Ethernet I/O and RTU I/O modules. In summary, wiring for power, communications and I/O is connected to each module's base. Then, setup choices are entered using the IntraLink Toolbox software and the system will be ready to run.

These general specifications apply to all Ethernet I/O modules. More detailed product specifications may be found in the online help system of the IntraLink Toolbox configuration utility.

Supply Voltage	10 - 30 VDC, 1.2 Watt typical per module (48 mA @ 24 VDC – varies by module and load).
RS485 Expansion	Connect up to 32 RTU I/O modules, Ethernet I/O modules or Modbus devices using RS485
Ethernet Isolation	1200 Volts RMS (for 1 minute)
Operating Temperature	-30 to 70 °C
Storage Temperature	-40 to 85 °C
Humidity	5 to 95% (non-condensing)
Protocols Supported	Modbus /TCP, IntraLink Open

Ethernet modules can be powered from the same DC source that is used to power your I/O devices. No separate power supply is required. Typically, 10 to 30 VDC power is applied to terminals 24 and 25 on the base of each module.

## Section 2

# Configuring Ethernet I/O

### Overview

Ethernet I/O modules must be properly configured. The modules are configured with IntraLink Toolbox and then downloaded. The configuration information is stored in non-volatile memory in the module's base. There are two ways to download the configuration information; directly via Ethernet or via an Ethernet I/O Setup module.

### Ethernet Download

An Ethernet I/O module can be downloaded by directly connecting the Ethernet I/O module to the Ethernet port on your PC. You must use a crossover cable when direct connecting. The module is configured via IntraLink Toolbox and then downloaded using Toolbox. See IntraLink Toolbox on-line Help for more details. Note that you may encounter difficulties when using the Ethernet download method to initially configure a module. If you cannot download the module using this method, use the RS232 Setup Module.

### RS232 Setup Module Download

The RS232 Setup Module (ILK-232-SETUP-R) is recommended to initially configure each Ethernet I/O module. To use the setup module, simply unplug the Ethernet module from its base and insert the setup module into the base.

**Note:** Ethernet and Remote I/O "smart bases" allow hot swap of live modules -- an exclusive feature that makes it permissible to configure Ethernet and Remote I/O modules in live systems.

The Ethernet I/O module configuration you created using the IntraLink Toolbox program will be written into permanent memory in the module's base. When the Ethernet module is reinserted into its base, the module will find and upload the configuration information, instantly configure itself and begin scanning I/O.

Once an Ethernet I/O module has been configured with an appropriate station address and IP address (Ethernet only), modified configuration data can be downloaded through the Ethernet port or RS485 port into the module base.

More information on the Remote I/O Setup Module can be found in the online help system of the IntraLink Toolbox.

### RS232 Wiring

Connect the setup module to your Windows PC using a standard null modem cable. Only the transmit (TD), receive (RD) and common return (GND) signals are actively used. The RS232 port on this configuration tool is electrically isolated to protect your computer in the event of field wiring errors. The setup module runs on the DC power connected to terminals 17 and 18 of the module base it is plugged into. No other connections are required. (I/O wiring can be left undisturbed.)

### RS232 Mode Selection

This module always communicates to the host PC at 9600 baud, with no parity and eight data bits. Be sure to select "Use Setup Module's Settings" as the communication device selection in the IntraLink Toolbox program.

### Ethernet LEDs

Every Ethernet I/O module has a number of LEDs. These LEDs can be useful for system diagnostics. These LEDs can be observed in the following states:

## I/O Module Status LED

**On, with a quick “OFF” BLINK** (1.9 seconds ON, .1 seconds OFF) - The module is configured and fully operational, but has not received a valid request from the host for a time longer than the specified time out period. A communication time out has occurred.

**Full ON** - The module is configured, fully operational, and has received communication from the host device before the timeout period expired. **This is the desired LED indication during system operation.**

**HALF BLINK** (1 second ON, 1 second OFF) - The module is not adequately configured and requires a download from the IntraLink Toolbox program.

**Full OFF** - There is no power to the module, or the status LED is being turned off intentionally by the IntraLink Toolbox program during the module loading operation.

**Off, with a quick “ON” BLINK** (1.9 seconds OFF, .1 seconds ON) - The module failed self-test at initialization. It will not attempt communication and should be replaced.

## Status LED Wink Feature

The “Status” LED of an I/O module can be intentionally winked (10 blinks/ second) by the IntraLink Toolbox program to visually identify the module when other modules are present.

## ACT / LNK LEDs

The activity (ACT) LED on an Ethernet I/O module will flicker anytime there is traffic on the Ethernet network, regardless of whom the network messages are intended for. The link (LNK) LED will be ON whenever a valid link to another Ethernet device is detected.

The best troubleshooting tools for Ethernet I/O modules are the Status, ACT, and LNK LEDs on each module. Each Ethernet Status LED indicates the health of the module and also the status of communication from the host device. Note that an Ethernet I/O module does not send a reply in response to a Wink command.

## Section 3

## Discrete I/O Modules

### ILK-DI8DO8 Overview

### ILK-DI8DO8-BE ILK-DI-16-BE

### 8 Discrete Inputs and 8 Discrete Outputs 16 Discrete Inputs

This module provides one terminal for each input or output channel. All inputs may be wired as sourcing or sinking. Outputs are wired in a sourcing (power switching) configuration only. An input count feature uses analog input registers to accumulate the positive transitions of each input. More information can be found in the on-line help in the IntraLink Toolbox program.

<b>Number of Channels</b>	<b>8 discrete inputs, 8 discrete outputs (ILK-DI8DO8 only)</b>
<b>Input Voltage Range</b>	<b>12/24 VDC/VAC</b>
<b>Input Current @ 24 VDC</b>	<b>6.7 mA</b>
<b>Output Voltage Range</b>	<b>10 – 30 VDC</b>
<b>Maximum Count Rate</b>	<b>100 Hz (6000 / minute) each input, plus selectable 2KHz (120,000 / minute) mode for input 1 only</b>

### Wiring and Jumpers

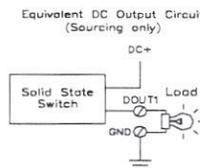
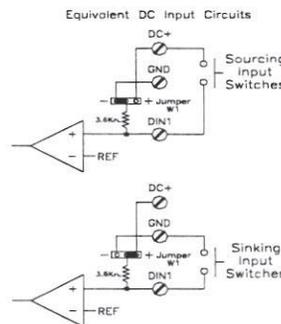
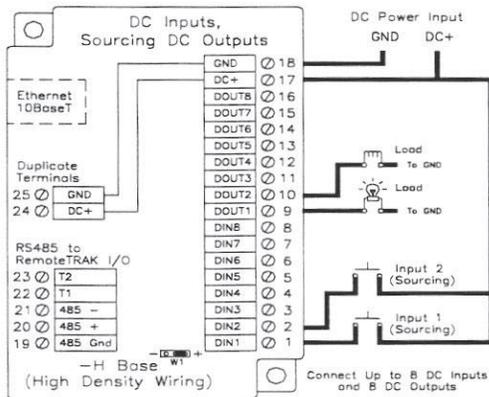
One wire from each sourcing field input should be bussed together and connected to terminal 17 (DC +). One wire from each sourcing field output and/or sinking field input should be bussed together and connected to terminal 18 (DC GND). Refer to the wiring diagram below. Set jumper W1 to match the wiring configuration of the inputs.

### TPO Feature

Time proportioned outputs pulse ON and OFF with a duty cycle proportional to an analog value stored in an analog output register. TPO outputs are a low cost way to get smooth proportional control of heaters and other process variables. Typically, TPO analog output registers are assigned to the output of PID or other control logic in an IsaGraf or other program. Use the IntraLink Toolbox software to set pulse cycling as fast as 10 mS or as slow (many minutes) as your system dynamics require. Each output may be configured as a TPO or ordinary discrete output.

### I/O Registers

<u>Function</u>	<u>IntraLink Open Registers</u>	<u>Modbus Registers</u>
Discrete Inputs	X0 – X7	10001 – 10008
Discrete Outputs	Y0 – Y7	00001 – 00008
TPO Values	AY0 – AY7	40001 – 40008
Counter Inputs	AX0 – AX7	30001 – 30008



## ILK-DI-16 Overview

## Wiring and Jumpers

## I/O Registers

# ILK-DI-16-BE

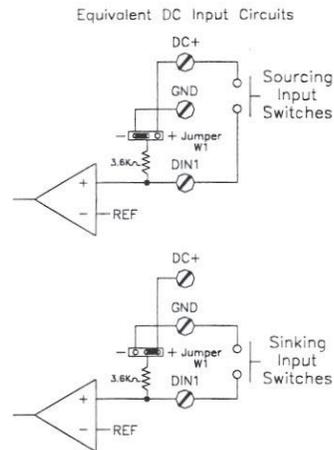
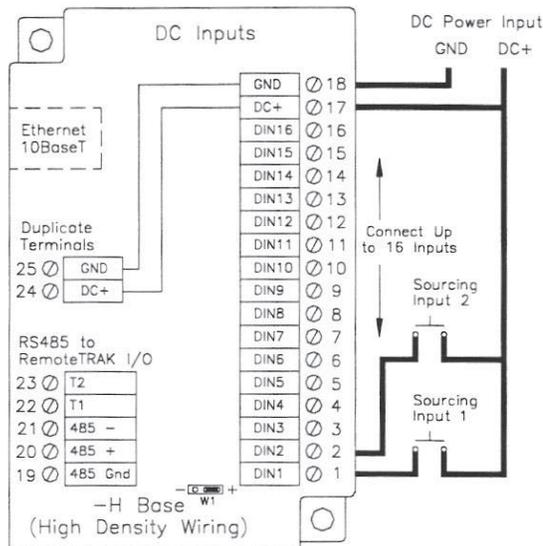
# High Density Discrete Input Module

This module provides sixteen input channels. Inputs may be wired as all sourcing or sinking. An input count feature uses analog input registers to accumulate the positive transitions of each input. More information on this and other features can be found in the on-line help supplied with the IntraLink Toolbox program.

<b>Number of Channels</b>	<b>16 discrete inputs (connected to a common source)</b>
<b>Input Voltage Range</b>	<b>12/24 VDC/VAC</b>
<b>Input Current @ 24 VDC</b>	<b>6.7 mA</b>

Positive DC or AC voltage must be applied to an input to indicate an ON condition. All channels are referenced to a common return or supply, which is connected to the negative side (ground) or positive side (DC+) of the DC power source. One wire from each sourcing field input should be bussed together and connected to terminal 17 (DC +). One wire from each sinking field input should be bussed together and connected to terminal 18 (DC GND). Refer to the wiring diagram below. Set jumper W1 to match the wiring configuration of the inputs.

Function	IntraLink Open Registers	Modbus Registers
Discrete Inputs	X0 – X15	10001 – 10016
Counter Inputs	AX0 – AX15	30001 – 30016



## Section 4

## Discrete Output Modules

### ILK-DO-16 Overview

### ILK-DO-16-BE

### High Density Discrete Output Module

Sixteen discrete output channels each provide up to 1 Amp DC to motor contactors, valves, and other loads. Inductive surge protection is provided. Each of the sixteen outputs may optionally be configured as Time Proportioned Outputs that pulse ON at a duty cycle proportional to an analog output register value. Typically these TPO outputs are controlled by a PID loop or other process algorithm in a control program. More information can be found in the on-line help supplied with the IntraLink Toolbox program.

<b>Number of Channels</b>	<b>16 discrete outputs connected to a common DC source</b>
<b>Output Voltage Range</b>	<b>10 - 30 VDC</b>
<b>Max. Load per Output</b>	<b>1 Amp</b>
<b>Max. Load per Module</b>	<b>8 Amps</b>
<b>Max. Inrush Current</b>	<b>5 Amps (for 100 mS)</b>

### Wiring

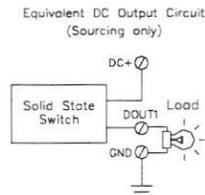
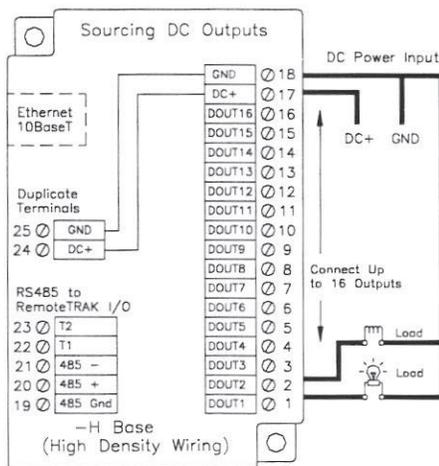
A single terminal is provided for each output channel. All outputs are powered from the DC power terminal. All channels are referenced to a common return, which is connected to the negative side (ground) of the DC power source.

### TPO Feature

Time proportioned outputs pulse ON and OFF with a duty cycle proportional to an analog value stored in an analog output register. TPO outputs are a low cost way to get smooth proportional control of heaters and other process variables. Typically, TPO analog output registers are assigned to the output of PID or other control logic in an ISaGRAF or other program. Use the IntraLink Toolbox software to set pulse cycling as fast as 10 mS or as slow (many minutes) as your system dynamics require. Each output may be configured as a TPO or ordinary discrete output.

### I/O Registers

<u>Function</u>	<u>IntraLink Open Registers</u>	<u>Modbus Registers</u>
Discrete Outputs	Y0 – Y15	00001 – 00016
TPO Values	AY0 – AY15	40001 – 40016



## Section 5

## Discrete / Analog Modules

### ILK-A18DI8 Overview

### ILK-A18D18-BE

### 8 Discrete Inputs and 8 4-20 mA Inputs

Eight 4-20 mA inputs provide 14 bit analog measurements. Discrete inputs may be wired as all sourcing or sinking. An input count feature uses analog input registers to accumulate the positive transitions of each input. More information on this and other features can be found in the on-line help supplied with the IntraLink Toolbox program.

<b>Number of Channels</b>	<b>8 analog inputs (14 bit resolution), 8 discrete inputs</b>
<b>Input Range</b>	<b>4 - 20 mA (analog), 12/24 VDC/VAC (discrete)</b>
<b>Analog Input Impedance</b>	<b>100 ohms</b> Note: input voltage drop = 2 volts at 20 mA
<b>Discrete Input Voltage Range</b>	<b>12/24 VDC/VAC</b>
<b>Input Current @ 24 VDC</b>	<b>6.7 mA</b>

### Wiring and Jumpers

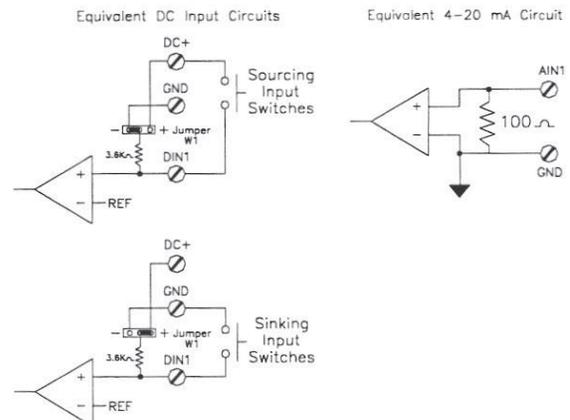
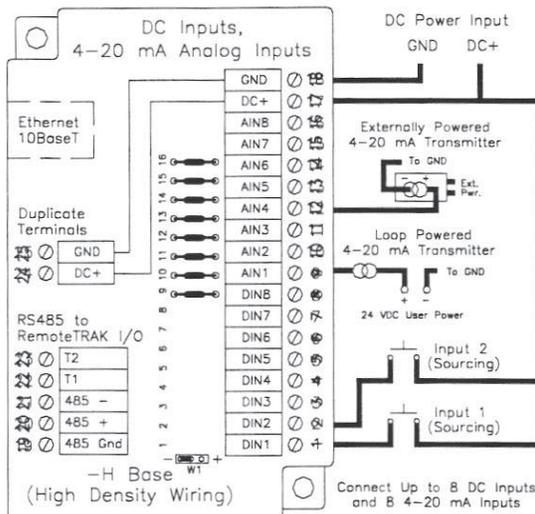
Positive DC or AC voltage must be applied to an input to indicate an ON condition. All channels are referenced to a common return or supply, which is connected to the negative side (ground) or positive side (DC+) of the DC power source. One wire from each sourcing field input should be bussed together and connected to terminal 17 (DC +). One wire from each sinking field input should be bussed together and connected to terminal 18 (DC GND). Refer to the wiring diagram below. Set jumper W1 to match the wiring configuration of the discrete inputs. A single input terminal is provided for each analog input channel. Care must be taken to externally provide a suitable instrumentation ground for these single ended input circuits.

### Current Shunts

Precision 100 ohm current shunts, beneath the hinged access door in the wiring base, pass current and maintain loop integrity even if the module is unplugged. A spare shunt is provided and may be simply inserted in place of any shunt that open circuits as a result of a current overload.

### I/O Registers

Function	IntraLink Open Registers	Modbus Registers
Analog Inputs	AX0 – AX7	30001 – 30008
Discrete Inputs	X0 – X7	10001 – 10008
Counter Inputs	AX8 – AX15	30009 – 30016



## Section 6

## Analog Input Modules

### ILK-AI-16 Overview

### Wiring

### Current Shunts

### I/O Registers

### ILK-AI-16-BE

### High Density 4-20 mA Analog Input Module

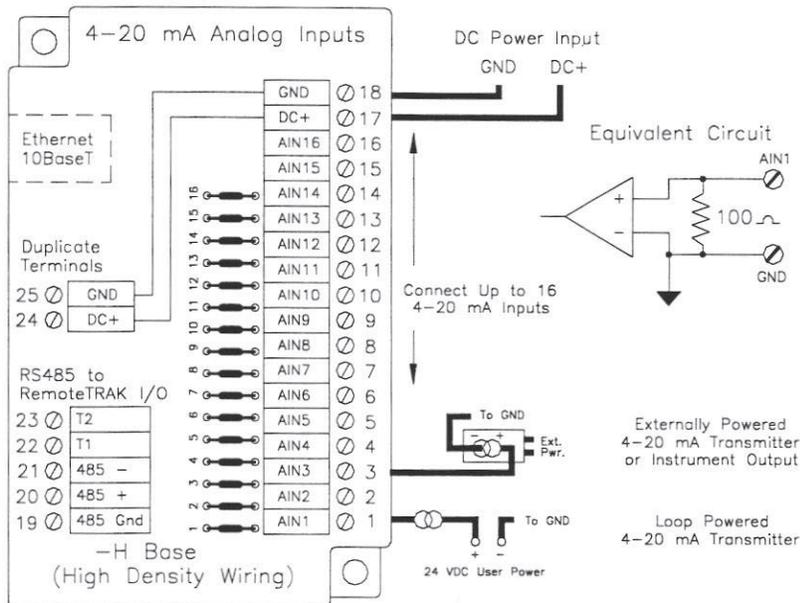
Sixteen 4-20 mA inputs provide 14 bit high resolution analog measurements. More information can be found in the on-line help supplied with the IntraLink Toolbox program.

**Number of Channels** 16 (14 bit resolution)  
**Input Range** 4 - 20 mA  
**Input Impedance** 100 ohms **Note:** input voltage drop = 2 volts at 20 mA

A single input terminal is provided for each measurement channel. Care must be taken to externally provide a suitable instrumentation ground for these single ended input circuits.

Precision 100 ohm current shunts, beneath the hinged access door in the wiring base, pass current and maintain loop integrity even if the module is unplugged. A spare shunt is provided and may be simply inserted in place of any shunt that open-circuits as a result of a current overload.

Function	IntraLink Open Registers	Modbus Registers
Analog Inputs	AX0 – AX15	30001 – 30016



# ILK-INS-08-BE

# Instrumentation Analog Input Module

## ILK-INS-08 Overview

Eight configurable inputs provide 16 bit high resolution analog measurements. More information can be found in the on-line help supplied with the IntraLink Toolbox program.

## ILK-INS-08 Wiring

Two input terminals are provided for each measurement channel. Channel to channel isolation is provided.

## 4-20 mA Input Jumpers

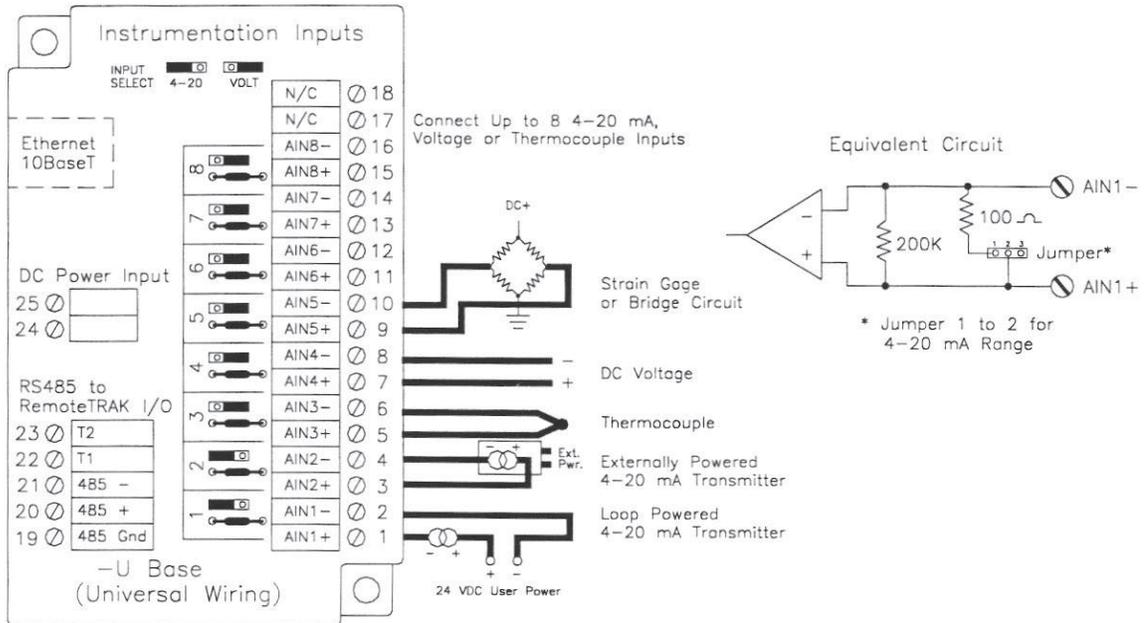
This module has a 4-20 mA input enable jumper for each channel. Set each jumper to match the desired input as shown in the diagram below. The jumper setting must match the range selection in the IntraLink Toolbox software.

## Current Shunts

Precision 100 ohm current shunts, beneath the hinged access door in the wiring base, pass current and maintain loop integrity even if the module is unplugged. A spare shunt is provided and may be simply inserted in place of any shunt that open-circuits as a result of a current overload.

## I/O Registers

Function	IntraLink Open Registers	Modbus Registers
Analog Inputs	AX0 – AX7	30001 – 30008



## Section 7 Analog I/O Module

### ILK-AI8AO4 Overview

### Wiring

### I/O Registers

## ILK-AI8AO4-BE

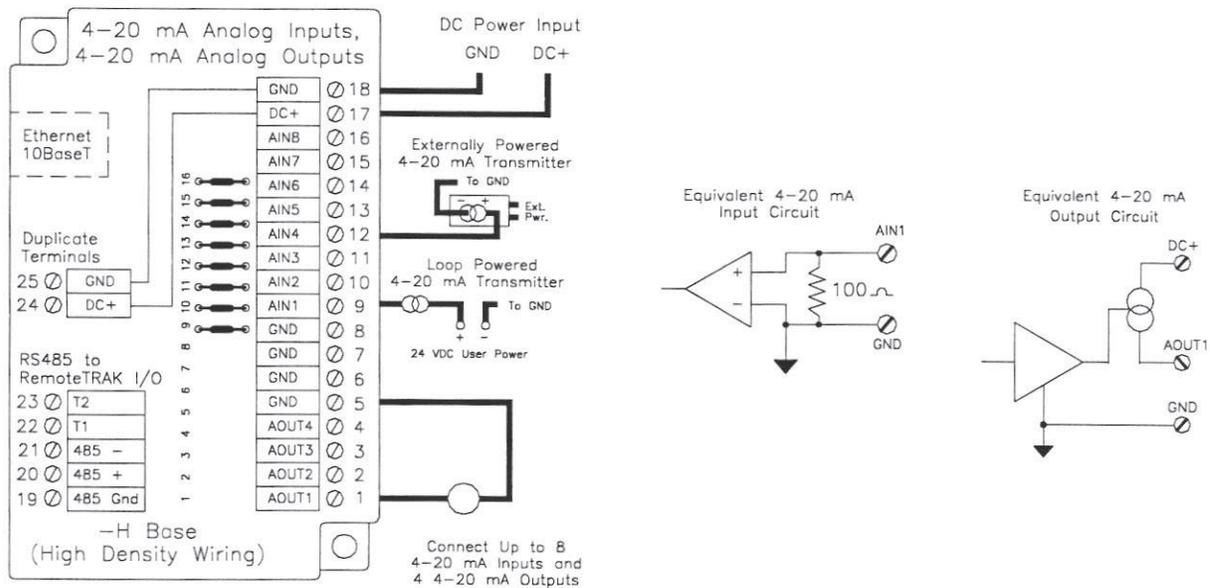
## Combined Analog Input and Output Module

This module combines eight 4-20 mA analog inputs and four 4-20 mA outputs. More information can be found in the on-line help supplied with the IntraLink Toolbox program.

<b>Number of Analog Inputs</b>	<b>8 (14 bit resolution)</b>
<b>Input Range</b>	<b>4 - 20 mA</b>
<b>Input Impedance</b>	<b>100 ohms</b> <b>Note:</b> input voltage drop = 2 volts at 20 mA
<b>Number of Analog Outputs</b>	<b>4 (16 bit resolution)</b>
<b>Output Range</b>	<b>4 - 20 mA</b>

A single input terminal is provided for each input and output channel. Care must be taken to externally provide a suitable instrumentation ground for these input and output circuits.

<u>Function</u>	<u>IntraLink Open Registers</u>	<u>Modbus Registers</u>
Analog Inputs	AX0 – AX7	30001 – 30008
Analog Outputs	AY0 – AY3	40001 – 40004



**Overview**

**ILK-8440-BR**

**RTU & Combination I/O Module**

This I/O module / RTU combines eight discrete inputs, four discrete outputs and 4 analog inputs. This module is different from the Ethernet I/O modules (xxx-BE part numbers) described in this manual because it features an RS232 port instead of an Ethernet port. The RS232 port is configured as a half-duplex modem port with an RTS line making it suitable for use with leased line modems (like the CMM202) as well as radios.

<b>Number of Discrete Inputs</b>	<b>8</b>
<b>Input Voltage Range</b>	<b>10- 30 Vdc</b>
<b>Number of Discrete Outputs</b>	<b>4</b>
<b>Max Load per Output</b>	<b>1 A</b>
<b>Max Inrush Current of Outputs</b>	<b>5 A (for 100 ms)</b>
<b>Number of Analog Inputs</b>	<b>4 (16 bit resolution)</b>
<b>Input Range</b>	<b>4 - 20 mA (Inputs 1-3)</b>
	<b>0 – 5 Vdc (Input 4)</b>
	<b>Inputs have an internal, self resetting fuse protection</b>

**Discrete Inputs**

The eight discrete inputs of this module are jumper selectable to be sourcing (ON when positive voltage is applied) or sinking (ON when contact closes to ground). The selection jumper is located in the modules base and is easily accessible by unplugging the logic module and opening the hinged door. You must set this jumper to match the way the inputs are wired.

**Discrete Input Counter Features**

The eight discrete inputs can be configured as counters with a flexible choice of modes. The counters report their values in corresponding 16 bit analog input registers. The first two inputs may be configured as high speed (10 KHz) counters. All of the discrete inputs may be configured as count-up, run-time (time the input is true) in seconds, run-time in minutes and other pulse accumulation modes. See IntraLink Toolbox help for more details on these modes. These counters initialize to zero each time power is cycled and they cannot be reset under software control.

**Discrete Outputs**

The four discrete outputs can source 10-30 Vdc to each load. All of the outputs return to a common ground.

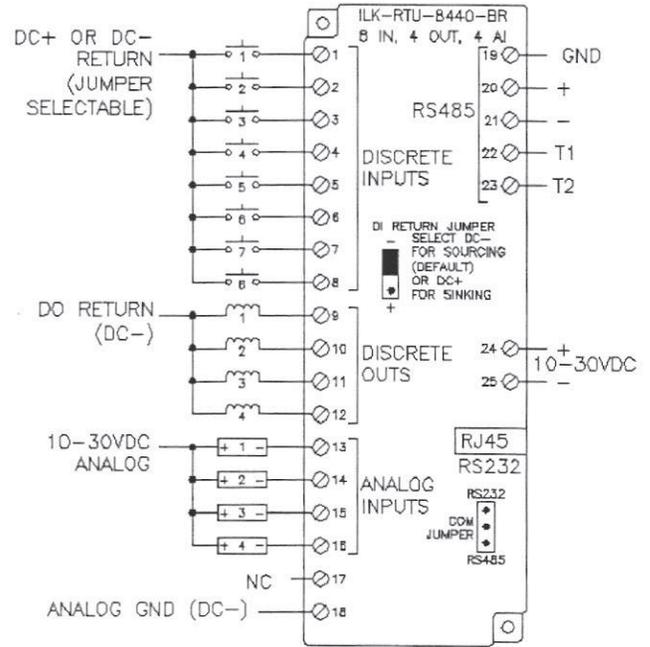
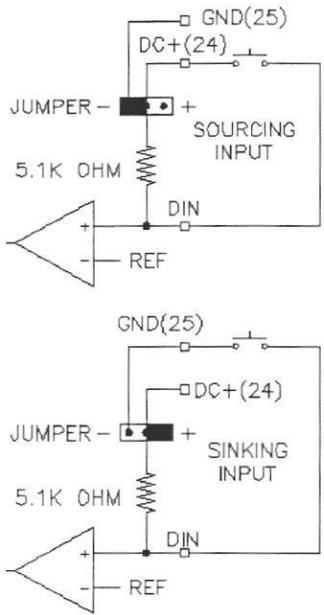
**Analog Inputs**

Analog inputs 1-3 accept a 4-20 mA signal from field devices. Analog input 4 was designed to read a 0-5 volt signal, in order to directly read A1000 submersible level sensor signals. All inputs are signal ended, returning to a common ground (terminal 18). An appropriate excitation voltage must be provided for the analog inputs. Inputs 1-3 have a 100 ohm precision shunt across the input. Input 4 has a 100k ohm shunt. All inputs are protected from excessive voltage by a self-resetting fuse. Inputs are reported as an un-scaled value from 0 – 32767. Refer to IntraLink Toolbox help for more information on calibrating and scaling analog inputs.

**I/O Registers**

<u>Function</u>	<u>IntraLink Open Registers</u>	<u>Modbus Registers</u>
Discrete Inputs	X0 – X7	10001 – 10008
Discrete Outputs	Y0 – Y3	00001 – 00004
Counter Inputs	AX0 – AX7	30001 – 30008 (Unsigned values 0 –65,535)
Analog Inputs	AX8 – AX11	30009 – 30012

EQUIVALENT DC INPUT CIRCUITS



**Serial Port Connections**

The RTU I/O Module has one communication port that is jumper selectable between an RS232 interface and an RS485 interface. The RS232/RS485 jumper is located behind the access door in the module base. The door is accessed by unplugging the logic module from the base. The RS232 interface is made through the RJ45 connector on the topside of the base. Signals supported include RX, TX, RTS and GND. Communication is half-duplex. The RS485 connections are made on terminals 19 through 23 on the base. The default baud rate for the serial port is 9600 baud, 8 data bits, 1 stop bit, and no parity. The serial port is used to download the setup parameters to the module. See IntraLink Toolbox help for more information.

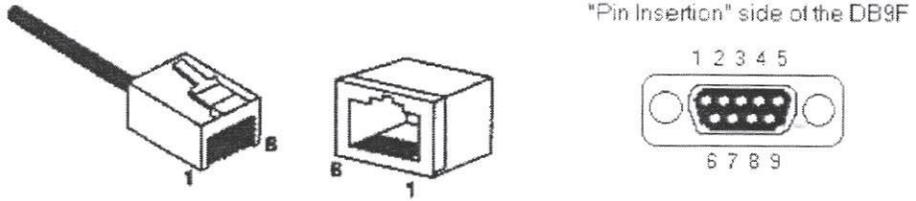
**RS232 Port Interface**

A female RJ45 connector on the base of the module provides the RS232 interface. The pin-outs follow the EIA/TIA-561 standard. See figure below. Use DB9 adaptor and a Ethernet straight thru patch cable to connect the RTU I/O module to your PC or other communications equipment.

RJ45 to DB9F Adapter pinout (Typical PC Adapter)

<u>LC3000 RJ45F</u>	<u>ADAPTER WIRE COLOR</u>	<u>DB9F</u>
Pin 1: NA	Blue	Pin 4: DTR (out)
Pin 2: NA	Orange	N/C
Pin 3: NA	Black	Pin 6: DSR (in)
Pin 4: GND	Red	Pin 5: GND
Pin 5: RXD (in)	Green	Pin 3: TXD (out)
Pin 6: TXD (out)	Yellow	Pin 2: RXD (in)
Pin 7: NA	Brown	Pin 7: RTS (out)
Pin 8: RTS (out)	White	Pin 8: CTS (in)

**RJ45 & DB9  
connector pinouts**



**RS485 Port Interface**

RS485 connections are made to screw terminals on the base assembly. These terminations provide a RS485 (2-wire, half duplex only) connection to an LC2000/3000 controller, other Ethernet I/O modules, or other equipment. Four terminals (signal ground, RS485+, RS485-, termination) are provided. Generally you connect + to + and - to -. Since there is no standard designation for RS485 terminals, this may vary when connecting to other manufacturers equipment. It is highly recommended that the signal ground be tied to an appropriate ground between all RS485 units. Use good quality cable with three conductors (twisted) plus a shield. Connect the shield to chassis ground on only one end of any cable run.

RS485 Termination: The RTU I/O module has termination components (150 ohm resistor, 0.1  $\mu$ F capacitor connected in series) already inside. To terminate an RS485 network connect the T terminal to the RS485 - terminal using the same type and size of wire already being used for the - connection. It is recommended that only two stations (one at the beginning of the network and one at the end of the network) be terminated.

## Section 9 Product Support

### Product Support

To obtain technical support or service for **Siemens Water Technologies, Control System** products, contact your local representative. For factory support call **Control Systems** and ask for Technical Support. Our phone numbers are:

+1 800-224-9474  
+1 (651)-766-2700 (local)  
+1 (651)-766-2754 ( Fax)

E-mail: [controlsystemssupport.water@siemens.com](mailto:controlsystemssupport.water@siemens.com)

Our mailing address:

**Siemens Water Technologies**  
**Control Systems**  
1239 Willow Lake Blvd  
Vadnais Heights, MN 55110

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**CONTROL SYSTEMS**

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 www.siemens.com/water

The ILK-OI3000 is an LCD display and keypad assembly providing an operator interface for the LC3000 controller. The 128x64 pixel backlit display, using text and graphics, shows process and alarm information to the operator and allows setpoint entry. Data and power are carried by a standard RJ-11 phone cable between the OI3000 and a dedicated port on the LC3000/LC2000. The display is tightly integrated with the LC3000/2000 controller for automatic access to system and tag data, and it is configured with IntraLink Toolbox to show job-specific process and alarm data

Part Number	Description	Application	Notes
ILK-OI3000	128x64 pixel LCD backlit display and keypad assembly for LC3000	provides operator interface for LC3000/2000	

## Specifications

### Environmental

Temperature Range  
 Storage: -20 to 70 C (-4 to 158 degrees F)  
 Operation: 0 to 50 C (32 to 122 degrees F)

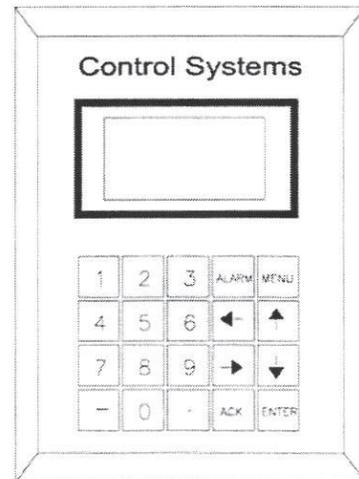
Properly installed, with a foam gasket between the mounting bezel and the panel, the OI3000 is rated NEMA 4.

### Physical

Dimensions: Panel cutout 4.75 x 6.00 in.  
 Front bezel 5.88 x 8.125 in.  
 Case depth 2.00 in.  
 Mounting: mounting clamps supplied

### Electrical

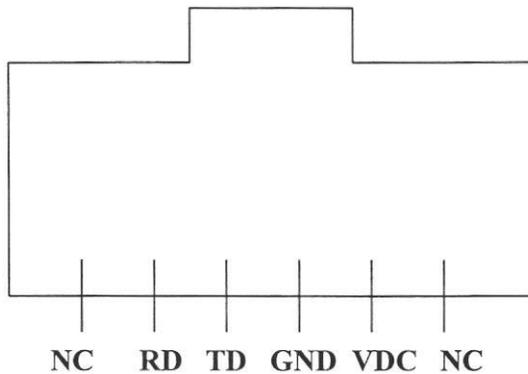
Power Requirements: 10 to 30 VDC



**Terminal Description and Normal Operation**

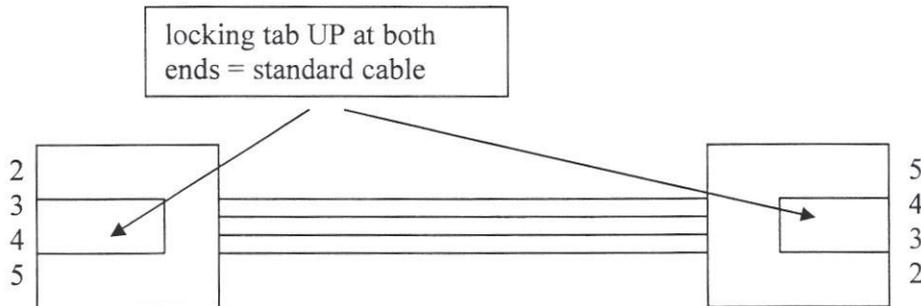
**Cable pinout**

Looking into RJ-11 connector socket on OI3000:



*RJ-11 pinout on OI3000*

The cable that runs between the OI3000 and the LC3000 is a straight-through standard IDC modular cable assembly, with no signals crossed inside the cable.



*Straight-through cable*

USFilter P/N = "LC3000 Reverse Style Adapter"

Conforming commercial cables:

Digi-Key Straight Cable Assembly P/N H1641-07-ND

Radio Shack Modular Line Cord P/N 279-339

**Normal Behavior at Power Up**

At power up, the OI3000 display should beep twice, clear the screen, turn the backlight on, and then display the Control Systems banner. The banner remains in place for approximately half a minute while the LC3000/2000 progresses through its bootup sequence. Then the LC3000/2000 should send commands to paint a default display on the OI3000. The default display is the topmost screen in the list of Process screens configured by the project engineer, often a graphic tank or well level.

Pressing a key on the OI3000 should produce a momentary flash (indicating receipt of a serial character) on the RD line of the Display port on the LC3000.

**Calibration/Testing Procedures****LCD Contrast Adjustment**

On the right-hand side of the case as viewed from in back there is an LCD contrast adjustment that can be made with a small screwdriver. LCD contrast is set at the factory and should require no further adjustment.

**Version Numbers**

The version number for the software running the microprocessor onboard the OI3000 is found by holding down the MENU key at power up. The version number will be displayed for several seconds before the display reverts to normal behavior.

The version number for the software creating display screens on the OI3000 from the LC3000/2000 controller is shown on the Config screen, reachable through the System submenu.

**User's Manual**

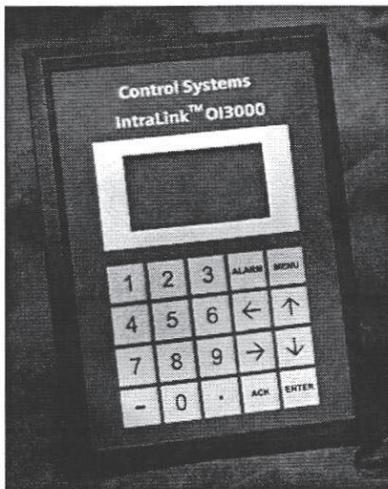
The [OI3000 Operation & Maintenance Manual](#) describes OI3000 operation in detail.

**PUBLICATION DIVIDER**

# SIEMENS

Water Technologies

## OI3000 Operator Interface Operation and Maintenance Manual



### Contents at a Glance:

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Section 4	Hardware and Technical Specifications	20
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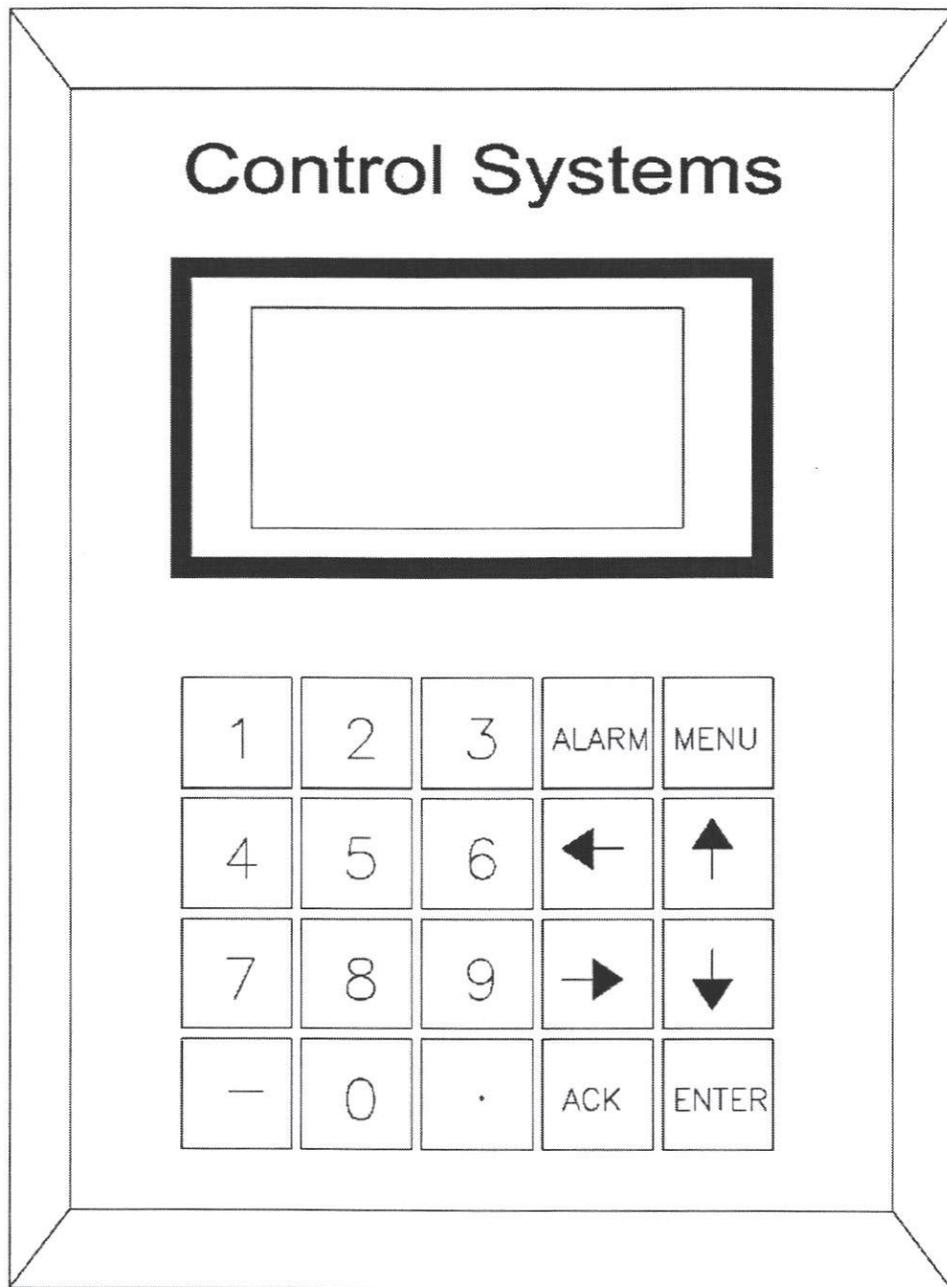
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+1 (651) 766-2700 • FAX +1 (651) 766 2701

## ***STATEMENT OF LIMITED WARRANTY***

The limited warranty applicable to the OI3000 is set forth in Siemens Water Technologies standard terms of sale that are made applicable to the purchase of these products.

**Note:** All information in this document applies to the **OI3000**, except where otherwise noted. Refer to the IntraLink Toolbox software online help system for details on configuration settings.

Last Revision: December 2008



*Figure 1 OI3000 operator interface and keypad assembly*

## **Section 1 Quick Start**

This section of the manual is designed to give the operator directions for accomplishing typical tasks presented by the operator interface, without having to read the whole document. Topic headings below are first tasks an operator is likely to face.

### **ACKing Alarms**

Press the ACK key or the ALARM key to take a shortcut to the Alarm List. Once there, press the ACK key to acknowledge alarms. As each alarm is acknowledged, the cursor jumps ahead to the next unacknowledged alarm. If the next unacknowledged alarm is not on the current screen, the screens advance automatically to find the next unacknowledged alarm and place the cursor on it.

Acknowledge all alarms by repeated ACK key presses. When there are no more unacknowledged alarms, the cursor disappears, the alarm warning message stops flashing and the built-in audible alarm stops beeping.

### **Viewing Alarms and Events**

Press the ALARM key to take a shortcut to the Alarm List. Use the Up Arrow and Down Arrow keys to navigate through the Alarm List. Items are on the alarm list because the alarm condition is true or the alarm is unacknowledged or both. The alarm list must be displayed before alarms can be acknowledged.

The Event List is a history of alarms and events. There is little or no urgency associated with the Event List. It is a means to review system behavior and reconstruct the chronology of alarms and events.

To get to the Event List from the Alarm List, press the MENU key once to move up one level to the Alarms submenu. The cursor will be on Alarms. Press the Down Arrow key to move the cursor to Events. Then press the ENTER key to go to the Event List. Use the Up Arrow and Down Arrow keys to navigate through the Event List.

Alarms and events are presented in reverse chronological order, with the most recent alarm or event shown first. The alarms and events appear with up to three on a screen. Press the Down Arrow key to advance the display to the next set of alarms and events.

### **Logging In**

At the Main Menu, look for Login at the bottom of Main Menu items. If no Login item is shown on Main Menu, then security for the system has been disabled. There is no need to log in.

If Login is showing, use the Down Arrow key to move the cursor to Login. Press the ENTER key to go to the Login Screen. Assuming the operator has not already logged in, he will be prompted to enter a login code. Key in a 4-digit login code and press the ENTER key.

The default login code for level 1 is 1111. The default for level 2 is 2222 and the default for level 3 is 3333.

Logging in at level 1 prevents the intrusion program block from considering the operator an intruder. Logging in at level 2 allows changing setpoints. Level 3 allows changing passwords, setting time, clearing the alarm and event lists and changing the alarm configuration.

### **Changing Setpoints**

Setpoint screens are the major place to view/change setpoints and some Process screens may also show the important setpoints or those who need to be changed frequently. To access the Setpoint screen or Process screen, go to main menu by pressing the MENU key and select the corresponding sub-menu by pressing the Up/Down Arrow and ENTER key. Press the Up Arrow or Down Arrow keys to move through the list of Setpoint/Process screens after entering the screen group.

Floating point values, analog (integer) values and discrete values all may be settable.

If a screen has one or more setpoints on it and the operator has logged in at level 2 or higher, then the cursor will appear on the topmost setpoint. The cursor may be moved from one setpoint to the next using the Left Arrow key or the Right Arrow key.

To set floats and analogs, key in the new value and press the ENTER key. The new value takes effect. If a mistake is made while keying in the new number or to leave the old value intact after an entry is started, press the MENU key to abort the number entry process and return the screen to its former state. Nothing is final until the ENTER key is pressed.

To set discrete values, just press the ENTER key to toggle the value. If a discrete value is off, pressing ENTER turns it on. If a discrete value is on, pressing ENTER turns it off. The On and Off text messages for the discrete are configured in the LC3000 Advanced Utilities.

### **Setting HOA's and other Switches**

Process/Setpoint screens may include HOA (Hand-Off-Auto) screens and other types of switch screens.

The first Process screen is found by pressing the MENU key repeatedly, until the first Process screen alternates with Main Menu. Press the Up Arrow or Down Arrow keys to move through the list of Process screens.

An HOA screen is intended as the software equivalent of a three-position switch knob.

On an HOA screen or any other type of switch screen, the text with the cursor on it shows the current position of the switch. If the operator is logged in at level 2 or higher, he can manipulate the position of the switch knob with the Right Arrow and Left Arrow keys, then he can press the ENTER key to set a new switch position. The cursor will move to the new set position.

A new switch position is not set until the ENTER key is pressed, so the operator may move the switch knob any which way without consequence using the Left Arrow or Right Arrow keys -- until the ENTER key is pressed.

### **Viewing Trends**

The trend data displayed by the OI3000 may be shifted backward in time by pressing the left arrow key, shifting the display two samples per key press. To go backwards quickly, one half screen per key hit, press the "6" key, just to the left of the Left Arrow. The OI3000 beeps when there is no older data available.

Pressing Right Arrow shifts trend data forward in time, two samples per key press. Pressing the "9" key shifts the data forward one half screen per key press. The OI3000 beeps when there is no newer data available.

Note: If there are setpoints on a trending screen, left/right arrow keys are used to switch among setpoints, not to shift trend time setting.

### **Silencing the Audible alarm**

Acknowledging all alarms silences the audible alarm.

### **Getting Back to the Beginning**

At any time, the operator may return to the default (first) Process screen by pressing the MENU key repeatedly. The deepest menu structure is three levels deep, so no more than three MENU key presses are required to return the display to the default Process screen.

Once the display is showing its default Process screen, continued MENU key presses will toggle the display back and forth between Main Menu and the default Process screen.

## Section 2 Display Operation

### Overview

The OI3000 is 128 x 64 pixels, backlit, graphical display coupled with a 20-key keypad. The OI3000 operator interface is usually mounted on the inner door of the electrical enclosure or in some other accessible location. It is connected by serial cable to a dedicated port on the LC3000 controller or to Port D on the LC2000. The operator interface is a window into the operation of the controller and the state of the controlled process. Through the operator interface, an operator can view process data, change setpoints, view and acknowledge alarms, view alarm history and view historical trends.

The OI3000 operator interface is configured using the Advanced Utilities of the IntraLink Toolbox software package. Please refer to the LC3000 Users Manual and Advanced Utilities On-line Help for more details.

### Key functions

#### Screen navigation keys

The operator interface is organized as a tree hierarchy of menus and lists. Main Menu is at the top of the hierarchy. Menu picks move the operator down a chosen path or branch to the end. At the end of any given menu path there is a list. It may be a one-screen list or a multi-screen list.

The MENU key moves the operator up on the menu hierarchy and the ENTER key moves him down. On a menu or sub-menu screen, the Up Arrow and Down Arrow keys move the cursor from one menu item to the next.

When the operator arrives at a list, the Up Arrow and Down Arrow keys show new screens in the list. Lists are arranged like a ring, so if the operator keeps pressing the Down Arrow key to see the next screen in a list, he will go through all of them, roll over to the first screen, and keep on going.

The up Arrow key can be a handy shortcut to the last or second-to-last screen on a list.

Once the operator is on a list screen, the Left Arrow and Right Arrow keys are used to move the cursor from one item to the next on that screen.

## Menu hierarchy illustrated

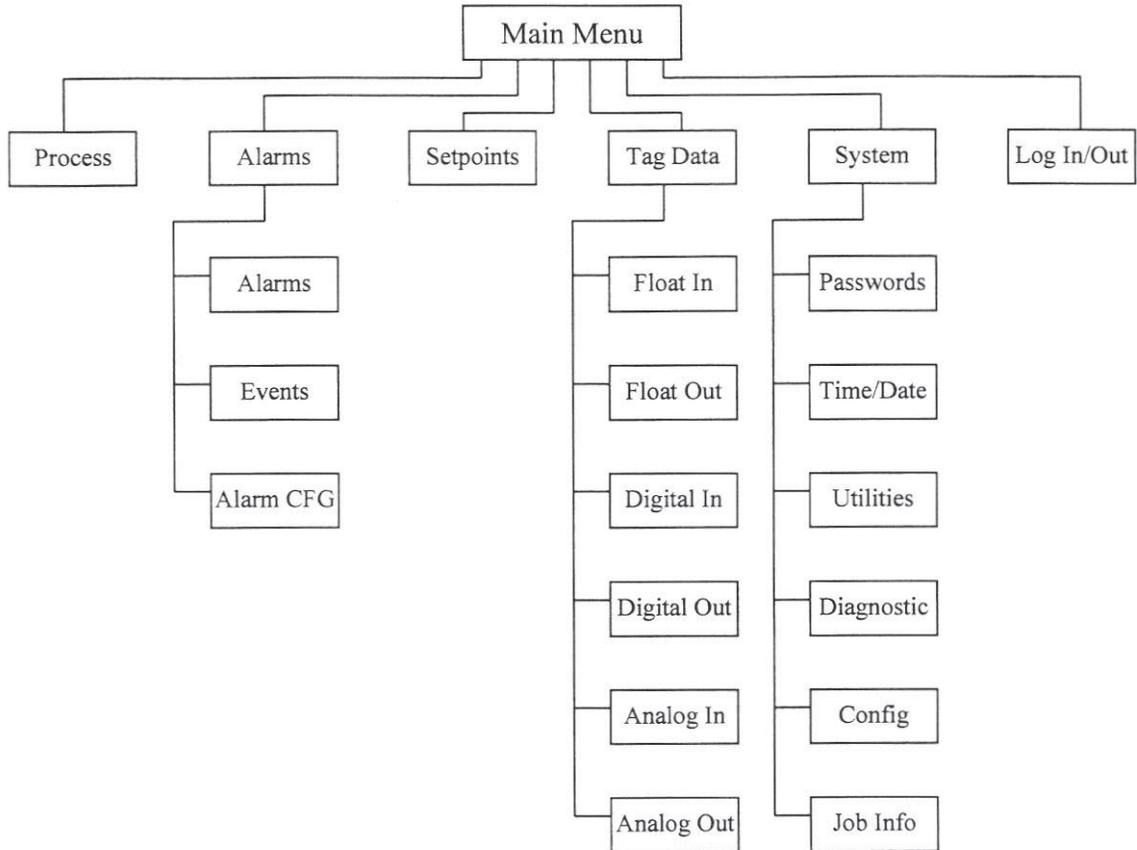


Figure 2 Menu hierarchy with lists at the end of every menu branch.

### ALARM and ACK keys

Both the ALARM key and the ACK key provide a shortcut to the Alarm List. No matter where the operator is on the display, even if he is in the midst of entering a number on some other screen, pressing the ALARM key or the ACK key brings him immediately to the Alarm List.

If there are no alarms, then pressing the ALARM key or the ACK key brings the operator to the Alarms sub-menu.

### Numeric entry keys

The twelve keys on the left-hand side of the keypad are for numeric entry. They become active when the display is in a state where numeric entry is possible.

If, for example, the display is showing a Process screen with setpoints on it and the operator is logged in at level 2 or higher, then there is a cursor at the topmost setpoint. When a number has the cursor on it, the number is settable. Numeric entry is possible.

The operator does not have to enter a number. But if he presses any numeric entry key, the display pops up a special screen to accept the number. Pressing the MENU key aborts the entry. Pressing the ENTER key finalizes the entry and writes the new value for the setpoint to the controller. There is no range checking so care needs to be taken to enter valid setpoints.

## **Configured Screens**

### **Process Screens & Setpoints Screens**

Process screens display process information with text and graphics. The first Process screen, intended to show the most important data for the process supervised by the controller, is the default display for the OI3000. It is shown when the controller and display are powered up. It is shown when the display times out after ten minutes without any keypad activity.

Setpoints screens provide a place to view/change setpoints.

Process & Setpoints screens are created using the Advanced Utilities part of the IntraLink Toolbox software. Some OI3000 display screens are created automatically, but all Process & Setpoints screens are created uniquely and are peculiar to the individual site and job.

Process/Setpoints screens are a list. The operator moves from one Process/Setpoints screen to the next using the Up Arrow and Down Arrow keys. There is no hierarchy within Process/Setpoints screens or organization by topic or function. There is only one list of Process/Setpoints screens.

When a Process/Setpoints screen has one or more settable values and the operator is logged in at level 2 or higher, then there will be a cursor on the topmost settable value. The cursor may be moved to the next settable value on the screen, if there is one, by pressing the Left Arrow or Right Arrow keys. When the cursor has reached the last settable value on a screen, it wraps around and starts again.

The Left Arrow and Right Arrow keys do not advance screens, they move the cursor around on a single given screen. The Up Arrow and Down Arrow keys change screens.

### **Alarm Screens**

If alarm points have been configured and if there are active alarms, then there will be one or more alarm screens showing the alarms in reverse chronological order, with the most recent alarms shown first.

Alarm screens are a list. So the Up Arrow and Down Arrow keys are used to move from one alarm screen to the next.

There are three alarm records shown per screen. The On Message or Off Message for the alarm is shown on the top line. The left-hand part of the second line shows the date and time associated with the displayed message. The right-hand field of the second line shows the ack status of the alarm.

For example, if the tag PUMP1\_HITEMP is configured as an alarm point, with Pump1 High Temp as the On Message and Pump 1 Temp Normal as the Off Message, then the alarm screen will show "Pump 1 High Temp" if the tag goes true, along with the time the tag went true. The alarm screen will show "Pump 1 Temp Normal" if the tag goes false, along with the time the tag went false. The right-hand field of the second line will show whether or not the alarm has been acknowledged.

For auto reset alarms, the ack status may be "UNACKD" or "ACKD." For manual reset alarms, ack status may be "UNACKD" or "ACKD" or "RSTREQ."

There are various outputs associated with alarms. There is more about alarm operation in Section 3 of this manual.

### **Event Screens**

Even if no alarms or events have been configured, there will be at least one item on the event list, and hence there will always be at least one event screen.

When the controller is powered up, the alarming application automatically records startup as an event. It also automatically records login and logout.

Changes in the status of alarm points are automatically recorded as events. For example, when an alarm input tag goes true, when it goes false, and when the alarm is acknowledged -- each of these occurrences changes the status of an alarm point. The alarm list is updated accordingly, and the occurrence is also recorded as an event. There is more about alarms and events in Section 3 of this manual.

### **Default Screens**

Default screens appear on the display whether or not screens have been configured using the Advanced Utilities in IntraLink Toolbox. Default screens are hard-coded into the display. They are produced automatically.

### **Tagdata Screens**

From Main Menu, use the Down Arrow key to get to the Tagdata selection, then press the ENTER key to go to the Tagdata submenu. The six Tagdata types are shown, along with the quantity of each type in the tag database.

Since the Tagdata submenu is a type of menu, the Up Arrow and Down Arrow keys are used to move the cursor to the next Tagdata type. Press the ENTER key to look at the chosen Tagdata list.

There are four Tagdata items on each screen. For each entry, the first line shows the tag name and the second line shows its value.

The tagdata lists are intended as a window into the raw data of the control system, making them a powerful troubleshooting tool. At any time, an operator may go to the tagdata lists and check the value held in a tag.

Tagdata screens are dynamically updated. If a value changes while the display is showing that particular value, the new value is written to the screen.

For Float In and Float Out tagdata lists, the number format is fixed at 6 places to the left of the decimal point and one place to the right. Digital In and Digital Out values are shown as 1's or 0's. Analog In and Analog Out are shown as integers.

For each data type, the data are shown in the same order as they are listed in the IO tag database file in the LC3000. No attempt is made to organize data by function or otherwise. Tagdata screens mirror the data in the tag database file.

### **System Screens**

From Main Menu, use the Down Arrow key to get to the System selection, then use the ENTER key to go to the System submenu.

#### **Passwords**

When the operator first arrives at the System submenu, the cursor is at Passwords. If he has logged in at level 1 or level 2, pressing the ENTER key does nothing. If the operator has logged in at level 3, then pressing the ENTER key produces the Passwords setting screen, a one-screen list.

The operator can use Left Arrow and Right Arrow keys to shift the cursor from one password level to the next. The display is ready to accept numeric input. To set a password, the operator keys in a 4-digit code and presses the ENTER key.

If all three passwords are "0000," then security is disabled. No login is required to change setpoints or change passwords or set time or erase alarm and event lists or change the alarm configuration. The system behaves the same as it would if security was enabled and the operator had logged in at level 3.

#### **Time/Date**

Arrow down once from Passwords, then press the ENTER key to get to the Time/Date screen, a one-screen list. If the operator has logged in at level 3, then there is a cursor on the Time/Date screen, meaning time may be set.

The cursor moves between hours, minutes, AM/PM, month, day of the month, year and time zone. Values at the cursor are adjusted using Up Arrow and Down Arrow keys.

The Time/Date screen is the only screen where the Up Arrow and Down Arrow keys are used to adjust values. On all other screens, any new value is keyed in using the 12 numeric entry keys on the left-hand side of the keypad.

Each field on the Time/Date screen has to be manipulated as necessary. If, for example, the display says 11:35 AM and the operator wants to set the clock ahead one hour, he would position the cursor over the "11" in "11:35" and press the Up Arrow key. Then he would move the cursor over to "AM" and press either the Up Arrow or Down Arrow keys to toggle

the value to "PM." Finally, he would press the ENTER key to write the new value to the system clock and to the battery-backed hardware clock.

The time zone field shows the local time offset relative to Universal Time, formerly called Greenwich Mean Time. For the four time zones in the continental United States, the regional names are given in parentheses after the numeric value.

The clock is not automatically updated for daylight savings time. This update must be done manually using the procedure described above.

### **Utilities**

The Utilities screen is a one-screen list. When it first appears, the cursor is resting on the status field for the audible alarm. No login is required to disable the audible alarm. Pressing the ENTER key toggles the audible alarm enable or disable status.

If the operator has logged in at level 3, then two more items appear on the Utilities screen underneath the audible alarm line. The operator has the option to clear the Alarm Record and to clear the Event Record.

The cursor may be moved from one location to the next by pressing the Left Arrow and Right Arrow keys. If the cursor is at CLEAR for Alarm Records or Event Records, then pressing the ENTER key clears the respective record. The text underneath the cursor does not change.

Clearing the alarm record should be reserved for times of startup of field devices or when known problems with field devices are creating cycling alarms. In normal operation, the alarm record should clear itself as alarm conditions are corrected and alarms are acknowledged. It is best to let the alarm record clear itself by this normal method.

The event record can become quite lengthy. The system can store up to 1000 events. After that, as new events occur, the oldest events are discarded to make room for the newest ones.

### **Diagnostics**

With the cursor resting on Diagnostics on the System submenu, the operator presses the ENTER key to see the contents of the /usr/local/bin directory in the Linux file system in the LC3000/2000. Missing files are a very likely source of trouble, especially at startup. The Diagnostics screen affords the opportunity to check for missing files in /usr/local/bin.

Required files include the following:

_tags_.6tg	IO tag database file
[station name].cfg	screen and alarm configuration file
timeZone.txt	time zone value
usfMakepipes1	communication between display and alarming
usfMakepipes2	communication between display and alarming
usfMonitor	small application for monitoring power
usfAlarm	alarming application

usfDisplay

display application

No matter what the operator's login level, there is never a cursor on the diagnostics screen. There is nothing to change, only information to view.

### **Config**

The Config screen, a one-screen list, shows the IP address of the LC3000/2000, its serial number, the version number of the display software, and the version number of the LC3000/2000 firmware. The IP address and serial number of the LC3000/2000 are needed when establishing communication between the LC3000/2000 and a computer running IntraLink Toolbox.

There is never a cursor on the Config screen. There is nothing to change, only information to view.

### **Job Info**

The Job Info screen, a one-screen list, shows the job name, the shop order number and the station name. The first two items are entered using the LC3000 Advanced Utilities in IntraLink Toolbox. The station name is found automatically by the display software and is an important system parameter.

In a system with more than one RTU, the station name distinguishes one particular RTU and its local data from the other RTUs in the system. The display software goes to /usr/local/bin and finds its station name by examining the \_tags\_.6tg file. Then, having found its station name, the software looks for a file with that exact station name and a .cfg extension in order to read in its display and alarm configurations.

For example, if the Job Info screen shows the station name as KNOB\_HILL\_LS1, then it is worthwhile to verify the presence in the /usr/local/bin directory of a KNOB\_HILL\_LS1.cfg file.

There is never a cursor on the Job Info screen. There is nothing to change, only information to view.

### **Login Screen**

Login is the last of the Main Menu items. If no Login item is shown on Main Menu, then security for the system has been disabled. All three passwords have been set to "0000." There is no need to log in.

If Login is showing, then one or more of the passwords has been set to a non-zero value. Security is enabled. Pressing the ENTER key with the cursor on the Login menu item brings up the Login page, a one-screen list.

Assuming the operator has not already logged in, he will be prompted to enter a login code. The operator should key in a 4-digit login code and press the ENTER key. When in doubt, try the

defaults. The default code for level 1 is 1111. The default for level 2 is 2222 and the default for level 3 is 3333.

Logging in at level 1 prevents the intrusion program block from considering the operator an intruder. Logging in at level 2 prevents the intrusion program block from considering the operator an intruder and it allows the operator to change setpoints. On Process screens with settable values, an operator logged in at level 2 sees the cursor on settable values.

In addition to retaining the privileges of level 1 and level 2, level 3 authorizes the operator to view and change passwords, set the time, clear alarm and event logs and change the alarm configuration.

If Login is showing on Main Menu and the operator presses the ENTER key but he is already logged in, then he is presented with the Logout screen, another one-screen list. The choices are shown on the screen. The operator may log out, log in again or go back to the Main Menu.

### **Implied Decimals**

If an analog (integer) value displays not as a whole number but as a float, with places to the right of the decimal point, it is not an error. The value has been configured for an implied decimal in the LC3000 Advanced Utilities.

For example, if an analog value is 1234 but the analog screen element has been configured for 2 places to the right of the decimal, then "12.34" will be displayed on the operator interface. If the value has been configured to be settable and the operator keys in "13.56," then the code multiplies the keyed-in value by 100 and writes 1356 to the tag database. If the operator browses to see the value in the Tagdata list -- it would be an analog in or an analog out -- he will see the actual value of 1234 or 1356. The decimal is shifted only for display.

From the operator's standpoint, the value behaves exactly like a float. The only exception to this perspective is the presence of the actual whole number value in the tag database.

### **Timeout**

If there has been no keypad activity for approximately ten minutes, the display assumes the operator has left. It turns off the backlight and returns the display to the default Process screen. It also checks the login level. If the login level is greater than 1, then it resets the login level to 1.

It is the responsibility of the operator to log out when he leaves the display, thereby re-arming the intrusion program block.

### **Making Changes to the Configuration File**

Both OI and alarm configuration data are contained in the [station\_name].cfg file, but the file includes a system for tracking changes to the two applications, allowing the display and alarming applications to react to a new file independently.

For example, if a change is made to the OI configuration using the LC3000 Advanced Utilities in IntraLink toolbox and the new [station\_name].cfg file is downloaded to the LC3000, the display application will restart, but the alarm application will not.

## **Section 3 Alarms**

### **Overview**

IntraLink controllers and the OI3000 have an alarming application that affords a method for tracking critical system variables and signaling when they are out of range.

Alarm points are configured using the Advanced Utilities in IntraLink Toolbox. Treatment of alarm points varies from their definition as simple events up to their definition as manual reset alarms, requiring an increasing level of operator involvement according to the point definition.

Each transition in the state of an alarm point is recorded as an event. The LC3000/2000 controller stores up to 1000 events in non-volatile memory, providing a history of controller operation.

Alarm and event records are held in man-readable text files in the LC3000/2000. The alarm and event files conform to a CSV (Comma Separated Variable) file format, a venerable file format supported by all spreadsheet programs.

The alarm record file is called alarmRecords.txt. The event record file is called eventRecords.txt. Both are located in the /nvram directory in the LC3000/2000 Linux file system.

### **Active alarms**

All alarms points, whether they are simple events, auto reset alarms or manual reset alarms, have an input tag. The input tag is a discrete value signaling the alarm condition. The alarming application scans the input tags of configured alarm points looking for a transition from false to true. The scan cycle time is not greater than two seconds.

When the input tag of an alarm point transitions from false to true, the alarm is added to the active alarm list. Once an alarm has been added to the active alarm list, it stays there until all the conditions for its removal from the list have been met.

If the alarm point has been configured as an auto reset alarm, then the conditions for its removal from the list are return of the input tag to a normal state and alarm acknowledgement. If the alarm point has been configured as a manual reset alarm, then the conditions for its removal from the list are return of the input tag to a normal state, alarm acknowledgement, and alarm reset.

Because an alarm stays on the active alarm list until all conditions for its removal have been met, it is completely possible for an alarm that has returned to normal to be on the list -- because it has not been acknowledged.

The active alarm list is what the operator sees when he presses the ALARM shortcut key.

### **Acknowledged and unacknowledged alarms**

When any alarm on the alarm list is unacknowledged, the alarming application attempts to draw the attention of the operator by beeping the audible alarm and flashing a message on the display screen.

In addition, group output tags may be active. If alarms have been organized into groups and group output tags are defined, these may be used to sound an external horn or turn on a flashing light.

Alarms may be acknowledged by repeated presses of the ACK key. The first press of the ACK key is a shortcut to the Alarm List. The display will show the most recent alarms, with the cursor on the most recent unacknowledged alarm. As the operator continues to press the ACK key to acknowledge alarms, the cursor jumps forward to the next unacknowledged alarm. When all the unacknowledged alarms on a screen have been acknowledged, the alarming application finds the next screen with unacknowledged alarms and advances to it, putting the cursor on the topmost unacknowledged alarm. The process continues until all alarms have been acknowledged.

When there are no more unacknowledged alarms, the cursor disappears; the audible alarm stops beeping, the alarm message stops flashing and group unacknowledged tags are cleared.

### **Audible alarm**

The audible alarm may be silenced through System\Utilities if the operator wants to quiet the system down without acknowledging all alarms.

### **How alarms are removed from the alarm list**

Just as the alarming application scans alarm point input tags to see if any alarms should be added to the alarm list, it scans the alarm list to see if conditions have been met to remove items from the list.

The most common type of alarm is an auto reset alarm. When an auto reset alarm input tag goes true, the alarm is written to the alarm list with the On Message, the time the input tag went true and "UNACKD" in the ack status field.

When the input tag goes false, the alarm application removes from the alarm list the alarm entry with the On Message and replaces it with a new entry showing the Off Message and the time the transition to off occurred.

When the alarm is acknowledged, the alarming application writes "ACKD" to the ack status field in place of "UNACKD." When the alarm has been acknowledged and the input tag has been cleared, the entry is removed entirely from the alarm list.

Manual reset alarms follow the same sequence except they require an additional key press, an explicit manual reset. After the alarm has been acknowledged and the alarm input has been cleared, the ack status field for a manual reset alarm shows "RSTREQ." An ENTER key press is required for the manual reset, completing the conditions required for removal of the manual reset alarm from the alarm list.

Alarm screens are dynamically updated. If an alarm changes state while it is being displayed, then the alarm screen refreshes and the new state of the alarm is shown. The alarm input tag may have transitioned from true to false, or perhaps the alarm was remotely acknowledged. The alarm screen will show the most recent state of the alarm. It is also entirely possible for the alarm to disappear because all conditions for its removal from the alarm list have been met.

### **Alarm groups, group outputs**

Alarms may have been configured as members of an alarm group. Up to five alarm groups may be configured. Each group has two outputs. One output is true if any alarm in the group is unacknowledged. The other output is true if any alarm in the group is on the alarm list.

### **Manual reset alarm outputs**

A manual reset alarm has an output tag. The output tag is true as soon as the alarm goes onto the active alarm list. The output tag stays true until all three conditions for removal of the alarm from the alarm list have been met.

There is no method for determining through the OI3000 what output tag is associated with a manual reset alarm. If the tag has an accurate and descriptive name, however, it probably can be found by paging through the Digital Out list in Tagdata.

### **Event Records**

An alarm point defined as an event ( sometimes called a pure event ) creates an entry to the event list whenever its input tag transitions from false to true or from true to false. A pure event is the type of alarm that requires no operator involvement. A pure event does not appear on the Alarm list. Pure events appear only on the Event list.

For example, if the operator wanted to keep track of pump starts over a given period, the pump run signal could be defined as an event. A record would be created showing each time the pump turned on and each time it turned off.

In addition to defined pure events, other entries to the event list are generated automatically. When the LC3000/2000 controller is powered up and the alarming application starts up, it automatically creates an event. Whenever the operator logs in or logs out, it is recorded as an event. Whenever there is a change in the state of an alarm point, the change is recorded as an event. For example, when an alarm input tag first goes true and the alarm is written to the alarm list, an event entry is generated. When the input tag goes false, an event entry is generated. When the alarm is acknowledged, an event entry is generated.

Unlike the alarm list, there is no set of circumstances where event list entries are deleted (except when the list fills to capacity). The event list is always growing.

The high limit for entries to the event list is 1000 events. After there are 1000 events on the event list, the oldest entries are discarded to make room for newer ones as they occur.

### **Clearing alarm and event logs**

The option to clear the alarm and event lists is available through System\Utilities for an operator logged in at level 3.

It promotes efficient operation of the LC3000 to clear the event list periodically. If a PC is available for archiving data and the procedure is reasonably convenient, it would be sensible to upload the eventRecords.txt file to the PC periodically, and then clear event records through System\Utilities at the controller.

IntraLink Toolbox is used to upload files from the LC3000. In Toolbox, choose Operations, then File Operations. A dialogue box pops up showing the Linux file structure in the LC3000. Double click on the nvram directory, and the dialogue box will show eventRecords.txt among the directory contents. Highlight eventRecords.txt, then click on Read File.

The alarm list does not accumulate entries endlessly the way the event list does. In a well-maintained system, the alarm list should be empty. If it has entries, some action should be in progress to acknowledge the alarms and clear the alarm conditions. The whole point of the alarm list is to draw attention to, then resolve, transitory events.

### **Viewing and Changing Alarm Configuration**

The alarm configuration is viewable through the display by picking "ALARM CFG," the third item on the Alarms submenu. Alarm cfg is a list, usually a multi-screen list, akin to the tagdata lists. The alarm cfg list shows the alarm configuration in the same order as it is given in the [station\_name].cfg file. The total number of configured alarm points is shown to the right of the alarm cfg menu pick.

Each alarm point entry shows the input tag name, the type of alarm, the group assignment and the enable/disable status.

If an operator is logged in at level 3, the cursor appears on the enable/disable field of the topmost alarm point on the screen. As is the case on other screens with settable values, Up Arrow and Down Arrow shift the display to the next screen, while Left Arrow and Right Arrow shift the cursor on a single screen.

Pressing the ENTER key toggles the enable/disable value. If an alarm point is enabled, pressing the ENTER key disables it. If an alarm point is disabled, pressing the ENTER key enables it. When the enable/disable status of an alarm point is changed, the change is communicated to the alarming application and it is also written to the [station\_name].cfg file, so the change will remain intact if power is cycled.

When an alarm is disabled, any alarm list entry or entries it has generated are removed from the alarm list, whether they have been acknowledged or not. Outputs dependent on the contents of the alarm list are adjusted accordingly.

### **Alarm behavior when power is interrupted**

The alarming application assumes at startup there are no alarms on the alarm list and alarm input tags are off. When it starts up, the alarming application examines the input tag values for each alarm point. If an input tag is on, the alarming application sees a transition from off (its starting assumption) to on (the actual tag value). The alarming application adds the alarm to the alarm list, the audible alarm sounds and the alarm warning box flashes on the display.

For example, at a site there are three alarm points whose input tags are on. The audible alarm has sounded, the alarm warning box has flashed on the display. The operator has heard the warnings and acknowledged alarms. The display is quiet. The operator goes about his business seeing what he can do to clear alarm conditions. Then power is lost for 30 seconds and there is no battery backup. When power returns, because their input tags are on, the same three alarms go active all over again.

At power up, the alarm list is rebuilt from scratch. The previous file containing the alarm list is thrown away. By contrast, the event list is maintained. It is not discarded at power up. In the power outage example above, the event list would have recorded the first three alarms and their acknowledgement. Then it would have recorded the alarming application startup when power returned, and it would have recorded the return of the three alarms.

## Section 4 Hardware and Technical Specifications

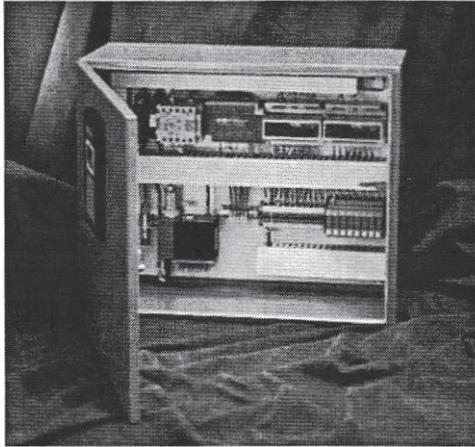
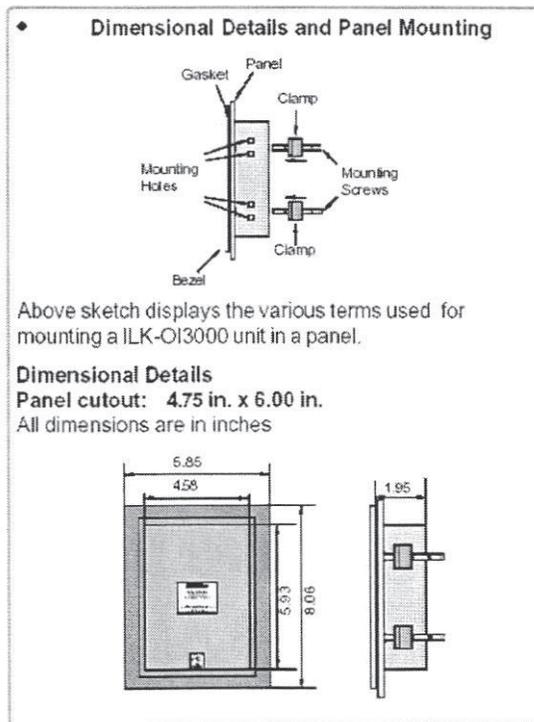


Figure 3 - A typical control enclosure. The OI3000 is mounted on door of the enclosure facing out. The LC3000 controller and other components are mounted on the back panel inside the enclosure.



### Panel Mounting

For mounting a ILK-OI3000 in a panel follow the procedure given below:

- 1) Make a cutout of the required size.
- 2) Put the gasket behind the bezel. The gasket may be sealed to the case using an adhesive.
- 3) Put the unit through the panel cutout.
- 4) Insert the clamps into the case.
- 5) Pull back the clamps until they seat into the retaining slots.
- 6) Tighten the clamping screws in an even pattern until the unit is secured into the panel.

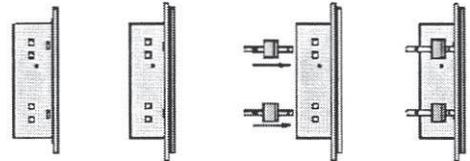
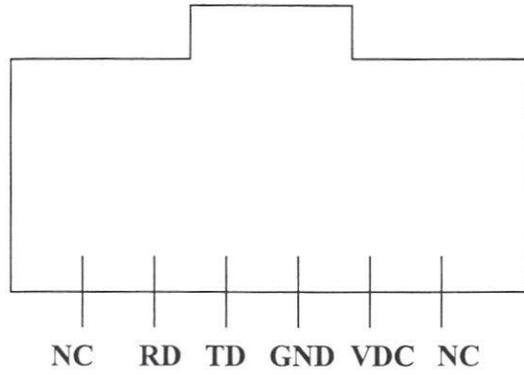


Figure 1: Gasket inserted.  
 Figure 2: Unit mounted in a panel.  
 Figure 3: Clamps being inserted in the mounting holes.  
 Figure 4: Clamps tightened in the mounting hole.

Figure 4 Dimensional Detail and Panel Mounting

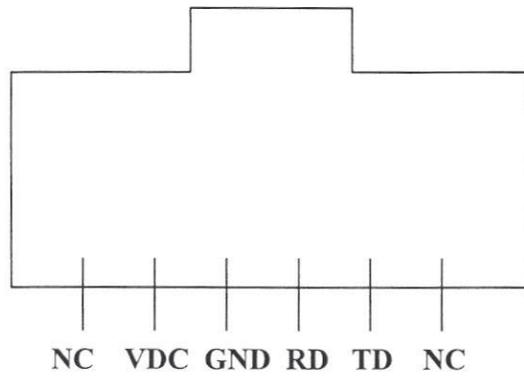
## Cable pinouts

Looking into the RJ-11 connector socket on the OI3000:



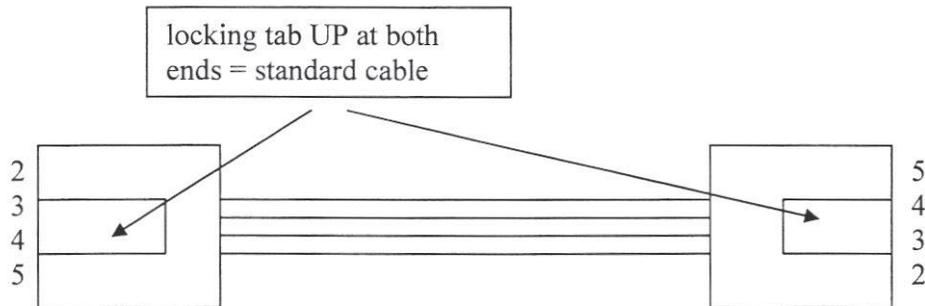
*Figure 5 RJ-11 pinout on the OI3000*

Looking into the RJ-11 Display port connector socket on the LC3000:



*Figure 6 RJ-11 Display port pinout on the LC3000*

Please note that the RJ-11 ports provide the signal crossing required for a straight cable connection between them. The cable that runs between the OI3000 and the LC3000 is a straight-through standard IDC modular cable assembly, with no signals crossed inside the cable.



*Figure 7 Straight-through cable*

IntraLink P/N = "LC3000 Reverse Style Adapter"

Conforming commercial cables:

Digi-Key Straight Cable Assembly P/N H1641-07-ND

Radio Shack Modular Line Cord P/N 279-339

#### **Power requirement**

10 - 30 VDC.

With the backlight on, the display draws approximately 100 mA at 12VDC.

#### **RS-232 parameters**

19200 baud at 8-N-1

These parameters are not settable.

#### **Environmental specification**

The OI3000 is rated NEMA 4.

Operating temperature: 0 to 50 degree C.

Storage temperature: -20 to 70 degrees C.

## Section 5 Troubleshooting and Support

### Behavior at power-up

When the OI3000 display is powered up, the backlight comes on and the display shows a Control Systems logo. The display remains in that state until it receives instructions from the LC3000 controller, generally 30 seconds to a minute after power up.

From a troubleshooting perspective, appearance of the backlight and logo indicate the OI3000 hardware is okay. If the display remains dark at power up, the most probable problem is lack of power, usually because the cable is disconnected or broken.

Holding down the MENU key at power-up forces the OI3000 to show the firmware version number for the display microprocessor.

There are no other diagnostic tools for the display itself.

### Error messages

When the display software in the LC3000/2000 is starting up, it looks for certain files it requires for operation. It looks for a configuration file called [station\_name].cfg. If it cannot find the file or fails to open it, the display driver clears the screen and puts up a "cfg file not found" message. The display driver looks for a \_tags\_.6tg file in order to fill its tagdata tables and display raw tagdata values to the operator. If the display driver cannot find the \_tags\_.6tg file, it clears the screen and puts up a "tag file not found" message.

Without the cfg file the display will show no Process screens. Job information will be missing on the System\Job Info screen and passwords will default to "0000".

Without the \_tags\_.6tg file, all tag data will be unavailable. There will be no entries in the Tagdata submenu. Process screens will produce a variety of "tag not found" error messages. Not only will the display not work, the controller itself will probably do very little, because tag definitions and manipulation of tag data are the heart of the LC3000/2000 control system.

The alarming application also looks for the [station\_name].cfg file. If it is missing, no alarms will be written to the alarm list because the alarming application does not know what tags to scan.

System\Diagnostics or IntraLink Toolbox may be used to review the contents of the /usr/local/bin directory in the LC3000/2000 to see if the necessary files are in the directory.

If necessary files are missing, the best troubleshooting procedure is to find the files, load them into /usr/local/bin, and restart the controller. Files are loaded to the LC3000/2000 using IntraLink Toolbox. Choose Operations, then File Operations. A dialogue box pops up showing the Linux file structure in the LC3000/2000. Double click on usr, then on local, then on bin to indicate the destination of the file to be loaded. Then click on Load File.

### **Checking for communication between LC3000/2000 and OI3000**

The LC3000/2000 has red LEDs to indicate activity on its ports, including LEDs for the TD (Transmit Data) and RD (Receive Data) lines on the dedicated Display port (LC3000) and port D (LC2000). The leftmost port on the bottom of the LC3000 is the display port. Port D on the LC2000 is located on screw terminals. Typically terminals 15,16,17 & 18 are used.

When a key is pressed on the OI3000 display, the LED on the RD line of the controller display port should light momentarily, indicating receipt of a character. This simple diagnostic reveals much. It shows the display hardware is behaving correctly as a subsystem. It is detecting key hits and generating a character to send to the LC3000/2000. The momentary LED flicker at the controller confirms the cable is good. Strictly speaking, it is possible the display is generating the wrong character to reflect the key hit or it is generating a character at the wrong baud rate, but these possibilities are remote. If the RD light on the LC3000/2000 is showing key hits, the display and the cable are probably good.

When the display driver is running, a key hit from the display usually generates a burst of traffic on the TD line from the LC3000/2000 as the display software issues commands for moving the cursor or creating a new screen. Sometimes, in the midst of the traffic burst on the TD line, there will be a flicker of lights on the RD line. These are flow control commands from the display regulating the data flow from the LC3000/2000.

These are qualitative descriptions of how the LC3000/2000 and OI3000 interact when things are working correctly. A substantial deviation from this behavior indicates error.

### **Garbled screen ... trash characters**

If, at any point, the screen display becomes garbled or is showing what look like trash characters, the easiest fix is to press the MENU key to move up one level in the menu hierarchy and then press the ENTER key to go back down.

If the display is unplugged, then plugged in again, the display driver goes about its business updating some screen elements and leaving others alone. The result is a mosaic. Usually there are remnants of the Control Systems logo on the display along with some updated values and some garbage characters.

The fix is to press the MENU key and then the ENTER key ( or sometime Up Arrow then Down Arrow keys) to go away from the present screen, then come back. In the process of coming back, the display driver erases everything, then recreates the screen from scratch, giving a complete and clean outcome.

### **Resetting the display**

It is possible, given very rare circumstance, to confuse and lock up the microprocessor on the display. If key-hits are generating no data on the RD line, or if commands from the LC3000/2000 (visible on the TD line) produce no action in the display, then the display microprocessor is not working correctly.

Clear the condition by cycling power to the display. Unplug the cable, wait a few seconds, then plug it back in. Press the MENU key and the ENTER key, or Up Arrow and Down Arrow keys, to refresh the display. If this does not work, verify correct operation of the LC3000/2000. It may be necessary to reset the controller.

### **Contacting Tech Support**

Please call your local support representative for technical support or replacement parts, or call Siemens Water Technologies, Control Systems at 1-800-224-9474 for more information.

CNR Fail = Call Not Running or Fail to Start

Turn HOA off for 10 sec. then go back  
to hand or Auto.



# Push Buttons and Operator Interface Specifiers Guide

## Class 9001, Type K, SK — 30 mm

### Common Operators

For use in hazardous locations – See page 150.

#### “START” Push Buttons

Operator Style	Description	Contact Block	Button Color	Type	Legend Plate
30.5 mm Industrial (Metal)			Black	KR1BH13	KN201SP
30.5 mm Corrosion Resistant (Non Metallic)			Black	SKR1BH13	KN101SP

#### “STOP” Push Buttons

Operator Style	Description	Contact Block	Button Color	Type	Legend Plate
30.5 mm Industrial (Metal)			Red	KR1RH13	KN202RP
30.5 mm Corrosion Resistant (Non Metallic)			Red	SKR1RH13	KN102RP

#### “OFF – ON” Selector Switch

Operator Style	Description	Contact Sequence	Knob Color	Type	Legend Plate
		Contact Block Included			
30.5 mm Industrial (Metal)			Black	KS11BH13	KN244SP
30.5 mm Corrosion Resistant (Non Metallic)			Black	SKS11BH13	KN144SP

#### “HAND – OFF – AUTO” Selector Switch

Operator Style	Description	Contact Sequence	Knob Color	Type	Legend Plate
		Contact Block Included			
30.5 mm Industrial (Metal)			Black	KS43BH13	KN260SP
30.5 mm Corrosion Resistant (Non Metallic)			Black	SKS43BH13	KN160SP

#### RED – 120 Vac – “ON” Pilot Light

Operator Style	Description	Type	Legend Plate
30.5 mm Industrial (Metal)		KP1R31	KN203SP
30.5 mm Corrosion Resistant (Non Metallic)		SKP1R31	KN103SP

#### GREEN – 120 Vac – “OFF” Pilot Light

Operator Style	Description	Type	Legend Plate
30.5 mm Industrial (Metal)		KP1G31	KN204SP
30.5 mm Corrosion Resistant (Non Metallic)		SKP1G31	KN104SP

#### RED – 120 Vac – “ON” Push-To-Test Pilot Light

Operator Style	Description	Type	Legend Plate
30.5 mm Industrial (Metal)		KT1R31	KN203SP
30.5 mm Corrosion Resistant (Non Metallic)		SKT1R31	KN103SP

#### GREEN – 120 Vac – “OFF” Push-To-Test Pilot Light

Operator Style	Description	Type	Legend Plate
30.5 mm Industrial (Metal)		KT1G31	KN204RP
30.5 mm Corrosion Resistant (Non Metallic)		SKT1G31	KN104RP



File CCN E42259 NKCR



File Class LR 25490 3211 03



Marking



# Push Buttons and Operator Interface Specifiers Guide

## Class 9001, Type K, SK — 30 mm Heavy Duty Operators

### Non-Illuminated Momentary Push Button Operators – UL Types 4, 13/NEMA Types 4, 13

For use in hazardous locations – See page 150.  
Contact blocks and legend plate not included unless otherwise noted.

Description	Color	Operator With 1 N.O. and 1 N.C. Contact (KA1)	Operator With 1 N.O. Contact (KA2)	Operator With 1 N.C. Contact (KA3)	Operator Only With No Contacts ⑤	
 Full Guard	Black	KR1BH13	KR1BH5	KR1BH6	KR1B	
	Red	KR1RH13	KR1RH5	KR1RH6	KR1R	
	Green	KR1GH13	KR1GH5	KR1GH6	KR1G	
	Universal ①	KR1UH13	KR1UH5	KR1UH6	KR1U	
	Other ②	KR1QH13	KR1QH5	KR1QH6	KR1Q	
 No Guard	Black	KR3BH13	KR3BH5	KR3BH6	KR3B	
	Red	KR3RH13	KR3RH5	KR3RH6	KR3R	
	Green	KR3GH13	KR3GH5	KR3GH6	KR3G	
	Universal ①	KR3UH13	KR3UH5	KR3UH6	KR3U	
	Other ②	KR3QH13	KR3QH5	KR3QH6	KR3Q	
 Extended Guard	Black	KR2BH13	KR2BH5	KR2BH6	KR2B	
	Red	KR2RH13	KR2RH5	KR2RH6	KR2R	
	Green	KR2GH13	KR2GH5	KR2GH6	KR2G	
	Universal ①	KR2UH13	KR2UH5	KR2UH6	KR2U	
	Other ②	KR2QH13	KR2QH5	KR2QH6	KR2Q	
 1 3/8" Diameter Mushroom Button	<b>Snap-In Mushroom Button</b>					
	Black	KR4BH13	KR4BH5	KR4BH6	KR4B	
	Red	KR4RH13	KR4RH5	KR4RH6	KR4R	
	Red ③	KR4R05H13	KR4R05H5	KR4R05H6	KR4R05	
	Green	KR4GH13	KR4GH5	KR4GH6	KR4G	
	Other ④	KR4QH13	KR4QH5	KR4QH6	KR4Q	
	<b>Screw-On Mushroom Button With Set Screw Security</b>					
	Black	KR24BH13	KR24BH5	KR24BH6	KR24B	
	Red	KR24RH13	KR24RH5	KR24RH6	KR24R	
	Green	KR24GH13	KR24GH5	KR24GH6	KR24G	
	Other ④	KR24QH13	KR24QH5	KR24QH6	KR24Q	
	 2 1/4" Diameter Mushroom Button	<b>Snap-In Mushroom Button</b>				
		Black	KR5BH13	KR5BH5	KR5BH6	KR5B
		Red	KR5RH13	KR5RH5	KR5RH6	KR5R
Red ③		KR5R05H13	KR5R05H5	KR5R05H6	KR5R05	
Green		KR5GH13	KR5GH5	KR5GH6	KR5G	
Other ④		KR5QH13	KR5QH5	KR5QH6	KR5Q	
<b>Screw-On Mushroom Button With Set Screw Security</b>						
Black		KR25BH13	KR25BH5	KR25BH6	KR25B	
Red		KR25RH13	KR25RH5	KR25RH6	KR25R	
Green		KR25GH13	KR25GH5	KR25GH6	KR25G	
Other ④		KR25QH13	KR25QH5	KR25QH6	KR25Q	

- ① The universal push button operators contain one each of the following color inserts: black, red, green, yellow, orange, blue and white.
- ② See table below.
- ③ Knob has the words "Emergency Stop" in raised letters highlighted in white for readability. Available in red snap-in mushroom buttons only.
- ④ See table below.
- ⑤ These operators can be ordered complete with contact blocks – for maximum block usage – see page 155. Add the "H" number chosen from page 151 to the end of the operator type number.  
**EXAMPLE: KR24B + H2(2 - KA1) = KR24BH2**

Color	② For KR1, 2, 3 Choose Color and Place Code in Type Number	④ For KR4, 5, 24, 25 Choose Color and Place Color Code in Type Number
Blue	L	L
Yellow	Y	Y
White	–	–
Orange	S	S
Gray	E	–

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# Push Buttons and Operator Interface Specifiers Guide

## Class 9001, Type SK — 30 mm

### Corrosion Resistant Operators

#### Non-Illuminated Momentary Push Button Operators – UL Types 4, 4X, 13/NEMA Types 4, 4X, 13

For use in hazardous locations – See page 150.

Contact Blocks And Legend Plate Not Included Unless Otherwise Noted

Description	Color	Operator With 1 N.O. and 1 N.C. Contact (KA1)	Operator With (KA2)	Operator With 1 N.C. Contact (KA3)	Operator Only With No Contacts ⑤	
 Full Guard	Black	SKR1BH13	SKR1BH5	SKR1BH6	SKR1B	
	Red	SKR1RH13	SKR1RH5	SKR1RH6	SKR1R	
	Green	SKR1GH13	SKR1GH5	SKR1GH6	SKR1G	
	Universal ①	SKR1UH13	SKR1UH5	SKR1UH6	SKR1U	
	Other ②	SKR1②H13	SKR1②H5	SKR1②H6	SKR1②	
 No Guard	Black	SKR3BH13	SKR3BH5	SKR3BH6	SKR3B	
	Red	SKR3RH13	SKR3RH5	SKR3RH6	SKR3R	
	Green	SKR3GH13	SKR3GH5	SKR3GH6	SKR3G	
	Universal ①	SKR3UH13	SKR3UH5	SKR3UH6	SKR3U	
	Other ②	SKR3②H13	SKR3②H5	SKR3②H6	SKR3②	
 Extended Guard	Black	SKR2BH13	SKR2BH5	SKR2BH6	SKR2B	
	Red	SKR2RH13	SKR2RH5	SKR2RH6	SKR2R	
	Green	SKR2GH13	SKR2GH5	SKR2GH6	SKR2G	
	Universal ①	SKR2UH13	SKR2UH5	SKR2UH6	SKR2U	
	Other ②	SKR2②	SKR2②H5	SKR2②H6	SKR2②	
 1 3/8 Mushroom Button	<b>Snap In Mushroom Button</b>					
	Black	SKR4BH13	SKR4BH5	SKR4BH6	SKR4B	
	Red	SKR4RH13	SKR4RH5	SKR4RH6	SKR4R	
	Red ③	SKR4R05H13	SKR4R05H5	SKR4R05H6	SKR4R05	
	Green	SKR4GH13	SKR4GH5	SKR4GH6	SKR4G	
	Other ④	SKR4④H13	SKR4④H5	SKR4④H6	SKR4④	
	<b>Screw-On Mushroom Button With Set Screw Security</b>					
	Black	SKR24BH13	SKR24BH5	SKR24BH6	SKR24B	
	Red	SKR24RH13	SKR24RH5	SKR24RH6	SKR24R	
	Green	SKR24GH13	SKR24GH5	SKR24GH6	SKR24G	
	Other ④	SKR24④H13	SKR24④H5	SKR24④H6	SKR24④	
	 2 1/4 Mushroom Button	<b>Snap-In Mushroom Button</b>				
		Black	SKR5BH13	SKR5BH5	SKR5BH6	SKR5B
Red		SKR5RH13	SKR5RH5	SKR5RH6	SKR5R	
Red ③		SKR5R05H13	SKR5R05H5	SKR5R05H6	SKR5R05	
Green		SKR5GH13	SKR5GH5	SKR5GH6	SKR5G	
Other ④		SKR5④H13	SKR5④H5	SKR5④H6	SKR5④	
<b>Screw-On Mushroom Button With Set Screw Security</b>						
Black		SKR25BH13	SKR25BH5	SKR25BH6	SKR25B	
Red		SKR25RH13	SKR25RH5	SKR25RH6	SKR25R	
Green		SKR25GH13	SKR25GH5	SKR25GH6	SKR25G	
Other ④		SKR25④H13	SKR25④H5	SKR25④H6	SKR25④	

① The universal push button operators include one each of the following color inserts: black, red, green, yellow, orange, blue and white.

② See table below.

③ Knob has the words "Emergency Stop" in raised letters highlighted in white for readability. Available in red snap-in mushroom buttons only.

④ See table below.

⑤ These operators can be ordered complete with contact blocks, for maximum block usage – see page 155. Add the "H" number chosen from page 151 to the end of the operator type number. **EXAMPLE: SKR24B + H2(2-KA1) = SKR24BH2**

Color	② For SKR1,2,3 Choose Color and Place Color Code in Type Number	④ For SKR4,5,24,25 Choose Color and Place Color Code in Type Number
Blue	L	L
Yellow	Y	Y
White	W	–
Orange	S	S
Gray	E	–

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**Push Buttons—Class 9001 Type SK—30 mm**  
Corrosion Resistant Non-Illuminated Operators

**SQUARE D**  
**www.SquareD.com**  
For the most up-to-date information

**17 PUSH BUTTONS AND OPERATOR INTERFACE**

**Non-Illuminated Momentary Push Button Operators—UL Types 4, 4X, 13/NEMA 4, 4X, 13**

For use in hazardous locations—See page 17-79.  
Contact blocks and legend plate not included unless otherwise noted.

Description	Color	Operator with 1 N.O. and 1 N.C. Contact (KA1)	Operator with 1 N.O. Contact (KA2)	Operator with 1 N.C. Contact (KA3)	Operator Only No Contacts v
 9001SKR1B Full Guard	Black	SKR1BH13	SKR1BH5	SKR1BH6	SKR1B
	Red	SKR1RH13	SKR1RH5	SKR1RH6	SKR1R
	Green	SKR1GH13	SKR1GH5	SKR1GH6	SKR1G
	Universal ▲	SKR1UH13	SKR1UH5	SKR1UH6	SKR1U
	Other #	SKR1#H13	SKR1#H5	SKR1#H6	SKR1#
 9001SKR3B No Guard	Black	SKR3BH13	SKR3BH5	SKR3BH6	SKR3B
	Red	SKR3RH13	SKR3RH5	SKR3RH6	SKR3R
	Green	SKR3GH13	SKR3GH5	SKR3GH6	SKR3G
	Universal ▲	SKR3UH13	SKR3UH5	SKR3UH6	SKR3U
	Other #	SKR3#H13	SKR3#H5	SKR3#H6	SKR3#
 9001SKR2B Extended Guard	Black	SKR2BH13	SKR2BH5	SKR2BH6	SKR2B
	Red	SKR2RH13	SKR2RH5	SKR2RH6	SKR2R
	Green	SKR2GH13	SKR2GH5	SKR2GH6	SKR2G
	Universal ▲	SKR2UH13	SKR2UH5	SKR2UH6	SKR2U
	Other #	SKR2#H13	SKR2#H5	SKR2#H6	SKR2#

▲ The universal push button operators include one each of the following color inserts: black, red, green, yellow, orange, blue and white.  
# See table below.

Description	Color	Operator with 1 N.O. and 1 N.C. Contact (KA1)	Operator with 1 N.O. Contact (KA2)	Operator with 1 N.C. Contact (KA3)	Operator Only No Contacts v
 9001SKR4B 1 1/4" Mushroom Button	<b>Snap-In Mushroom Button</b>				
	Black	SKR4BH13	SKR4BH5	SKR4BH6	SKR4B
	Red	SKR4RH13	SKR4RH5	SKR4RH6	SKR4R
	Red †	SKR4R05H13	SKR4R05H5	SKR4R05H6	SKR4R05
	Green	SKR4GH13	SKR4GH5	SKR4GH6	SKR4G
	Other *	SKR4#H13	SKR4#H5	SKR4#H6	SKR4#
 9001SKR5B 2 1/4" Mushroom Button	<b>Screw-On Mushroom Button with Set Screw Security</b>				
	Black	SKR24BH13	SKR24BH5	SKR24BH6	SKR24B
	Red	SKR24RH13	SKR24RH5	SKR24RH6	SKR24R
	Green	SKR24GH13	SKR24GH5	SKR24GH6	SKR24G
	Other *	SKR24#H13	SKR24#H5	SKR24#H6	SKR24#
	<b>Snap-In Mushroom Button</b>				
Black	SKR5BH13	SKR5BH5	SKR5BH6	SKR5B	
Red	SKR5RH13	SKR5RH5	SKR5RH6	SKR5R	
Red †	SKR5R05H13	SKR5R05H5	SKR5R05H6	SKR5R05	
Green	SKR5GH13	SKR5GH5	SKR5GH6	SKR5G	
Other *	SKR5#H13	SKR5#H5	SKR5#H6	SKR5#	
<b>Screw-On Mushroom Button with Set Screw Security</b>					
Black	SKR25BH13	SKR25BH5	SKR25BH6	SKR25B	
Red	SKR25RH13	SKR25RH5	SKR25RH6	SKR25R	
Green	SKR25GH13	SKR25GH5	SKR25GH6	SKR25G	
Other *	SKR25#H13	SKR25#H5	SKR25#H6	SKR25#	

† Knob has the words "Emergency Stop" in raised letters highlighted in white for readability.  
\* See table below.  
v These operators can be ordered complete with contact blocks. For maximum block usage, see page 17-85. Add the "F" number chosen from page 17-80 to the end of the operator type number and add the cost of the "F" number to the operator cost.

Color	* SKR1, 2, 3 Place Color Code in Type Number	* SKR4, 5, 24, 25 Place Color Code in Type Number
Blue	L	L
Yellow	Y	Y
White	W	...
Orange	S	S
Gray	E	...

For additional information, reference Catalog #9001CT0301.

**Push Buttons—Class 9001 Type K, SK and KX—30 mm**  
 Type K, SK and KX—30 mm  
 Class 9001

**SQUARE D**  
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 For the most up-to-date information

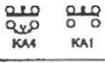
17 PUSH BUTTONS AND OPERATOR INTERFACE

The Class 9001 Type KA contact blocks are FINGERSAFE® contact blocks (meeting VDE 0106 Part 100). They have one screw mounting and captive (backed out) plus/minus terminal screws. These contact blocks are double-break, direct-acting contacts. Because of the wiping action of these contacts, they are suitable for use with programmable controllers. All contact blocks listed below accept up to 2 #12–#24 AWG solid or stranded wires. Recommended tightening torque for screw terminals is 7 in.-lbs.

**Standard Contact Blocks**

Description	Symbol	Type
 (Clear Cover) Direct-Acting	KA1	KA1
 (Green Cover) Direct-Acting	KA2	KA2
 (Red Cover) Direct-Acting	KA3	KA3
 (Clear Cover) N.O. Contact Early Closing	KA4	KA4
 (Red Cover) N.C. Contact Late Opening	KA5	KA5
 (Green Cover) N.O. Contact Early Closing	KA6	KA6

**Additional Circuit Arrangements Available**

Sequencing A N.O. Contact of KA4 closes before N.O. Contact on KA1		Order One Type KA4 and One Type KA1
Overlapping A N.C. Contact of KA4 closes before N.C. Contact of KA5 Opens		Order One Type KA4 and One Type KA5

A For push buttons or two-position selector switches only. For sequencing or overlapping contacts on other operators, consult your nearest Square D/Schneider Electric sales office.

Symbol	Contact Blocks with Binder Head Screws (not FINGERSAFE)	
	Type	Quantity*
	KA21	25-Up
	KA22	25-Up
	KA23	25-Up
	KA24	25-Up
	KA25	25-Up

Gold Flashed Contacts with Standard Pressure Wire Terminals	
Type	
KA31	
KA32	
KA33	
KA34	
KA35	

\* Minimum order quantity is 25. The price represents one individual contact block.

Contact blocks listed below are not FINGERSAFE, but provide:

- Terminals that accept ring tongue/fork tongue connectors
- Short single circuit contact blocks (0.75" deep vs. 0.97" deep on the FINGERSAFE)
- Same as old style Series G product available prior to March, 1989.
- Use form Y238 (add to catalog # as suffix— Example: 9001KRU1H13Y238)



Symbol	Type	Symbol	Type
	KA1G		KA4G
	KA2G		KA5G
	KA3G		KA6G

Contact blocks listed below are not FINGERSAFE, but have Quick-Connect terminals.

Symbol	Type
	KA12
	KA13

Dimensions ..... Catalog 9001CT0301

**Maximum Current Ratings For Control Circuit Contacts—Types KA1–KA6, KA21–25, KA31–35, KA1G–KA6G**

Volts	AC						Volts	DC				
	Inductive (NEMA / UL Type A500) 35% Power Factor					Resistive 75% Power Factor Make, Break and Continuous Amperes		Inductive and Resistive (NEMA Q600)				
	Make		Break		Continuous Carrying Amperes			Make and Break				Continuous Carrying Amperes
	Amperes	VA	Amperes	VA				KA1	KA2 KA3	KA4	KA5 KA6	
120	60	7200	6.0	720	10	10	125	0.55	0.55	...	...	2.5
240	30	7200	3.0	720	10	10	250	0.27	0.27	...	...	2.5
480	15	7200	1.5	720	10	10	600	0.10	0.10	...	...	2.5
600	12	7200	1.2	720	10	10						

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# Push Buttons—Class 9001 Type SK—30 mm

## Corrosion Resistant Pilot Lights

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17 PUSH BUTTONS AND OPERATOR INTERFACE

### Pilot Lights—UL Types 4, 4X, 13/NEMA 4, 4X, 13

For use in hazardous locations—See page 17-79.  
Legend plate not included.

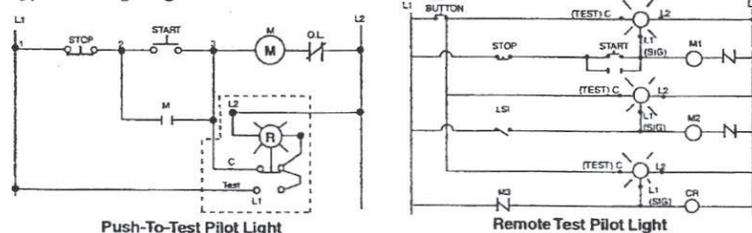
Description	Voltage	Style	With Red Fresnel Color Cap	With Green Fresnel Color Cap	With Other Color Cap	Price	Without Color Cap
 9001SKP1 Standard Pilot Light (Non-metallic fresnel color cap shown)	110–120 V, 50–60 Hz	Transformer	SKP1R31	SKP1G31	SKP1■	\$102.	SKP1
	220–240 V, 50–60 Hz	Transformer	SKP7R31	SKP7G31	SKP7■	102.	SKP7
	24–28 Vac/dc	Full Voltage	SKP35R31	SKP35G31	SKP35■	83.	SKP35
	For other voltages see Table ▲	Transformer, Flashing or LED♦	SKP▲R31	SKP▲G31	SKP▲■	102.	SKP▲
		Full Voltage, Neon or Resistor*	SKP▲R31	SKP▲G31	SKP▲■	83.	SKP▲
 9001SKT1 Push-To-Test Pilot Light (Non-metallic fresnel color cap shown)	110–120 V, 50–60 Hz	Transformer	SKT1R31	SKT1G31	SKT1■	131.	SKT1
	220–240 V, 50–60 Hz	Transformer	SKT7R31	SKT7G31	SKT7■	131.	SKT7
	24–28 Vac/dc	Full Voltage	SKT35R31	SKT35G31	SKT35■	111.	SKT35
	For other voltages see Table ▲	Transformer, Flashing or LED♦	SKT▲R31	SKT▲G31	SKT▲■	131.	SKT▲
		Full Voltage, Neon or Resistor*	SKT▲R31	SKT▲G31	SKT▲■	111.	SKT▲
 9001SKTR38 Remote Test Pilot Light (Non-metallic fresnel color cap shown)	120 Vac Only	Resistor	SKTR38R31	SKTR38G31	SKTR38■	131.	SKTR38
	24–28 Vac Only	Full Voltage	SKTR35R31	SKTR35G31	SKTR35■	131.	SKTR35
	For other voltages see Tables ▲■▼	Full Voltage or Resistor ▼	SKTR▲R31	SKTR▲G31	SKTR▲■	131.	SKTR▲
 Pilot Light For Intrinsically Safe Circuits (NEMA 4X)	Intrinsically safe equipment must not release electrical or thermal energy capable of igniting certain explosive or combustible hazardous atmospheres, for which the equipment has been tested. These pilot lights are intrinsically safe when used with suitable approved barrier or barrier relay. These pilot lights are Factory Mutual (FM) approved. Consult your local Square D sales office for further details. These pilot lights are fully encapsulated—there are no replaceable parts—except for the SK40 ring nut. Use KN100 series plastic legend plates as shown on Pages 17-81 and 17-82.		KP44R	KP44G	KP44Y (Yellow Color Cap)	119.	....
	Operating Voltage Range	Nominal Current	V max = 32 V I max = 165 mA				
	20–30 Vac/dc	25 mA					

- ▲ Add the voltage assembly code as chosen from table, page 17-77.  
EXAMPLE: SKTAR31 with 60 Vac red LED voltage = SKT37LRR31.
- Add the color code as chosen from the color cap table below.  
EXAMPLE: SKP1■ with a blue fresnel cap = SKP1L31.
- ♦ The cap must be the same color as the LED light module chosen, e.g., for green LED, use green color cap.
- \* On neon light modules, use clear color caps only.
- ▼ Use only full voltage or resistor voltage assembly codes on remote test pilot lights. Do not choose LED, neon or transformer codes. For AC use only.

#### Color Caps

Color	■ Plastic Fresnel	■ Plastic Domed
Amber	A31	A9
Blue	L31	L9
Clear	C31	C9
Green	G31	G9
Red	R31	R9
White	W31	W9
Yellow	Y31	Y9

#### Typical Wiring Diagram

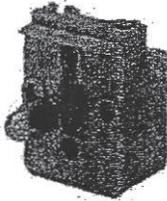


## Push Buttons—Class 9001 Type K, SK and KX—30 mm Electrical Components

### Standard Light Modules for Types K, SK, and KX Control Units \*

For use in hazardous locations—See page 17-79.

- Neon type light modules—use CLEAR color caps only.
- LED light modules require that the color cap and the LED be the same color, or use a clear color cap.



Voltage	Description	For Use With Single Lamp III. Operators as Indicated ▲	Light Module Type †	Voltage Assembly Code	Rating	Replacement Lamp Part Number ‡
6 Vac/dc	Full Voltage	All	KM31	31	.9 VA	2550101020
12–14 Vac/dc	Full Voltage	All	KM32	32	1.2 VA	2550101037
18 Vac/dc	Resistor	All	KM33	33	1.4 VA	2550101037
24–28 Vac/dc	Full Voltage	All	KM35	35	1.2 VA	2550101002
24–28 Vac/dc	LED Red	All Except ■	KM35LR	35LR	.28 VA	6508805210
24–28 Vac/dc	LED Green	All Except ■	KM35LG	35LG	.28 VA	6508805212
24–28 Vac/dc	LED Yellow	All Except ■	KM35LY	35LY	.28 VA	6508805211
24–28 Vac/dc	LED White	All Except ■	KM35LW	35LW	.28 VA	6508805214
24–28 Vac/dc	LED Blue	All Except ■	KM35LL	35LL	.28 VA	6508805213
48 Vac/dc	Full Voltage	All	KM36	36	2.6 VA	2550101025
110–120 V, 50–60 Hz	Transformer	All Except ■	KM1	1	2.4 VA	2550101020
110–120 V, 50–60 Hz	Flashing	All Except ■	KMF1	F1	.85 VA	2550101036
120 Vac/dc	Resistor	All	KM38	38	3.0 VA	2550101027
120 Vac/dc	Full Voltage	All	KM38	38	3.0 VA	2550101027
120 Vac/dc	Neon	All Except ■	KM11	11	0.2 VA	2550101013
120 Vac/dc	LED Red	All Except ■	KM38LR	38LR	1.4 VA	6508805210
120 Vac/dc	LED Green	All Except ■	KM38LG	38LG	1.4 VA	6508805212
120 Vac/dc	LED Yellow	All Except ■	KM38LY	38LY	1.4 VA	6508805211
120 Vac/dc	LED White	All Except ■	KM38LW	38LW	1.4 VA	6508805214
120 Vac/dc	LED Blue	All Except ■	KM38LL	38LL	1.4 VA	6508805213
208–220 V, 50–60 Hz	Transformer	All Except ■	KM3	3	2.5 VA	2550101020
220–240 V, 50–60 Hz	Transformer	All Except ■	KM7	7	2.0 VA	2550101020
240 Vac/dc	Resistor	All Except ■	KM25	25	6.0 VA	2550101027
240 Vac/dc	Neon	All Except ■ and KX	KM12	12	0.3 VA	2550101013
277 V, 50–60 Hz	Transformer	All Except ■	KM8	8	2.4 VA	2550101020
380–480 V, 50–60 Hz	Transformer	All Except ■	KM5	5	2.8 VA	2550101020
480 Vac/dc	Neon	All Except ■ and KX	KM14	14	0.5 VA	2550101013
550–600 V, 50–60 Hz	Transformer	All Except ■	KM6	6	2.5 VA	2550101020

### Shallow Depth Light Modules For Types K and SK Control Units \*

For use in hazardous locations—See page 17-79. Reduces the depth of illuminated push buttons with contact blocks by over 33%.



Voltage	Description	Light Module Type †	Voltage Assembly Code	Rating	Replacement Lamp Part Number ‡
24–28 Vac/dc	Full Voltage	KM55	55	1.2 VA	2550101002
110–120 Vac/dc	Full Voltage	KM58	58	3.0 VA	2550101027

- ▲ 9001K, SK, KX.
- Do not use on any remote test version pilot light.
- † All light modules with an LED above 12 V use a 14 V bipolar LED.
- ‡ For use with all operators except KX and remote test pilot.
- ▼ Check light module label for series and replacement number.



File E42259  
CCN NKCR



File LR25490  
Class 3211 03



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# Push Buttons—Class 9001 Type SK—30 mm

Corrosion Resistant Pilot Lights

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17 PUSH BUTTONS AND OPERATOR INTERFACE

## Pilot Lights—UL Types 4, 4X, 13/NEMA 4, 4X, 13

For use in hazardous locations—See page 17-79.  
Legend plate not included.

Description	Voltage	Style	With Red Fresnel Color Cap	With Green Fresnel Color Cap	With Other Color Cap	Without Color Cap
 9001SKP1 Standard Pilot Light (Non-metallic fresnel color cap shown)	110–120 V, 50–60 Hz	Transformer	SKP1R31	SKP1G31	SKP1■	SKP1
	220–240 V, 50–60 Hz	Transformer	SKP7R31	SKP7G31	SKP7■	SKP7
	24–28 Vac/dc	Full Voltage	SKP35R31	SKP35G31	SKP35■	SKP35
	For other voltages see Table ▲	Transformer, Flashing or LED ♦	SKP▲R31	SKP▲G31	SKP▲■	SKP▲
		Full Voltage, Neon or Resistor*	SKP▲R31	SKP▲G31	SKP▲■	SKP▲
 9001SKT1 Push-To-Test Pilot Light (Non-metallic fresnel color cap shown)	110–120 V, 50–60 Hz	Transformer	SKT1R31	SKT1G31	SKT1■	SKT1
	220–240 V, 50–60 Hz	Transformer	SKT7R31	SKT7G31	SKT7■	SKT7
	24–28 Vac/dc	Full Voltage	SKT35R31	SKT35G31	SKT35■	SKT35
	For other voltages see Table ▲	Transformer, Flashing or LED ♦	SKT▲R31	SKT▲G31	SKT▲■	SKT▲
		Full Voltage, Neon or Resistor*	SKT▲R31	SKT▲G31	SKT▲■	SKT▲
 9001SKTR38 Remote Test Pilot Light (Non-metallic fresnel color cap shown)	120 Vac Only	Resistor	SKTR38R31	SKTR38G31	SKTR38■	SKTR38
	24–28 Vac Only	Full Voltage	SKTR35R31	SKTR35G31	SKTR35■	SKTR35
	For other voltages see Tables ▲ ■ ▼	Full Voltage or Resistor ▼	SKTR▲R31	SKTR▲G31	SKTR▲■	SKTR▲
 Pilot Light For Intrinsically Safe Circuits (NEMA 4X)	Intrinsically safe equipment must not release electrical or thermal energy capable of igniting certain explosive or combustible hazardous atmospheres, for which the equipment has been tested. These pilot lights are intrinsically safe when used with suitable approved barrier or barrier relay. These pilot lights are Factory Mutual (FM) approved. Consult your local Square D sales office for further details. These pilot lights are fully encapsulated—there are no replaceable parts—except for the SK40 ring nut. Use KN100 series plastic legend plates as shown on Pages 17-81 and 17-82.		KP44R	KP44G	KP44Y (Yellow Color Cap)	
	Operating Voltage Range	Nominal Current	V max = 32 V I max = 165 mA			
	20–30 Vac/dc	25 mA				

▲ Add the voltage assembly code as chosen from table, page 17-77.  
EXAMPLE: SKTR31 with 60 Vac red LED voltage = SKT37LRR31.

■ Add the color code as chosen from the color cap table below.  
EXAMPLE: SKP1■ with a blue fresnel cap = SKP1L31.

♦ The cap must be the same color as the LED light module chosen, e.g., for green LED, use green color cap.

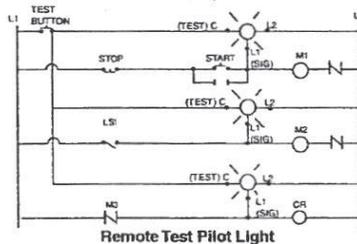
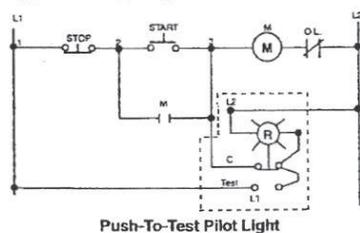
\* On neon light modules, use clear color caps only.

▼ Use only full voltage or resistor voltage assembly codes on remote test pilot lights. Do not choose LED, neon or transformer codes. For AC use only.

### Color Caps

Color	■ Plastic Fresnel	■ Plastic Domed
Amber	A31	A9
Blue	L31	L9
Clear	C31	C9
Green	G31	G9
Red	R31	R9
White	W31	W9
Yellow	Y31	Y9

### Typical Wiring Diagram

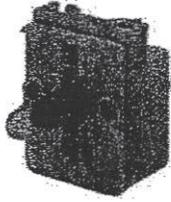


## Push Buttons—Class 9001 Type K, SK and KX—30 mm Electrical Components

### Standard Light Modules for Types K, SK, and KX Control Units \*

For use in hazardous locations—See page 17-79.

- Neon type light modules—use CLEAR color caps only.
- LED light modules require that the color cap and the LED be the same color, or use a clear color cap.

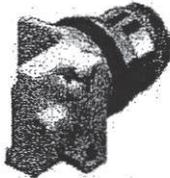


Voltage	Description	For Use With Single Lamp Ill. Operators as Indicated ▲	Light Module Type †	Voltage Assembly Code	Rating	Replacement Lamp Part Number ‡ ▽
6 Vac/dc	Full Voltage	All	KM31	31	.9 VA	2550101020
12–14 Vac/dc	Full Voltage	All	KM32	32	1.2 VA	2550101037
18 Vac/dc	Resistor	All	KM33	33	1.4 VA	2550101037
24–28 Vac/dc	Full Voltage	All	KM35	35	1.2 VA	2550101002
24–28 Vac/dc	LED Red	All Except ■	KM35LR	35LR	.28 VA	6508805210
24–28 Vac/dc	LED Green	All Except ■	KM35LG	35LG	.28 VA	6508805212
24–28 Vac/dc	LED Yellow	All Except ■	KM35LY	35LY	.28 VA	6508805211
24–28 Vac/dc	LED White	All Except ■	KM35LW	35LW	.28 VA	6508805214
24–28 Vac/dc	LED Blue	All Except ■	KM35LL	35LL	.28 VA	6508805213
48 Vac/dc	Full Voltage	All	KM36	36	2.6 VA	2550101025
110–120 V, 50–60 Hz	Transformer	All Except ■	KM1	1	2.4 VA	2550101020
110–120 V, 50–60 Hz	Flashing	All Except ■	KMF1	F1	.85 VA	2550101036
120 Vac/dc	Resistor	All	KM38	38	3.0 VA	2550101027
120 Vac/dc	Full Voltage	All	KM38	38	3.0 VA	2550101027
120 Vac/dc	Neon	All Except ■	KM11	11	0.2 VA	2550101013
120 Vac/dc	LED Red	All Except ■	KM38LR	38LR	1.4 VA	6508805210
120 Vac/dc	LED Green	All Except ■	KM38LG	38LG	1.4 VA	6508805212
120 Vac/dc	LED Yellow	All Except ■	KM38LY	38LY	1.4 VA	6508805211
120 Vac/dc	LED White	All Except ■	KM38LW	38LW	1.4 VA	6508805214
120 Vac/dc	LED Blue	All Except ■	KM38LL	38LL	1.4 VA	6508805213
208–220 V, 50–60 Hz	Transformer	All Except ■	KM3	3	2.5 VA	2550101020
220–240 V, 50–60 Hz	Transformer	All Except ■	KM7	7	2.0 VA	2550101020
240 Vac/dc	Resistor	All Except ■	KM25	25	6.0 VA	2550101027
240 Vac/dc	Neon	All Except ■ and KX	KM12	12	0.3 VA	2550101013
277 V, 50–60 Hz	Transformer	All Except ■	KM8	8	2.4 VA	2550101020
380–480 V, 50–60 Hz	Transformer	All Except ■	KM5	5	2.8 VA	2550101020
480 Vac/dc	Neon	All Except ■ and KX	KM14	14	0.5 VA	2550101013
550–600 V, 50–60 Hz	Transformer	All Except ■	KM6	6	2.5 VA	2550101020

**Note:** Standard light modules are available in other voltages. Contact your nearest Square D/Schneider Electric sales office for details.

### Shallow Depth Light Modules For Types K and SK Control Units \*

For use in hazardous locations—See page 17-79. Reduces the depth of illuminated push buttons with contact blocks by over 33%.



Voltage	Description	Light Module Type †	Price of Light Module	Voltage Assembly Code	Rating	Replacement Lamp Part Number ‡
24–28 Vac/dc	Full Voltage	KM55	\$57.	55	1.2 VA	2550101002
110–120 Vac/dc	Full Voltage	KM58	57.	58	3.0 VA	2550101027

- ▲ 9001K, SK, KX.
- Do not use on any remote test version pilot light.
- † All light modules with an LED above 12 V use a 14 V bipolar LED.
- \* For use with all operators except KX and remote test pilot.
- ‡ Check light module label for series and replacement number.



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File LR25490  
Class 3211 03



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# Push Buttons—Class 9001 Type K and SK—30 mm

## Replacement Parts

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17 PUSH BUTTONS AND OPERATOR INTERFACE

### Ring Nuts

Used On	Type	Used On	Type
K1L	K44	SK1L	SK44
K30-K37	K45	...	...
K70-K73	K45	...	...
K20, K21, K22, K23	K45	SK20, SK21, SK22, SK23	SK45
K20, K21, K22, K23 ♦	SK46	SK20, SK21, SK22, SK23 ♦	SK46
K2L	K49	SK2L	SK49
K3L	K111	...	...
KP, KTR	K41	SKR, SKTR	SK41
KR1	K41	SKR1	SK41
KR11	K42	SKR11	SK42
KR12 ▲	K42	SKR12 ▲	SK42
KR12 ■	K41	SKR12 ■	SK41
KR13, 14, 15	K55	...	...
KR2	K42	SKR2	SK42
KR20	K49	...	...
KR24	K49	...	...
KR25	K49	...	...
KR3	K40	SKR3	SK40
KR4	K41	SKR4	SK41
KR5	K41	SKR5	SK41
KR6	K47	...	...
KR67	K47	...	...
KR7	K47	...	...
KR8	K58	SKR8	6509704401
KR9	K41	SKR9	SK41
KS	K45	SKS	SK45
KS ♦	SK46	SKS ♦ SKRU11 SKRU1,2,3,4,5,10	SK46 SK41 SK40
KT	K49	SKT	SK49

- ▲ Maintained button of two button operator.
- Momentary button of two button operator.
- ♦ Secondary ring nut (holds knob on selector switch or potentiometer).

### Replacement Lamps For Series A-F (black) Light Modules

Light Module Type	Lamp Number (ANSI)	Square D Replacement Lamps	
		Part Number	
KM1	GE44*	...	
KM2	GE1490	2550101003	
KM3	GE44*	...	
KM4	GE1490	2550101003	
KM5	GE44*	...	
KM6	GE44*	...	
KM7	GE44*	...	
KM8	GE44*	...	
KM9	GE755	2550101020	
KM11	CMDK1A5	2550105014	
KM12	CMDK1A5	2550105014	
KM13	CMDK1A5	2550105014	
KM14	CMDK1A5	2550105014	
KM15	CMDK1A5	2550105014	
KM21	SYL12PSB	2550105003	
KM22	SYL12PSB	2550105003	
KM23	SYL28PSB	2550105008	
KM25	SYL120PSB	2550105005	
KM31	SYL6PSB	2550105007	
KM32	SYL12PSB	2550105003	
KM34	SYL24PSB	2550105004	
KM35	SYL28PSB	2550105008	
KM36	SYL48PSB	2550105009	
KM37	SYL60PSB	2550105010	
KM38	SYL120PSB	2550105005	

\* GE44 and GE755 are interchangeable (GE755 gives longer life). If a GE44 lamp is ordered, a GE755 (2550101020) will be substituted. For a replacement lamp in a current series light module see the light module listing on page 17-77.

### Repair Parts

Description	Part Number
E10 Key	2941101100
Gray cap for KR11, KR12, SKR11, or SKR12	3105217001
Clear plastic top (only) for 9001K44 & SK44	4487D63X1
Ring Nut	
Gasket for Type K and SK Push-Pull Knob	6509701801
Gasket for Plastic Illuminated Lens	6509701901
Gasket for Type K and SK selector switch knob	3105406401
Black Compensating Gasket (Type K and SK Operators)	6509702001
Liner for Non-Illuminated Operators	6509704901
Locking Thrust Washer	6512231201
Nylon Spacer	6509705001
Locking Thrust Washer (Std. Type SK Operator)	6512240601
Push-Pull Mushroom Adapter ▼	K54
Rubber Boot for Joystick	6512243201
Knob on Joysticks without latch	4458D20X3

▼ Allows Type -20 and -21 mushroom color caps to be used on push-pull operators. Use of 9001K54 voids Type 6 rating.

### KU Replacement Ring Nuts (Threaded Inside and Out)

Used On	Part Number
KU1 through KUB, KU27, KU37, KU47	3105204101
KU17, KU18	3105205901

### Interlock



For mechanically interlocking two push buttons so that only one button can be depressed at a time. A Type K3 attachment is furnished with the 9001 KR11, KR12, SKR11, SKR12, SKRU1 and SKRU11 operators. However, these are maintained operators and the K3 interlock serves to release one of the buttons when the other is depressed. When used with momentary contact buttons, the K3 interlock does not hold the buttons in the depressed position. It simply prevents pushing both buttons at the same time. The Type K3 Interlock is mounted behind the operators. Operators not included.

Type	
K3	

### Screwdriver



Used to tighten mounting screws on contact blocks and light modules.

Type	
K69	

### Wrenches



K95

K1

Where Used	Type
For tightening ring nuts on Types K, KX, SK and J control units	K95
For protective cap kits	K1





# Series 3 QOU<sup>®</sup> Circuit Breakers and QYU<sup>®</sup> Supplementary Protectors

## Interruptores automáticos QOU<sup>®</sup> serie 3 y protectores suplementarios QYU<sup>®</sup>

### Disjoncteurs QOU<sup>®</sup> série 3 et protecteurs supplémentaires QYU<sup>®</sup>

Retain for future use. / Conservar para uso futuro. / À conserver pour usage ultérieur.

#### ⚠ DANGER / PELIGRO / DANGER

##### HAZARD OF ELECTRIC SHOCK, EXPLOSION, OR ARC FLASH

- Apply appropriate personal protective equipment (PPE) and follow safe electrical work practices. See NFPA 70E.
- This equipment must be installed and serviced only by qualified electrical personnel.
- Turn off all power supplying this equipment before working on or inside equipment.
- Always use a properly rated voltage sensing device to confirm power is off.
- Replace all devices, doors and covers before turning on power to this equipment.

**Failure to follow these instructions will result in death or serious injury.**

##### PELIGRO DE DESCARGA ELÉCTRICA, EXPLOSIÓN O DESTELLO POR ARQUEO

- Utilice equipo de protección personal (EPP) apropiado y siga las prácticas de seguridad eléctrica establecidas por su Compañía (consulte la norma NFPA 70E).
- Solamente el personal eléctrico especializado deberá instalar y prestar servicio de mantenimiento a este equipo.
- Desenergice el equipo antes de realizar cualquier trabajo en él.
- Siempre utilice un dispositivo detector de tensión nominal adecuado para confirmar la desenergización del equipo.
- Vuelva a colocar todos los dispositivos, las puertas y las cubiertas antes de energizar el equipo.

**El incumplimiento de estas instrucciones podrá causar la muerte o lesiones serias.**

##### RISQUE D'ÉLECTROCUTION, D'EXPLOSION OU D'ÉCLAIR D'ARC

- Portez un équipement de protection personnel (ÉPP) approprié et observez les méthodes de travail électrique sécuritaire. Voir NFPA 70E.
- Seul un personnel qualifié doit effectuer l'installation et l'entretien de cet appareil.
- Coupez toute alimentation de cet appareil avant d'y travailler.
- Utilisez toujours un dispositif de détection de tension à valeur nominale appropriée pour s'assurer que l'alimentation est coupée.
- Remplacez tous les dispositifs, les portes et les couvercles avant de mettre l'appareil sous tension.

**Si ces précautions ne sont pas respectées, cela entraînera la mort ou des blessures graves.**

#### INSTALLATION

1. Turn off all power supplying this equipment before working on or inside equipment.
2. Circuit breaker lugs can be rotated to allow access to wire binding screw from top or bottom of circuit breaker.

#### INSTALACIÓN

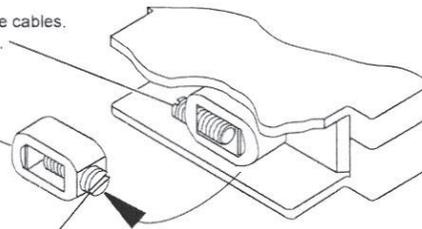
1. Desenergice el equipo antes de realizar cualquier trabajo en él.
2. Las zapatas de los interruptores automáticos se pueden girar para permitir el acceso al tornillo de sujeción de cables por arriba o por abajo del interruptor.

#### INSTALLATION

1. Coupez l'alimentation de l'appareil avant d'y travailler.
2. Les cosses des disjoncteurs peuvent être tournées pour permettre l'accès à la vis de fixation du fil par le haut ou par le bas du disjoncteur.

07303053

1. Remove wire binding screw.  
Retire el tornillo de sujeción de cables.  
Enlever la vis de fixation de fil.
2. Rotate lug body to desired position.  
Gire el cuerpo de la zapata hasta la posición apropiada.  
Faire tourner le corps de la cosse vers la position appropriée.
3. Replace wire binding screw.  
Vuelva a colocar el tornillo de sujeción de cables.  
Remettre en place la vis de fixation du fil.



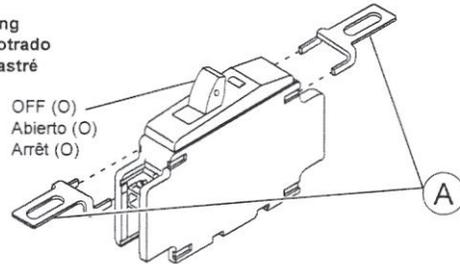
**MOUNTING FEET**

NOTE: If circuit breaker was purchased in a bulk pack, mounting feet must be ordered separately.

1. Install mounting feet (A) on each end of circuit breaker.

07303055 07303054

Flush Mounting  
 Montaje empotrado  
 Montage encastré

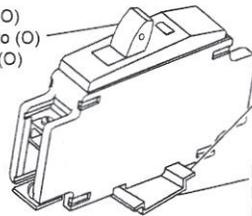


2. Use a screw through each mounting foot to fasten circuit breaker inside enclosure.

**DIN RAIL MOUNTING**

07303057 07303056

OFF (O)  
 Abierto (O)  
 Arrêt (O)



**BASES DE MONTAJE**

NOTA: Si el interruptor automático se compró como parte de un paquete, las bases de montaje se deben solicitar por separado.

1. Instale las bases de montaje (A) en cada extremo del interruptor automático.

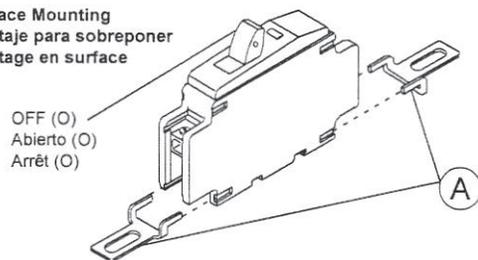
2. Coloque un tornillo a través de cada base de montaje para fijar el interruptor automático al interior del gabinete.

**MONTAJE EN RIEL DIN**

1. Slide notch onto DIN Rail tip. Deslice la muesca sobre el borde del riel DIN. Faire glisser l'encoche sur le bord du rail DIN.

Pull tab to release.  
 Jale la lengüeta para liberar.  
 Tirer sur la languette pour libérer.

Surface Mounting  
 Montaje para sobreponer  
 Montage en surface



**PIEDS DE MONTAGE**

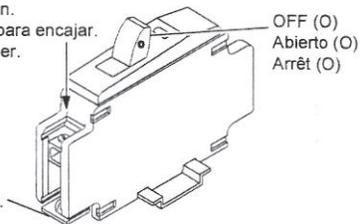
REMARQUE: Si le disjoncteur a été acheté dans un paquet économique, les pieds de montage doivent être commandés séparément.

1. Installer les pieds de montage (A) à chaque extrémité du disjoncteur.

2. Utiliser une vis à travers chaque pied de montage pour fixer le disjoncteur à l'intérieur du coffret.

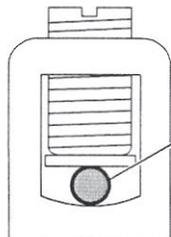
**MONTAGE SUR RAIL DIN**

2. Push down to snap on. Empuje hacia abajo para encajar. Enfoncer pour engager.



**CONNECTING WIRES**

07303058



See circuit breaker for lug wire range and tightening torque.  
 Consulte la etiqueta del interruptor automático para obtener el calibre del cable y el par de apriete.  
 Voir l'étiquette du disjoncteur pour obtenir le calibre des fils et le couple de serrage.

**CONEXIÓN DE LOS CABLES**

Solamente el personal especializado deberá instalar, hacer funcionar y prestar servicios de mantenimiento al equipo eléctrico. Schneider Electric no asume responsabilidad alguna por las consecuencias emergentes de la utilización de este material.

Importado en México por:  
 Schneider Electric México, S.A. de C.V.  
 Calz. J. Rojo Gómez 1121-A  
 Col. Gpe. del Moral 09300 México, D.F.  
 Tel. 55-5804-5000  
 www.schneider-electric.com.mx

**RACCORDMENT DES FILS**

Seul un personnel qualifié doit effectuer l'installation, l'utilisation, l'entretien et la maintenance du matériel électrique. Schneider Electric n'assume aucune responsabilité des conséquences éventuelles découlant de l'utilisation de cette documentation.

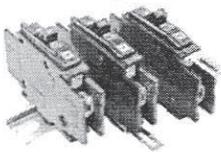
Schneider Canada Inc.  
 19 Waterman Avenue, M4B 1 Y2  
 Toronto, Ontario  
 1-800-565-6699  
 www.schneider-electric.ca

Electrical equipment should be installed, operated, serviced, and maintained only by qualified personnel. No responsibility is assumed by Schneider Electric for any consequences arising out of the use of this material.

Schneider Electric  
 3700 Sixth St. SW  
 Cedar Rapids, IA 52404 USA  
 1-888-SquareD (1-888-778-2733)  
 www.SquareD.com



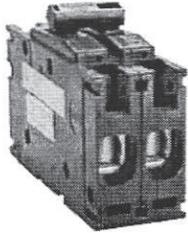
**QOU and QYU Unit Mount  
Miniature Circuit Breakers  
Class 720**



**Low Ampere QOU  
Miniature Circuit  
Breakers**

**General Specifications Common to All Low Ampere  
QOU Circuit Breakers**

- For convenient flush mount, surface mount or DIN mount (symmetrical rail 35 x 7.5 DIN/EN 50 022)
- Single handle with internal common trip
- Terminal lug wire size (1) #14-#2 AWG Cu or Al
- Reversible line and load lugs
- Field-installable quick connectors
- UL Listed 48 Vdc (5,000 AIR)
- UL Listed as HACR Type—10-70 A



**High Ampere  
QOU Circuit Breakers**

**General Specifications  
Common to All High Ampere  
QOU Circuit Breakers**

- Flush mount, surface mount, and DIN rail mount
- Internal common trip
- Lugs supplied in standard position only
- Terminal lug wire size (1) #12-#2/0 AWG Cu or Al
- UL Listed 60 Vdc per pole (5000 AIR)—  
**Note:** except switches
- UL Listed as HACR type—80-125 A

**QOU Miniature Circuit Breakers**

QOU unit mount miniature circuit breakers (cable-in/cable-out) are ideal for OEM applications. They have Square D's unique Visi-Trip feature and can be DIN rail-mounted or surface- or flush-mounted using mounting feet.

Ampere Rating	1-pole 120 Vac		2-pole 120/240 Vac		2-pole 240 Vac		3-pole 240 Vac	
	Catalog No.	Price	Catalog No.	Price	Catalog No.	Price	Catalog No.	Price
<b>10,000 AIR</b>								
10	QOU110		QOU210		QOU210H		QOU310	
15	QOU115		QOU215		QOU215H		QOU315	
20	QOU120		QOU220		QOU220H		QOU320	
25	QOU125		QOU225		QOU225H		QOU325	
30	QOU130		QOU230		QOU230H		QOU330	
35	QOU135		QOU235		.....		QOU335	
40	QOU140		QOU240		.....		QOU340	
45	QOU145		QOU245		.....		QOU345	
50	QOU150		QOU250		.....		QOU350	
60	QOU160		QOU260		.....		QOU360	
70	QOU170		QOU270		.....		QOU370▲	
80	QOU180▲		QOU280▲		.....		QOU380▲	
90	QOU190▲		QOU290▲		.....		QOU390▲	
100	QOU100▲		QOU2100▲		.....		QOU3100▲	
125	.....		QOU2125▲		.....		.....	

**22,000 AIR**

15	QOU115VH		QOU215VH		.....		QOU315VH	
20	QOU120VH		QOU220VH		.....		QOU320VH	
25	QOU125VH		QOU225VH		.....		QOU325VH	
30	QOU130VH		QOU230VH		.....		QOU330VH	
35	QOU135VH		QOU235VH		.....		.....	
40	QOU140VH		QOU240VH		.....		.....	
45	QOU145VH		QOU245VH		.....		.....	
50	QOU150VH		QOU250VH		.....		.....	
60	QOU160VH		QOU260VH		.....		.....	

**QOU-HM**

High magnetic trip circuit breakers are recommended for applications where high initial inrush may occur and for individual dimmer applications.

15	QOU115HM		.....		.....		.....	
20	QOU120HM		.....		.....		.....	

**QYU UL1077 Recognized Supplementary Protectors (5,000 AIR)**

		1-pole 277 Vac							
15	QYU115		.....		.....		.....		.....
20	QYU120		.....		.....		.....		.....
25	QYU125		.....		.....		.....		.....
30	QYU130		.....		.....		.....		.....

**QOU Non-Automatic Switches**

Non-automatic switches have the same physical packaging as miniature circuit breakers, but provide no overcurrent or short circuit protection. They are UL Listed per UL1087 and are CSA certified.

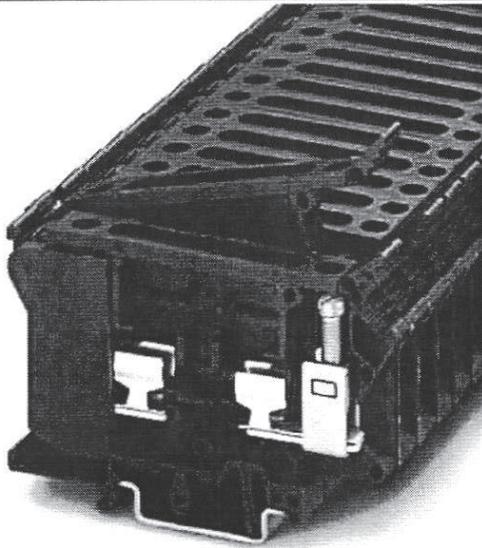
60	.....	...	.....	...	QOU200	<b>58.00</b>	QOU300
100	.....	...	.....	...	QOU2000	<b>164.00</b>	QOU3000
125	.....	...	.....	...	QOU20001	<b>301.00</b>	QOU30001

▲ High-ampere QOUs use appropriately sized terminal lugs and accessories.

**PUBLICATION DIVIDER**

Please note that the data given here has been taken from the online catalog. For comprehensive information and data, please refer to the user documentation at <http://www.download.phoenixcontact.com>. The General Terms and Conditions of Use apply to Internet downloads.

### ▶ Extract from the online catalog



Fuse terminal block for cartridge fuse insert, cross section: 0.5 - 16 mm<sup>2</sup>, AWG: 26 - 8, width: 10.2 mm, color: black

Order No.	3004171
Ord designation	UK 6,3-HESI
EAN	4017918090685
Pack	50 Pcs.
Customs tariff	85363010
Weight/Piece	0,03418 KG
Catalog page information	Page 305 (CL-2007)

### ▶ Product notes

WEEE/RoHS-compliant since: 01/01/2003



**IMPORTANT :** This date is valid for Customers in Germany only. Date Format is MM/DD/YYYY. Please contact your local in-country Phoenix Contact location or designated business partner for a Logistics Compliant date in your area. In order to guarantee delivery of RoHS-Compliant product, please purchase Phoenix Contact parts from authorized Phoenix Contact representatives and distributors.

UK 6,3-HESI



► **Technical data**

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**General**

Number of levels	1
Number of connections	2
Color	black
Insulating material	PA
Inflammability class acc. to UL 94	V2

**Dimensions**

Width	10.2 mm
Length	79 mm
Height NS 35/7,5	60.5 mm
Height NS 35/15	68 mm
Height NS 32	65 mm

**Technical data**

Fuse	G / 6,3 x 32
Fuse type	Glass
Rated surge voltage	6 kV
Contamination class	3
Surge voltage category	III
Insulating material group	I
Connection in acc. with standard	IEC 60947-7-3
Nominal current $I_N$	10 A
Nominal voltage $U_N$	500 V (As a fuse terminal block)

**Connection data**

Conductor cross section solid min.	0.5 mm <sup>2</sup>
Conductor cross section solid max.	16 mm <sup>2</sup>
Conductor cross section stranded min.	0.5 mm <sup>2</sup>
Conductor cross section stranded max.	16 mm <sup>2</sup>
Conductor cross section AWG/kcmil min.	20
Conductor cross section AWG/kcmil max	6
Conductor cross section stranded, with ferrule without plastic sleeve min.	0.5 mm <sup>2</sup>
Conductor cross section stranded, with ferrule without plastic sleeve max.	10 mm <sup>2</sup>
Conductor cross section stranded, with ferrule with plastic sleeve min.	0.5 mm <sup>2</sup>
Conductor cross section stranded, with ferrule with plastic sleeve max.	10 mm <sup>2</sup>
2 conductors with same cross section, solid min.	0.5 mm <sup>2</sup>
2 conductors with same cross section, solid max.	4 mm <sup>2</sup>
2 conductors with same cross section, stranded min.	0.5 mm <sup>2</sup>
2 conductors with same cross section, stranded max.	4 mm <sup>2</sup>
2 conductors with same cross section, stranded, ferrules without plastic sleeve, min.	0.5 mm <sup>2</sup>
2 conductors with same cross section, stranded, ferrules without plastic sleeve, max.	4 mm <sup>2</sup>
2 conductors with same cross section, stranded, TWIN ferrules with plastic sleeve, min.	0.5 mm <sup>2</sup>

## UK 6,3-HESI



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2 conductors with same cross section, stranded, TWIN ferrules with plastic sleeve, max.	6 mm <sup>2</sup>
Cross section with insertion bridge, solid max.	10 mm <sup>2</sup>
Cross section with insertion bridge, stranded max.	10 mm <sup>2</sup>
Type of connection	Screw connection
Stripping length	12 mm
Internal cylindrical gage	B6
Screw thread	M 4
Tightening torque, min	1.2 Nm

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**► Certificates / Approvals**

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## Certificate logos



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**CSA**

Nominal voltage $U_N$	600 V
Nominal current $I_N$	25 A
AWG/kcmil	26-8

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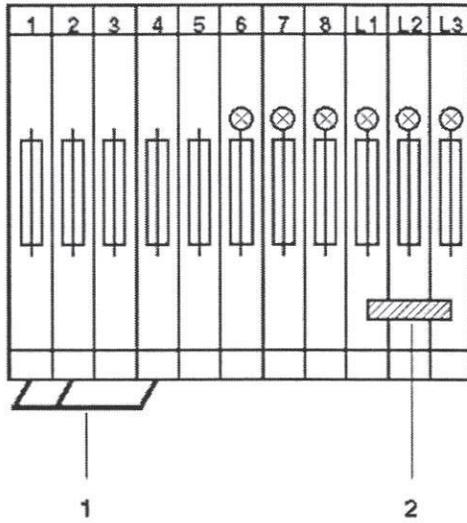
**UL**

Nominal voltage $U_N$	600 V
Nominal current $I_N$	10 A
AWG/kcmil	26-8

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▶ Drawings

Circuit diagram



1 = fixed bridge  
 2 = insertion bridge

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► **Address**

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PHOENIX CONTACT Inc., USA  
586 Fulling Mill Road  
Middletown, PA 17057  
USA  
Phone (800) 888-7388  
Fax (717) 944-1625  
<http://www.phoenixcon.com>  
Phoenix Contact  
Technical modifications reserved;

**PUBLICATION DIVIDER**

### Description

- Time delay, glass tube
- Optional leaded version available
- 1/4 x 1-1/4 (6.3mm x 32mm) physical size
- Glass tube, nickel-plated brass endcap construction
- UL Listed product meets standard 248-14

ELECTRICAL CHARACTERISTICS		
Rated Current	Amp Rating	Opening Time
1/16 - 30A	100%	None
	135%	60 minutes max.
	200%	120 seconds max.
1/16 - 3A	200%	5 seconds min.
3-2/10 - 8A	200%	12 seconds min.

### Agency Information

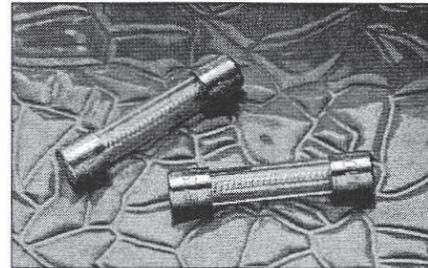
- UL Listed Card: MDL 1/16 - 8A (Guide JDYX, File E19180)
- UL Recognized Card: MDL 9 - 30A (Guide JDYX2, File E19180)
- CSA Certification Card: MDA 2/10 - 15 (Class No. 1422-01)

### Environmental Data

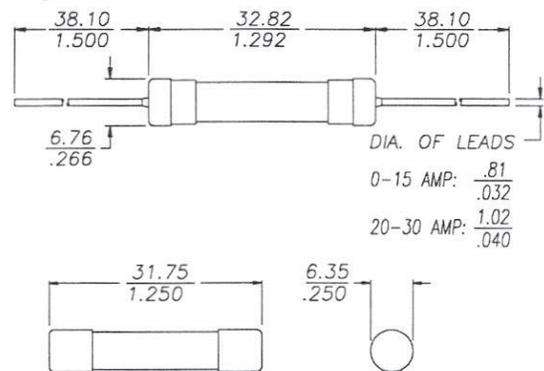
- Shock: 1/100A and 8/10A – MIL-STD-202, Method 213, Test Condition I; 1A thru 30A – MIL-STD-202, Method 207, (HI Shock)
- Vibration: 1/100A and 8/10A – MIL-STD-202, Method 201; 1/4A thru 30A – MIL-STD-202, Method 204, Test Condition C (Except 5g, 500HZ)

### Ordering

- Specify product code, option code and packaging code



Dimensions (mm/in)  
Drawing Not to Scale



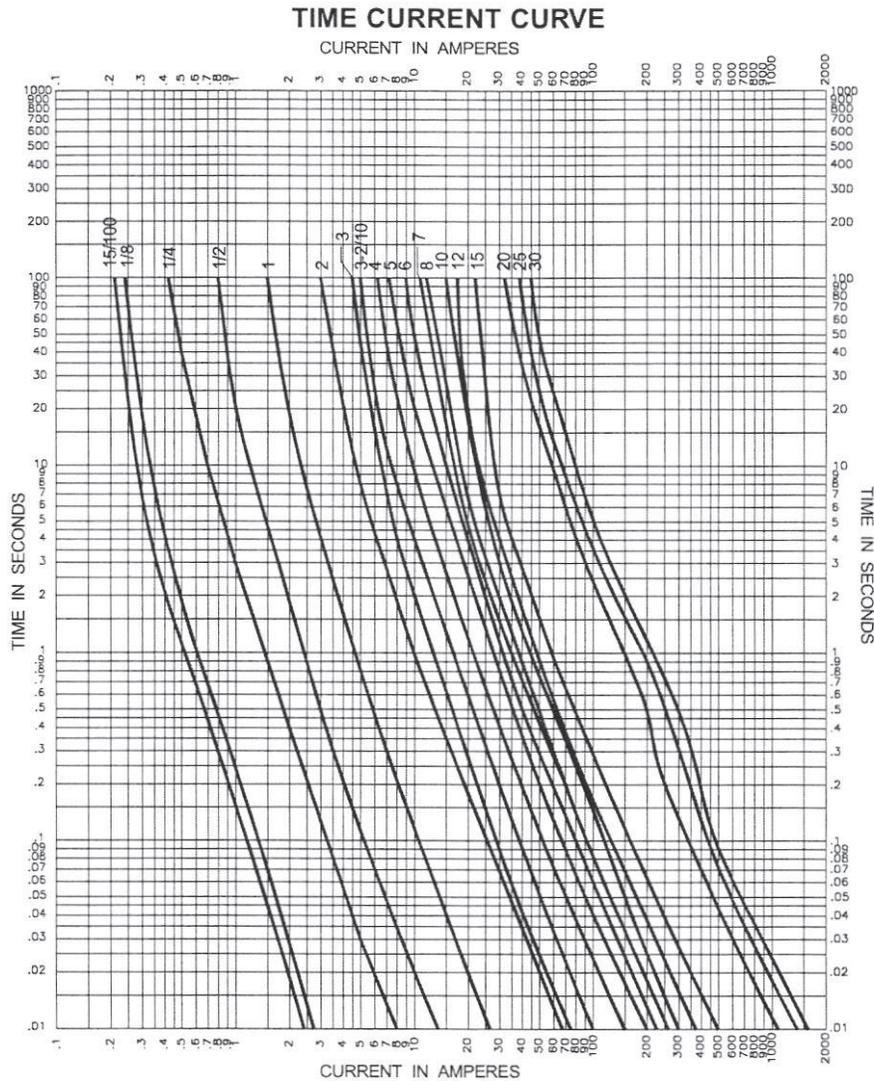
Product Code	Voltage Rating AC	AC Interrupting Rating*			Typical DC Cold Resistance** (ohms)	Typical Melting I <sup>2</sup> t† AC	Typical Voltage Drop‡
		250V	125V	32V			
		35A	10000A	-			
MDL-1/16	250V	35A	10000A	-	38.006	0.0046	2.79
MDL-1/10	250V	35A	10000A	-	15.900	0.0420	1.95
MDL-1/8	250V	35A	10000A	-	9.850	0.0422	1.52
MDL-3/16	250V	35A	10000A	-	4.680	0.116	N/A
MDL-2/10	250V	35A	10000A	-	4.115	0.314	0.972
MDL-1/4	250V	35A	10000A	-	0.320	0.447	0.965
MDL-3/10	250V	35A	10000A	-	2.300	0.412	0.808
MDL-3/8	250V	35A	10000A	-	2.800	0.982	1.46
MDL-1/2	250V	35A	10000A	-	1.725	1.656	1.27
MDL-3/4	250V	35A	10000A	-	0.822	4.343	1.01
MDL-1	250V	35A	10000A	-	0.525	11.498	0.995
MDL-1-1/4	250V	100A	10000A	-	0.320	86.2	0.722
MDL-1-1/2	250V	100A	10000A	-	0.250	22.7	0.721
MDL-2	250V	100A	10000A	-	0.173	62.3	0.644
MDL-2-1/4	250V	100A	10000A	-	0.068	49.6	0.535
MDL-2-1/2	250V	100A	10000A	-	0.096	63.1	0.410
MDL-3	250V	100A	10000A	-	0.067	67.5	0.345
MDL-4	250V	200A	10000A	-	0.035	19.3	0.187
MDL-5	250V	200A	10000A	-	0.023	32.0	0.160
MDL-6	250V	200A	10000A	-	0.018	37.4	0.155
MDL-6-1/4	250V	200A	10000A	-	0.018	38.7	0.152
MDL-7	250V	200A	10000A	-	0.018	42.7	0.140
MDL-8	250V	200A	10000A	-	0.011	47.8	0.119
MDL-9	32V	-	-	1000A	0.009	51.5	0.124
MDL-10	32V	-	-	1000A	0.008	64.4	0.114
MDL-15	32V	-	-	1000A	0.006	354.0	0.130
MDL-20	32V	-	-	1000A	0.002	2914.0	0.530
MDL-25	32V	-	-	1000A	0.001	15221.0	0.30
MDL-30	32V	-	-	1000A	0.001	15581.0	0.40

\* Interrupting Ratings (Interrupting ratings were measured at 70% - 80% power factor on AC)

\*\* DC Cold Resistance (Measured at  $\leq 10\%$  of rated current)

† Typical Melting I<sup>2</sup>t (A<sup>2</sup>Sec) (I<sup>2</sup>t was measured at listed interrupting rating and rated voltage.)

‡ Typical Voltage Drop (Voltage drop was measured at 25°C  $\pm$  3°C ambient temperature at rated current)



OPTION CODE	
Option Code	Description
B	Board Washable - Hermetically sealed to withstand aqueous cleaning
V	Axial leads - brass overcaps with copper and nickel flash, plated in tin lead

PACKAGING CODE	
Packaging Code	Description
BK	100 pieces of fuses packed into a cardboard carton with flaps folded
BK1	1,000 pieces of fuses packed into a cardboard carton with flaps folded
BK8	8,000 pieces of fuses packed into a cardboard carton with flaps folded



# SITOP Power Supplies

## Switched Mode Regulated Technology

### Power supplies, single phase

#### Description

The compact regulated power supplies in LOGO! design are primary switched-mode devices, which offer high efficiency, safe electrical isolation (SELV) and low weight.

They provide a single-phase connection with a wide input voltage range for worldwide use and variable output voltage.

Different versions are available depending on the output current and output voltage required.

Power supplies offer:

- Single-phase connection with wide input voltage range.
- Adjustable output voltage.
- Green LED indication for output voltage status.
- Can be snapped on DIN rail.
- Radio interference suppression, class B.
- Ambient temperature -20 °C to +55 °C.

#### Selection and ordering data

Design	Input voltage, rated value $U_e$ Rated	Output voltage, rated value $U_a$ Rated	Current, rated value $I_a$ Rated	Dimensions (W x H x D) mm	Order no.	Weight approx. kg	
<b>5 VDC power supplies</b>							
Enclosure 54 mm wide	<b>3 A</b>	100 – 240 VAC (85 – 264 VAC)	5 VDC ±3%	3 A	54 x 90 x 55	<b>6EP13111SH02</b>	0.2
	<b>6.3 A</b>	100 – 240 VAC (85 – 264 VAC)	5 VDC ±3%	6.3 A	72 x 90 x 55	<b>6EP13111SH12</b>	0.3
<b>12 VDC power supplies</b>							
	<b>1.9 A</b>	100 – 240 VAC (85 – 264 VAC)	12 VDC ±3%	1.9 A	54 x 90 x 55	<b>6EP13211SH02</b>	0.2
	<b>4.5 A</b>	100 – 240 VAC (85 – 264 VAC)	12 VDC ±3%	4.5 A	72 x 90 x 55	<b>6EP13221SH02</b>	0.3
<b>15 VDC power supplies</b>							
Enclosure 72 mm wide	<b>1.9 A</b>	100 – 240 VAC (85 – 264 VAC)	15 VDC ±3%	1.85 A	54 x 90 x 55	<b>6EP13511SH02</b>	0.2
	<b>4 A</b>	100 – 240 VAC (85 – 264 VAC)	15 VDC ±3%	4 A	72 x 90 x 55	<b>6EP13521SH02</b>	0.3
<b>24 VDC power supplies</b>							
	<b>1.3 A</b>	100 – 240 VAC (85 – 264 VAC)	24 VDC ±3%	1.3 A	54 x 90 x 55	<b>6EP13311SH02</b>	0.2
	<b>2.5 A</b>	100 – 240 VAC (85 – 264 VAC)	24 VDC ±3%	2.5 A	72 x 90 x 55	<b>6EP13321SH42</b>	0.3
	<b>4 A</b>	100 – 240 VAC (85 – 264 VAC)	24 VDC ±3%	4 A	90 x 90 x 55	<b>6EP13321SH51</b>	0.3
Enclosure 90 mm wide							

Further information is provided in catalog KT 10 1 [www.siemens.com/sitop](http://www.siemens.com/sitop)

# SITOP Power Supplies Switched Mode Regulated Technology

Power supplies, single-phase

## Description

SITOP switched mode power supplies offer high efficiency, safe electrical isolation (SELV) and low weight.

Different versions are available depending on the output current and application required.

The 2.5 A, 5 A and 10 A power supplies are the first members of a generation of 24 VDC power supplies, called SITOP smart. They come with a 1/3 smaller width compared to the former generation, ATEX and UL class 1, div 2 agency approvals for

use in hazardous locations and a power boost function to serve high inrush loads.

Power supplies are suitable for worldwide single-phase networks. Every power supply provides LED status display, adjustable output voltage and can be snapped on DIN rail.

Power supplies meet

- radio interference suppression class B,
- ambient temperature range from 0 °C to +60 °C.

## Selection and ordering data

Design	Input voltage, rated value $U_e$ Rated	Output voltage, rated value $U_o$ Rated	Current, rated value $I_a$ Rated	Dimensions (W x H x D) mm	Order No.	Weight approx. kg
<b>24 VDC power supplies</b>						
	<b>* 0.375 A</b> 48 – 220 VDC (30 – 264 VDC/ 30 – 187 VAC)	24 VDC ±2%	0.375 A	22.5 x 80 x 91	<b>6EP17312BA00</b>	0.2
	<b>* 0.5 A</b> 120 – 230 VAC (93 – 264 VAC)	24 VDC ±2%	0.5 A	22.5 x 80 x 91	<b>6EP13312BA10</b>	0.2
Limitation of input current harmonics according to EN 61 000-3-2.						
	<b>2.5 A</b> 120 – 230 VAC (85 – 132 VAC/ 170 – 264 VAC)	24 VDC ±3%	2.5 A	33 x 125 x 125	<b>6EP13322BA10</b>	0.4
Limitation of input current harmonics according to EN 61 000-3-2						
	<b>5 A</b> 120 – 230 VAC (85 – 132 VAC/ 170 – 264 VAC)	24 VDC ±3%	5 A	50 x 125 x 125	<b>6EP13332BA01</b>	0.5
	<b>5 A</b> 120 – 230 VAC (85 – 132 VAC/ 170 – 264 VAC)	24 VDC ±3%	5 A	50 x 125 x 125	<b>6EP13332AA01</b>	0.5
Limitation of input current harmonics according to EN 61 000-3-2						
	<b>10 A</b> 120 – 230 VAC (85 – 132 VAC/ 170 – 264 VAC)	24 VDC ±3%	10 A	70 x 125 x 135	<b>6EP13342BA01</b>	0.8
	<b>10 A</b> 120 – 230 VAC (85 – 132 VAC/ 170 – 264 VAC)	24 VDC ±3%	10 A	70 x 125 x 135	<b>6EP13342AA01</b>	0.8
Deg. of protection IP 65, adapted to ET 200X; Wall mounting radio interference suppression class A, ambient temperature -20°C to 55°C						
	<b>10 A</b> 120 – 230 VAC (93 – 132 VAC/ 187 – 264 VAC)	24 VDC ±3%	10 A	140 x 270 x 126	<b>6EP13342CA00</b>	1.7
Limitation of input current harmonics according to EN 61 000-3-2						
	<b>20 A</b> 120 – 230 VAC (90 – 132 VAC/ 187 – 264 VAC)	24 VDC ±3%	20 A	280 x 125 x 92	<b>6EP13362BA00</b>	2.0
<b>3 VDC to 52 VDC power supply</b>						
Limitation of input current harmonics according to EN 61 000-3-2, adjustable output voltage 3 V – 52 V, output max. 10 A or 120 W						
	<b>max. 10 A or 120 W</b> 120 – 230 VAC (85 – 132 VAC/ 170 – 264 VAC)	3 – 52 VDC ± 1%	10 A	75 x 125 x 125	<b>6EP13532BA00</b>	0.9

\* without adjustable output voltage.

Further information is provided in catalog KT 10.1 or [www.siemens.com/sitop](http://www.siemens.com/sitop)

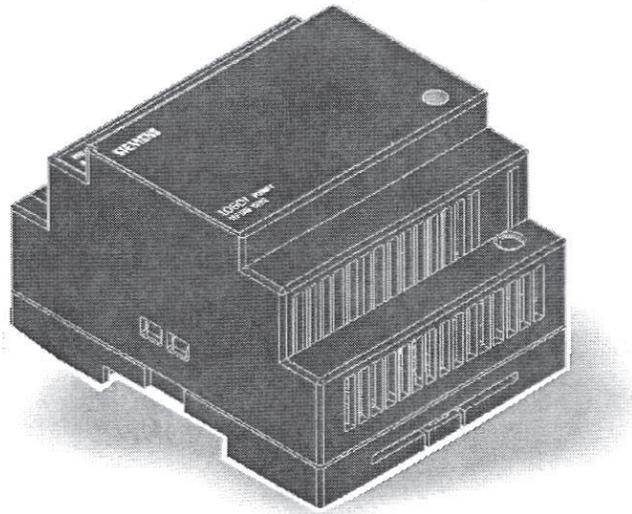
**PUBLICATION DIVIDER**

## LOGO!Power

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Betriebsanleitung  
Operating instructions  
Instructions d'utilisation  
Istruzione per l'uso  
Instrucciones de uso

Nr.: C98130-A7560-A2-4-6419



### Hinweis

Diese Betriebsanleitung enthält aus Gründen der Übersichtlichkeit nicht sämtliche Detailinformationen zu allen Typen des Produkts und kann auch nicht jeden denkbaren Fall der Aufstellung, des Betriebes oder der Instandhaltung berücksichtigen. Weiterführende Hinweise erhalten Sie über die örtliche Siemens-Niederlassung bzw. über die Homepage <http://www.siemens.de/sitop>. Technische Änderungen jederzeit vorbehalten. In Zweifelsfällen gilt der deutsche Text.

### Note

These instructions cannot claim to cover all details of possible equipment variations, nor in particular can they provide for every possible example of installation, operation or maintenance. Further information is obtainable from your local Siemens office or visit our homepage <http://www.siemens.de/sitop>. Subject to change without prior notice. The German text applies in cases of doubt.

### Note

Pour des raisons de clarté, cette notice ne contient pas toutes les informations de détail relatives à tous les types du produit et ne peut pas non plus tenir compte de tous les cas d'installation, d'exploitation et de maintenance imaginables. Pour de plus amples informations, veuillez-vous adresser à votre agence Siemens ou consultez notre site <http://www.siemens.de/sitop>. Sous réserve de modifications techniques. En cas de divergences, le texte allemand fait foi.

### Nota

Ai fini della chiarezza le presenti istruzioni di servizio non contengono tutte le informazioni dettagliate su tutti i tipi del prodotto e non possono nemmeno trattare tutti i casi di installazione, di esercizio o di manutenzione. Per ulteriori informazioni rivolgersi alla filiale Siemens di zona o consultare la homepage <http://www.siemens.de/sitop>. Ci riserviamo eventuali modifiche tecniche. In caso di differenze o problemi è valido il testo tedesco.

### Nota

Por razones de claridad, estas instrucciones no contienen todas las informaciones detalladas relativas a todos los tipos del producto ni pueden considerar todos los casos de instalación, de operación y de mantenimiento imaginables. Para más información, contacte con la sucursal local de Siemens o visite la Web <http://www.siemens.de/sitop>. Sujeto a cambios técnicos sin previo aviso. En caso de duda, prevalece el texto alemán.



**Warning notes**

LOGO!Power is a stabilized power supply unit designed for use on the single-phase a.c. mains. The power supply unit must be installed in compliance with the relevant DIN/VDE Regulations or the specific national standards. The connection to the supply voltage must be performed in accordance with VDE 0100 and VDE 0160. A protective device (fuse) and a disconnecting switch for safety isolation of the power supply unit must be provided. Trouble-free and safe operation of the unit is dependent on proper transport and storage, as well as installation by qualified personnel.

**Danger of electric shock !**

During the operation of any electric devices, it is inevitable that certain parts of these devices are subject to hazardous voltages. Improper use of these devices can therefore result in loss of life or severe personal injuries, as well as substantial property damage. Potentiometer U<sub>A</sub> is only allowed to be actuated using an insulated screwdriver!



**Caution !**

Electrostatically sensitive devices (ESD). Devices may only be opened by qualified personnel !

**Installation and assembling:**

LOGO!Power may only be installed and wired by a qualified expert who is conversant with and observes the generally applicable technical standards and the relevant standards and specifications.

**⚠ Danger** Before starting any installation or maintenance work, turn the main switch of the plant off and secure the unit against being re-energized. An appropriate disconnecting switch must be provided for maintenance, in order to be able to disconnect the unit from the supply circuit. LOGO!Power is a built-in device and must therefore be installed in a distributor box or a control cabinet. After installation, it must be ensured that all the terminals are properly covered. Only then is the unit sufficiently protected against accidental touching of live parts.

The unit can be snapped onto DIN EN 50022-35x15 or DIN EN 50022-35x7,5 bars. To snap the unit on to the DIN bar, hang it with its nose ① into the bar ③ and press until the spring ② snaps into place (see page 7). If difficulty is experienced in snapping the unit on to the bar, loosen the spring ② slightly as described under "Removing the Power Supply Unit". To remove from the DIN bar, use a screw driver to loosen the spring ② in the direction of the arrow.

Use a screw driver with a 3 mm blade for wiring (Terminal torque is 4,4Lb-in). No connector sleeves are required for the terminals. You can use wires (use copper wire rated 65/75°C) up to a cross-section of 1 x 2,5 mm<sup>2</sup> (AWG 14) or 2 x 1,5 mm<sup>2</sup> (AWG 16). Under no circumstances may the mains cable and the outgoing feeder be routed together! When using LOGO!Power together with devices subject to the class of protection I (with PE conductor), a link „-“ to „PE“ having a min. cross section of 1.5 mm<sup>2</sup> must be established.

To ensure proper heat dissipation, install the unit vertically with the input and output terminals on the top. Clearances of 2 cm should be provided above and beneath the unit, in order not to restrict the natural convection.

Parallel connection of two similar devices to increase the power is permitted (provided the difference of the output voltages is < 0,2% and the line impedances are equal to the load).

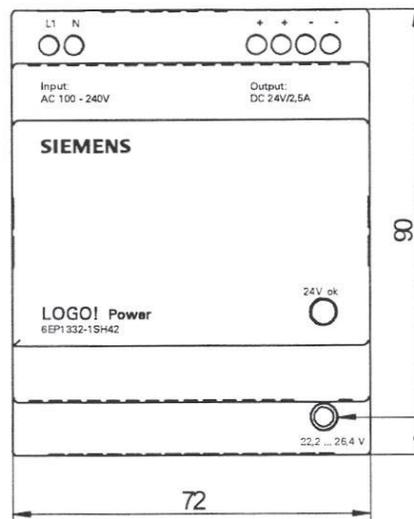
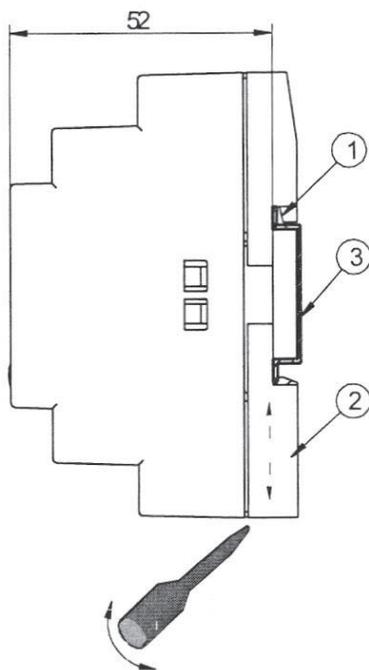
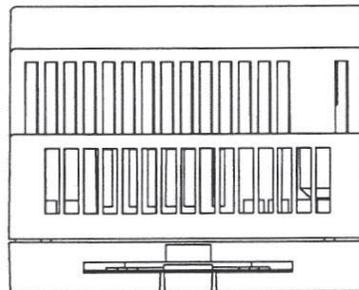
**Technical specifications:** Specifications valid for input voltage 230 V AC and ambient temperature +25 °C, unless otherwise stated. They are subject to change without prior notice.

Type:	5V/6,3A	12V/4,5A	15V/4A	24V/2,5A
Order-No.:	6EP1311-1SH12	6EP1322-1SH02	6EP1352-1SH02	6EP1332-1SH42
<b>Input:</b>				
Rated voltage V <sub>in</sub> :	100-240 V AC	100-240 V AC	100-240 V AC	100-240 V AC
Voltage range:	85...264 V AC	85...264 V AC	85...264 V AC	85...264 V AC
Line frequency range:	47...63 Hz	47...63 Hz	47...63 Hz	47...63 Hz
Mains buffering:	> 40 ms	> 40 ms	> 40 ms	> 40 ms
Rated current I <sub>in</sub> :	0,71-0,37 A	1,13-0,61 A	1,24-0,68 A	1,22-0,66 A
Protection in the mains supply line:	recommended: circuit breaker (IEC 898) up from 16 A char. B or up from 10 A char. C			
<b>Output:</b>				
Rated voltage V <sub>out</sub> :	5 V DC	12 V DC	15 V DC	24 V DC
Residual ripple/spikes:	< 100/100 mV <sub>pp</sub>	< 200/300 mV <sub>pp</sub>	< 200/300 mV <sub>pp</sub>	< 200/300 mV <sub>pp</sub>
Setting range:	4,6...5,4 V DC	10,5...16,1 V DC	10,5...16,1 V DC	22,2...26,4 V DC
Rated current I <sub>out</sub> :	6,3 A	4,5 A	4 A	2,5 A
Current limitation :	8,2 A typ.	5,9 A typ.	5,0 A typ.	3,4 A typ.
Efficiency at full load:	83 % typ.	85 % typ.	85 % typ.	87 % typ.
<b>Environmental conditions:</b>				
Transportation and storage temperature:	-40 °C...+70 °C	-40 °C...+70 °C	-40 °C...+70 °C	-40 °C...+70 °C
Ambient temperature during operation:	-20 °C...+55 °C	-20 °C...+55 °C	-20 °C...+55 °C	-20 °C...+55 °C
Degree of protection:	IP 20	IP 20	IP 20	IP 20
Pollution Degree environment:	2	2	2	2
Humidity rating:	Climate category 3K3 acc. to EN 60721, relative air humidity 5...95 %, without condensation			
EMC interference emission:	EN 50081-1, class B acc. to EN 55022			
EMC interference immunity:	EN 61000-6-2, EN 61000-4-2/-3/-4/-5/-6/-11			
<b>Safety:</b>				
Protection class:	UL 60950, Class II (double insulated, without protective earth PE)			
Galvanic isolation primary/secondary:	SELV output voltage acc. to EN 60950 and EN 50178			

**Certificates:**

- CE CE marking acc. to 98/336 EEC and 73/23 EEC
- UL UL 508 (Listed, File E197259), UL 60950 (Recognized, File E151273), Class 2 outputs for the 24V models
- FM Class I, Division 2, Groups A,B,C,D, T4
- GL Approval for shipbuilding to Germanischer Lloyd

Maßbild / Montagehinweis  
 Dimensional drawing / Installation note  
 Dimensions / montage  
 Disegno Quotato / Indicazioni di montaggio  
 Dimensiones / Indicaciones de montaje



Einstellbarkeit U<sub>a</sub>  
 Adjustment  
 Reglage  
 Regolazione  
 Ajuste

Gewicht ca. / Weight approx / Poids ca. / Peso aprox. / Peso ca. 0,25kg (0,55 lb)

Herausgegeben von  
 SIMEA  
 Bereich A&D  
 Siemensstraße 88-92  
 A 1210 Wien

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 Liefermöglichkeiten und technische  
 Änderungen vorbehalten



### CONTROL SYSTEMS

1239 WILLOW LAKE BOULEVARD  
 VADNAIS HEIGHTS, MINNESOTA 55110  
 651 - 766 - 2700 Fax: 651 - 766 - 2701  
 www.siemens.com/water

The 9182 DC to DC Converter module converts an unregulated 10.5 VDC - 20 VDC, to a regulated 24 VDC with a maximum output current of 900mA. A 2 Amp fast acting fuse and a high capacity transient suppression diode protect the module.

The 9182 DC to DC Converter module is used to supply 24 VDC to small Programmable Logic Controllers and to 4-20mA current loops.

Part Number	Description
96032665	12VDC to 24VDC Converter Model 9182

## Specifications

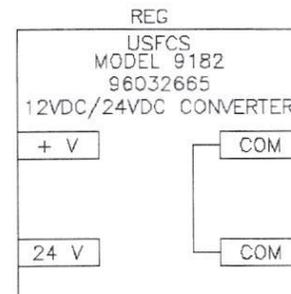
### Physical

Dimensions: 2.5" X 3.0"

Snaptrack mounting

### Electrical

Maximum Input Voltage:	20 VDC
Minimum Input Voltage for rated Output:	10.5 VDC
Input Power Fuse	2 Amp
Output Voltage:	24 VDC +/- 0.5
Peak output current:	900mA



## Terminal Description and Normal Operation

Terminal +V	Incoming Voltage 10.5 VDC - 20 VDC
Terminal 24 V	Output Voltage Regulated 24VDC
Com	+V and 24 V Common

Note: The input and output are on the same common negative.

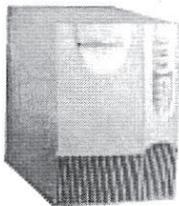
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# EATON

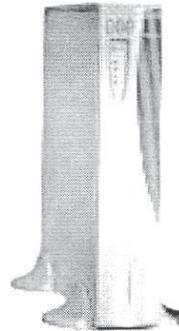
# Powerware

## Powerware® 5125 Family Uninterruptible Power System

Product Focus



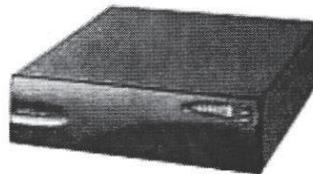
Powerware 5125 tower  
model 1000 to 2200 VA



Powerware 5125 two-in-one  
form factor 1000 to 3000 VA

### Features

- Protects connected equipment from common power anomalies including surges, sags, brownouts, and over-voltage
- Provides more real wattage in less space with a .9 power factor—protecting more equipment and leaving more room for expansion.
- Available in two-in-one form factor (1000-3000 VA) and rack mount (5000/6000 VA) products
- Offers the choice of rackmount or tower installation—space-saving 2U packaging for 1000-3000 VA, 3U for 5000/6000 VA models—including batteries
- Increases battery life through microprocessor-controlled Advanced Battery Management (ABM)<sup>®</sup> technology
- Enables prioritized shutdown of non-essential equipment during outages to maximize backup time for critical devices
- Increases uptime with hot-swappable batteries and electronics, without interrupting power to connected systems (2400–6000 VA models)
- Ensures data and system integrity with a complete suite of power management software and connectivity options
- Provides a two-year limited warranty with next business day replacement, 10-year pro-rated warranty, and \$150,000 load protection guarantee; optional Gold Plans available (US and Canada\*)



Powerware 5125 rackmount  
5000 to 6000 VA

### Introducing the expanded Powerware 5125 family of UPSs

The Powerware® 5125 family of uninterruptible power systems (UPSs) resolves the five primary problems with incoming utility power—outages, sags, surges, brownouts, and over-voltage conditions—and supplies clean, conditioned power to all connected equipment. It also offers varying degrees of protection from other problems, such as line noise, frequency variation, harmonics, and switching transients.

Incorporating more than 40

years of UPS design experience, Powerware 5125 UPSs deliver power protection for PC/workstation clusters, enterprise networking systems, server farms, and data center systems—anywhere continuous, clean power must be provided in a compact package at an affordable price.

This proven family of UPSs—which already included models for 1000-3000 VA—has been expanded with new 5000 VA and 6000 VA models that offer space-saving designs and innovative features at competitive prices to deliver greater return from your IT investment.

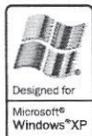
### Product Snapshot

**Power Rating:** 1000–2200 VA tower models  
1000–3000 VA - two-in-one models  
(rackmount and tower)  
5000–6000 VA rackmount models

**Voltage:** 200, 208, 220, 230, 240 Vac

**Frequency:** 50/60 Hz (auto-sensing)

**Configuration:** tower, two-in-one form factor  
or rackmount



Designed for  
Microsoft®  
Windows®XP

## Power more servers in less space

Powerware 5125 models in the 1000-3000 VA range only occupy 2U. For maximum deployment flexibility, the standard chassis (available in beach gray or black) can be deployed as a tower unit or in a rack.

Up to 6000 VA of UPS power is packed into three units (3U) of rack space—a mere 5.25" high, including batteries. This space-saving 3U design is one of the most power-dense 5000-6000 VA UPSs you can buy. That means more rack space is available for other critical equipment, such as servers, disk arrays, and extra batteries.

In addition to occupying less rack space than competing alternatives, Powerware 5125 UPSs deliver significantly more wattage—more power to protected equipment for the same utility dollar. The Powerware 5125 5000 VA and 6000 VA models power 30 percent more servers in 40 percent less space compared to the leading competitive offering.

The difference is a .9 power factor—a measure of apparent power versus real power. By delivering more real output power, the Powerware 5125 can actually power more servers than another UPS of equivalent VA rating. This feature applies to two-in-one and rack mount models.

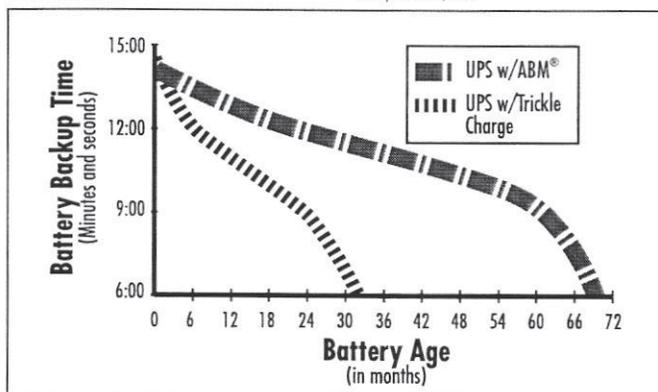
## Line-interactive design shields systems from silent threats

The line-interactive 5125-series UPSs regulate voltage by boosting input utility voltage up or moderating it down as necessary before allowing it to pass to the protected equipment.

And if input voltage varies as much as 20 percent over

nominal voltage or 30 percent under—which can easily happen when running on generator power—the Powerware 5125 accepts this inconsistent voltage and delivers clean, consistent output.

Unlike typical line-interactive systems, Powerware 5125 UPSs do not switch back and forth to battery power to accomplish this (which would shorten battery life and increase battery replacement costs), and do not send disruptive voltage spikes when boosting power up to specification.



Data based on tests performed by an independent battery manufacturer.

## Extend battery life with Advanced Battery Management (ABM)® technology

Most UPS manufacturers in the market today offer batteries that are constantly 'trickle-charged'—a process that degrades the battery's internal chemical composition, reducing potential battery service life by as much as 50 percent. In contrast, Powerware ABM technology uses sophisticated sensing circuitry and an innovative three-stage charging technique that increases the useful service life of UPS batteries while optimizing battery recharge time.

The Powerware 5125 provides up to 60 days' notice of the end of useful battery service life, to allow ample time to hot-swap batteries without ever having to shut down connected equipment.

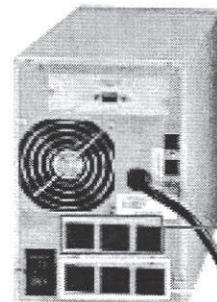
## POWERWARE 5125 BATTERY RUNTIME CHART (MINS. FULL/HALF LOAD)

Load VA	Internal	1 EBM	2 EBMs	3 EBMs	4 EBMs
<b>Tower models</b>					
1000	5/14	25/60	55/170	83/199	109/228
1500	6/17	33/79	63/146	92/174	120/201
2200	5/14	26/60	55/170	81/198	106/224
<b>Two-in-one (rackmount and tower) models</b>					
1000	7/19	33/68	58/120	82/166	105/214
1500	5/13	23/57	49/161	73/172	96/205
2400	7/19	35/73	60/124	85/177	110/229
3000	5/15	25/61	49/103	69/146	90/190
<b>Rackmount models</b>					
5000	7/19	24/61	46/106	67/156	89/210
6000	5/15	19/49	36/85	53/125	71/168

\* Up to 4 EBMs can be connected to all models. EBM runtimes include internal batteries. Runtime chart provides typical information. Battery runtimes are approximate and may vary with equipment, configuration, battery age, temperature, etc.

## Load Segments feature maximizes battery backup for critical systems

Using Powerware LanSafe™ power management software, you can independently control "Load Segments," which are groups of receptacles on the rear panel of the Powerware 5125 UPS. This feature enables you to manage scheduled shutdowns and sequential startups of protected loads. During a power outage, you could shut down power to non-critical devices (Load Segment 2), thereby extending battery backup time available for critical devices (Load Segment 1). When the Load Segments feature is used with Powerware connectivity cards, users can remotely re-boot locked-up network equipment. Simply connect to the interface card over the network, and toggle the password-protected Load Segment controller to get your network back online.



Load Segment 1 with critical equipment

Load Segment 2 with less critical equipment

Powerware 5125 tower model 1000 to 2200 VA

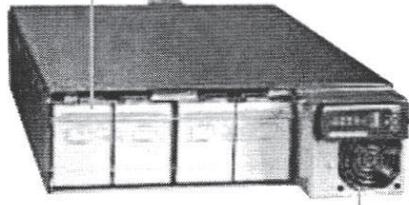
## Add battery modules for even more backup capacity

Up to four Extended Battery Modules can be added to provide additional battery backup capacity as necessary. Batteries are hot-swappable and can be replaced at any time without interrupting UPS operation and load protection.

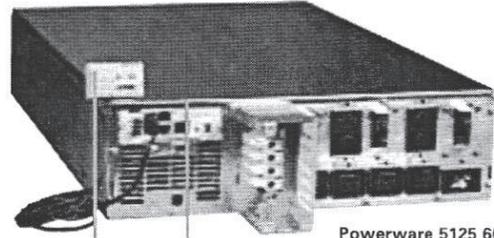
Extended Battery Modules are available in three forms: tower models, 2U and 3U rack mount models, designed to install tightly in tandem with the UPS for a clean look that enhances the appearance of the data center while saving precious space.

Hot-swappable battery modules - when batteries reach the end of their useful life, replace battery modules without powering down connected equipment (available on all models)

Hot-swappable electronic modules - replace electronics modules without shutting down connected equipment (available on 2400 VA to 6000 VA models)



Powerware 5000/6000 VA rackmount model



EMP  
ConnectUPS-X  
Web/SNMP card

Powerware 5125 6000 VA  
rack mount hardwired model

### Easily service the UPS without interrupting power to protected systems

LEDs on the front panel of the Powerware 5125 indicate the presence of alarm conditions, battery utilization, bad or low batteries, site wiring faults, and incoming utility power, as well as current load levels relative to UPS capacity.

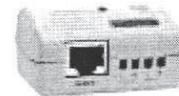
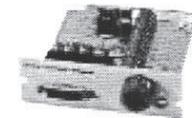
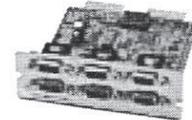
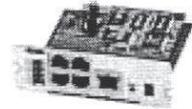
When batteries reach the end of their useful life, or electronics modules require service, replacement is easy. With simple access through the front panel, users can install new battery and electronics modules without ever powering down connected servers or removing the unit from the rack.

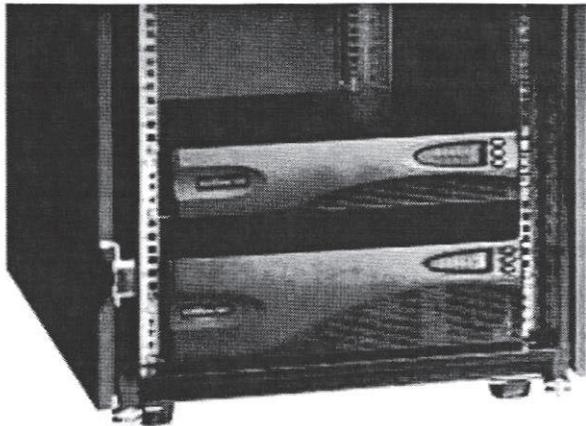
The key is an internal automatic bypass feature (available on 2400 VA-6000 VA models) that allows the UPS to continuously provide power to critical equipment while you're working on the system. Even if you pull out the electronics, the UPS keeps doing its job.

### Connectivity options offer maximum flexibility

Connectivity options are available to suit nearly any communication requirement. The standard unit is equipped with a RS-232 serial communications port and a built-in USB port (5000 and 6000 VA models) to interface with power management software. You can customize your UPS by adding any of the following X-Slot interface options for other types of communications:

- ConnectUPS Web/SNMP Interface Card enables direct control and monitoring in SNMP-based networks, plus the ability to monitor UPS status and meters through a Web browser (includes built-in switch hub)
- Multi-server Card enables up to six serially connected devices of mixed operating systems to be independently managed and controlled by a single UPS
- Relay Interface Card provides dry-contact interface between the UPS and any relay-connected device, including the IBM® eServer® iSeries (AS/400) and a variety of industrial applications
- Environmental Monitoring Probe (EMP) works with the ConnectUPS Web/SNMP card, remotely monitoring temperature, humidity, and the status of two contacts/sensors, such as smoke detector and open-door detector





Powerware 5125 2U and 3U rackmount models

### Power management software unifies and centralizes UPS management

Every Powerware 5125 UPS comes with a CD that includes multi-media demonstrations, product data sheets, and the following power management software:

- Free LanSafe power management software for network shutdown
- 30-day trial version of Powerware PowerVision® UPS performance analysis and monitoring software



Powerware LanSafe power management software gives you control and visibility over all your UPS systems, using an intuitive, graphical interface and SNMP (Simple Network Management Protocol).

Using Eaton's innovative Powerware management software, you can securely monitor UPS and battery performance over your LAN or the Web, establish prioritized shutdown of network devices and client/server applications, test all networked UPS systems from one node, analyze trends and network conditions, and stay informed of potential power problems by pager and email.

### Gain a new level of confidence

The culmination of 40 years of R&D excellence, the newly expanded Powerware 5125 UPS family delivers confidence—confidence that your organization's critical electronics are protected by reliable and effective line-interactive protection, and confidence that Eaton will be there with you for the long term with warranty coverage and expert technical support.

Eaton offers a comprehensive, two-year limited warranty covering parts and labor. For warranty service on your Powerware 5125, we will ship a replacement unit via overnight express.

For added confidence, your Powerware 5125 UPS is also covered by a 10-year pro-rated warranty and \$25,000 load protection guarantee.

To find out more, visit our Web site at [www.powerware.com](http://www.powerware.com), or contact us at 1-800-356-5794.

### AVAILABLE OPTIONS

Order Number	Description
05141562-0021	4-post rackmount kit (1000-3000 VA rackmount models) fits 19-inch racks
05146726-5501	2-post rackmount kit (1000-3000 VA rackmount models) fits 19-inch racks
05146871-5501	3-Slot seismic mounting kit (1000/1500 rackmount models only)
05146875-5501	5-Slot seismic mounting kit (1000/1500 rackmount models only)
05146447-5502	Multi-server card
05146508-5501	USB card
1018460	Relay card
103002974-5501	ConnectUPS Web/SNMP card
103002510-5501	Modbus card
103003637-5501	Environmental Monitoring Probe (EMP)
05146519-001	Powerpass® Distribution Module (1000/1500 rackmount models only)
05146401-5501	Power Distribution Unit 250 VA 0U form factor. Side cabinet mount (5000/6000 VA)

**MODEL SELECTION GUIDE - POWERWARE 5125**

MODEL NUMBER <sup>1</sup>	POWER RATING (VA,WATT)	INPUT/OUTPUT VOLTAGE (VAC) <sup>2</sup>	INPUT CONNECTION	OUTPUT RECEPTACLES <sup>3</sup>	DIMENSIONS HxWxD (IN/MM)	WEIGHT (LBS/KG)	PART NUMBER/UPC CODE
<b>Tower Models (North America)</b>							
PW 5125 1000	1000/700	120	5-15P, 6 ft line cord	(6) 5-15R	9.45 x 6.38 x 15.79/ 240 x 162 x 401	34.3/15.6	05146629-5501/ 790341032937
PW 5125 1500	1440/1050	120	5-15P, 6 ft line cord	(6) 5-15R	9.84 x 6.38 x 18.39/ 250 x 162 x 467	50.7/23.0	05146632-5501/ 790341032968
PW 5125 2200	1920/1600	120	5-20P, 6 ft line cord	(6) 5-15R, (2) 5-20R	9.84 x 8.07 x 19.41/ 250 x 205 x 493	68.3/31.0	05146635-5501/ 790341032999
PW 5125 2200b	2080/1600	208	IEC-320-15A, Inlet <sup>4</sup>	(9) IEC-320-10A (C13)	9.84 x 8.07 x 19.41/ 250 x 205 x 493	68.3/31.0	05146636-5501/ 790341033002
<b>Tower Models (International)</b>							
PW 5125 1000i	1000/700	230	IEC-320-10A, Inlet <sup>4</sup>	(6) IEC-320-10A (C13)	9.45 x 6.38 x 15.79/ 240 x 162 x 401	34.3/15.6	05146630-5501/ 790341032944
PW 5125 1500i	1500/1050	230	IEC-320-10A, Inlet <sup>4</sup>	(6) IEC-320-10A (C13)	9.84 x 6.38 x 18.39/ 250 x 162 x 467	50.7/23.0	790341032975/ 790341032975
PW 5125 2200i	2200/1600	230	IEC-320-10A, Inlet <sup>4</sup>	(9) IEC-320-10A (C13)	9.84 x 8.07 x 19.41/ 250 x 205 x 493	68.3/31.0	05146637-5501/ 790341033019
<b>Two-in-One (Rackmount and Tower) Form Factor Models<sup>5</sup> (North America)</b>							
PW 5125 1000 RM	1000/900	120	5-15P, 6 ft line cord	(6) 5-15R	3.5 x 17.0 x 19.4/ 89 x 432 x 494	61.0/27.67	05146666-5501/ 790341033033
PW 5125 1500 RM	1440/1340	120	5-15P, 6 ft line cord	(6) 5-15R	3.5 x 17.0 x 19.4/ 89 x 432 x 494	61.0/27.67	05146669-5501/ 790341033064
PW 5125 2400 RM	2400/2250	120	L5-30P, (12' attached)	(1) L5-30R, (6) 5-15R	3.5 x 19.0 x 24.5/ 89 x 483 x 623	89.0/40.40	05147564-5501/ 790341033510
PW 5125 3000 RM	2880/2700	120	L5-30P, (12' attached)	(1) L5-30R, (6) 5-15R	3.5 x 19.0 x 24.5/ 89 x 483 x 623	89.0/40.40	05147152-5501/ 790341035273
<b>Two-in-One (Rackmount and Tower) Form Factor Models<sup>5</sup> (International)</b>							
PW 5125 1000i RM	1000/900	230	IEC-320-10A, Inlet <sup>4</sup>	(6) IEC-320-10A (C13)	3.5 x 17.0 x 19.4/ 89 x 432 x 494	61.0/27.67	05146667-5501/ 790341033040
PW 5125 1500i RM	1500/1340	230	IEC-320-10A, Inlet <sup>4</sup>	(6) IEC-320-10A (C13)	3.5 x 17.0 x 19.4/ 89 x 432 x 494	61.0/27.67	05146670-5501/ 790341033071
PW 5125 2400i RM	2400/2250	230	IEC-309 16A P, (12' attached)	(1) IEC-320-16A (C19) (9) IEC-320-10A (C13)	3.5 x 19.0 x 24.5/ 89 x 483 x 623	89.0/40.40	05147565-5501/ 790341035327
PW 5125 3000g RM	3000/2700	200-240	IEC-320-16A, receptacle	(1) IEC-320-16A (C19) (9) IEC-320-10A (C13)	3.5 x 19.0 x 24.5/ 89 x 483 x 623	89.0/40.40	05147155-5501/ 790341035297
PW 5125 3000e RM	3000/2700	230	IEC-320-16A, receptacle	(1) IEC-320-16A (C19) (9) IEC-320-10A (C13)	3.5 x 19.0 x 24.5/ 89 x 483 x 623	89.0/40.40	05147641-5501/ 790341035921
PW 5125 3000i RM	3000/2700	230	IEC-309 16A P	(1) IEC-320-16A (C19) (12' attached)	3.5 x 19.0 x 24.5/ (9) IEC-320-10A (C13)	89.0/40.40	05147154-5501/ 790341035280
<b>Rackmount Models Only<sup>6</sup></b>							
PW 5125 5000 RM	5000/4500	200/208, 220, 230, 240	L6-30P	L6-30R on short cord, (2) L6-20 (4) C13	5.25 x 17.50 x 26.0/ 133 x 445 x 661	161/73	103003611-5501/ 790341043414
PW 5125 6000 RM HW	6000/5400	200-240	HW (terminal block)	HW, (4)C19, (4)C13	5.25 x 17.50 x 26.0/ 133 x 445 x 661	161/73	103003610-5501/ 790341043582
PW 5125 6000i RM	6000/5400	220, 230, 240	IEC309-32A	IEC309-32A on short cord, (4)C19, (4)C13	5.25 x 17.50 x 26.0/ 133 x 445 x 661	161/73	103003612-5501/ 790341043421
<b>Optional Extended Battery Modules (EBMs)</b>							
For use with PW 5125 24 V EBM 1000 VA tower models only	N/A	N/A	N/A	N/A	9.84 x 6.38 x 18.66/ 250 x 162 x 474	59.5/27.0	05146638-5501/ 790341033088
For use with PW 5125 48 V EBM 1500/2200 VA tower models only	N/A	N/A	N/A	N/A	9.84 x 6.38 x 18.66/ 250 x 162 x 474	59.5/27.0	05146639-5501/ 790341033095
For use with PW 5125 48 V EBM RM 1000/1500 VA RM models only	N/A	N/A	N/A	N/A	3.5 x 17.0 x 19.4/ 89 x 432 x 494	65.0/29.5	05147148-5501/ 790341033101
For use with PW 5125 120 RM 2400/3000 VA RM models only	N/A	N/A	N/A	N/A	3.5 x 19.0 x 24.5/ 89 x 483 x 622	121.0/54.9	05147156-5501/ 790341035303
For use with PW 5125 240 EBM (beach grey) 5000/6000 VA RM models only	N/A	N/A	N/A	N/A	5.25 x 17.50 x 24.75/ 133 x 445 x 629	169/76	103003387-5501/ 790341041007
For use with PW 5125 240 EBM (black) 5000/6000 VA RM models only	N/A	N/A	N/A	N/A	5.25 x 17.50 x 24.75/ 133 x 445 x 629	169/76	103003387-6501/ 790341041014

1. 50/60 automatic frequency selection. 2. 120 V models are 110 V, 120 V, 127 V user-selectable. 230 V models are 220 V, 230 V, 240 V user-selectable. 208 V models are 208 V, 220 V, 230 V, 240 V user-selectable. 3. Includes (2) each IEC interconnect cables. 4. 1000-1500 VA models are divided into (2) Load Segments (receptacle groups). 2200-3000 VA models are divided into (3) Load Segments (receptacle groups). 5000/6000VA models are divided into (2) Load Segments. 5. Unit fits into standard 19-inch racks. Mounting kits are sold separately. 6. 5000/6000 VA models ship with both black and beige front panel bezels; models include rail kits and mounting hardware; factory installed ConnectUPS Web/SNMP/xHub card available by inserting -5507 for -5501.

# Technical Specifications<sup>1</sup>

Electrical Input	1000-2200 VA	2400-3000 VA	5000/6000 VA
Nominal Voltage <sup>2</sup>	120, 208 and 230 Vac <sup>2</sup>	120, 208 and 230 Vac <sup>2</sup>	200/208, 220, 230 and 240 Vac <sup>2</sup>
Input Voltage Ranges (for user-selectable voltages)	low voltage: 77-152 V high voltage: 154-288 V		160-288
Operating Frequency	50/60 Hz, auto-sensing		
Frequency Range	46-54 hz for 50 hz; 56-64 hz for 60 hz		

## Electrical Output

On Utility Voltage Regulation	-10% to +6% of nominal
On Battery Voltage Regulation	±5% RMS
Voltage Wave Shape (on battery)	sine wave
Output Protection	short circuit protection

## Battery

Battery Type	sealed, lead-acid; maintenance free
Battery Runtime	see Battery Run Time table
Battery Replacement	hot-swappable internal batteries and external batteries modules
Recharge Time	<3 hours to 90% usable capacity
Start-On-Battery	allows start of UPS without utility input

## General

Electrical Power Module Replcmnt	no	yes, hot-swap	yes, hot-swap
Diagnostics	full system self-test on power up		
UPS Bypass	no bypass	internal bypass	
Transfer Time	4ms typical, 6ms max		
Dimensions and Weights	see Model Selection Guide		
Overload (normal operation)	110% overload, shutdown after 3 minutes 150% overload, shut down 10 cycles	100-102 % indefinite	103-112% 2 minutes and > 112% 12 line cycles

## Communications

User Interface	front control panel		
Audible Alarms	for various UPS alarm conditions, including: on battery, low battery, overload, UPS fault		
Network Transient Protector	UL 497 A, in/out jacks RJ45 (high voltage models network protection) & RJ11 (low voltage models modem protection)	No	
REPO Port	meets NEC code 645-11 intent and UL requirements		
Communication Ports	see Communications Slot	native USB and serial port	
Communication Slot	RS-232 single serial module (standard) options available, see options chart	Web/SNMPxHub card factory installed; other options also available	
Cable	6-foot communications cable included		
Power Management Software	Powerware Software Suite CD-ROM (bundled with UPS)		

## Environmental

Safety Certifications	UL; cUL; NOM; C-Tick; CE marking		UL; cUL; NOM; C-Tick; CE marking TUV/VDE, GS
EMC Compliance	FCC Part 15, EN50091-2, Class A for 2.2 KVA and RM; Class B for 1000 and 1500 VA tower models	FCC Part 15	EN50091-2, Class A
Operating Temperature	0 to 40°C (32 to 104°F)		10°C to 40°C
Storage Temperature	-15 to 50°C (5 to 122°F)		-25°C to 55°C
Relative Humidity	0% to 95% non-condensing		
Lightning & Surge Protection	ANSI/IEEE C62.41 (IEEE 587), IEC61000-4-5		
Surge Energy Rating	high-energy 6500 A peak		
Audible Noise	less than 40 dBA typical	less than 45 dBA typical	
Altitude	3000m (10,000 ft) without derating		

1. Specifications are subject to change without notice due to continuing product improvement programs. 2. See Model Selection Guide for user-selectable voltages.

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Finland: 358.94.52.661  
France: 33.1.6012.7400  
Germany: 49.7841.666.0  
Italy: 39.02.66.04.05.40  
Norway: 47.23.03.65.50  
Sweden: 46.8.598.940.00  
United Kingdom: 44.1753.608.700

ASIA PACIFIC  
Australia/NZ: 61.2.9878.5000  
China: 86.21.6361.5599  
HK/Korea/Taiwan: 852.2745.6682  
India: 91.11.2649.9414 to 18  
Singapore/SEA: 65.6829.8888

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Powerware

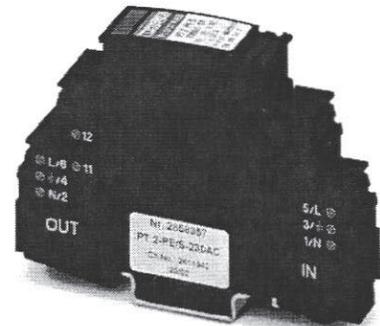
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5125FXA  
July 2005



# PT 2-PE/S-120AC/FM

Order No.: 2856812

The figure shows the PT 2-PE/S-230AC/FM version



<http://eshop.phoenixcontact.de/phoenix/treeViewClick.do?UID=2856812>

DIN rail module with pluggable surge protection type 3 for terminal equipment, fault signaling and remote indication contact. Design: 120 V AC

Commercial data	
EAN	4017918952952
Pack	1 Pcs.
Customs tariff	85363010
Weight/Piece	0.0799 KG

### Product notes

WEEE/RoHS-compliant since:  
06/23/2006



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### Certificates / Approvals



Certification

CB, CCA, CSA, GOST, KEMA, OEVE

**Accessories**

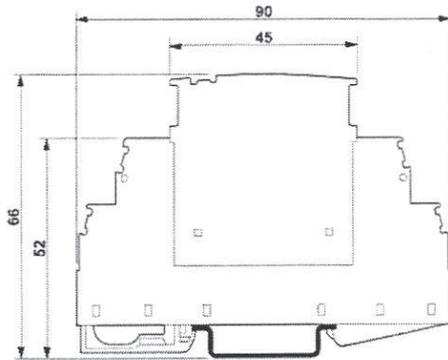
Item	Designation	Description
<b>Marking</b>		
1050004	ZB 5 :UNBEDRUCKT	Zack strip, unprinted, 10-section, for individual labeling with M-PEN, ZB-T or CMS system, pack is sufficient for 100 terminal blocks, for a terminal width of 5.2 mm, color: White
2715212	ZB 5,8,LGS:FORTL.ZAHLEN	Zack marker strip, 10-section, printed horizontally: with consecutive numbers, 1-10, 11-20 etc. up to 991-1000, color: white
1050305	ZB 5,8:SO/CMS	Zack strip, 10-section, divisible, special printing, marking according to customer requirements
2715209	ZB 5,8:UNBEDRUCKT	Zack strip, unprinted, strips with 10 labels for individual labeling with M-PEN or CMS system, for terminal block width: 5.8 mm, color: White
1050017	ZB 5,LGS:FORTL.ZAHLEN	Zack strip, 10-section, printed horizontally: with the numbers, 1-10, 11-20 etc. up to 991-1000, color: white
1050415	ZB 5,LGS:L1-N,PE	Zack strip, printed horizontally, strips with 10 labels, L1, L2, L3, N, PE, L1, L2, L3, N, PE, color: white
1050295	ZB 5:SO/CMS	Zack strip, 10-section, divisible, special printing, marking according to customer requirements

**Additional products**

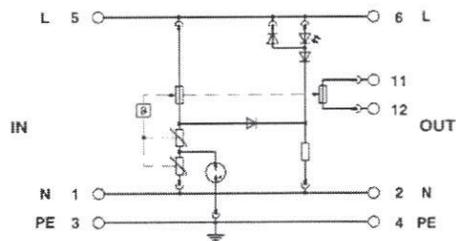
Item	Designation	Description
<b>Assembly</b>		
2839295	SSA 3-6	shield fast connections for conductor diameter 3 - 6 mm. Potential connection cable: 200 mm, black
2839512	SSA 5-10	Shield fast connection for conductor diameters 5 - 10 mm. Potential connection cable: 200 mm, black

## Drawings

### Dimensioned drawing



### Circuit diagram



**Address**

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Flachsmarktstr. 8  
32825 Blomberg, Germany  
Phone +49 5235 3 00  
Fax +49 5235 3 41200  
<http://www.phoenixcontact.com>



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## Single Outlet Receptacle EMG-30-SD/US/15A

January 2004

### Features:

- DIN-Rail Mounted
- Fully Enclosed
- UL Listed: E238705
- Compact Design

### Description:

This DIN-Rail mounted single outlet package was specifically designed to meet the demanding size constraints that standard dual outlet packages cannot.

At only 30mm wide, this package is ideal for locations where an outlet needs to be located in a panel while keeping exposed high voltage lines safe.

This package is fully enclosed to ensure safety from any possible contact with 120Vac. The grounding pin for the plug is also located on the top side to prevent accidental shorts from objects that could touch the live and neutral contacts.

Wiring for the outlet can be accomplished from either side of the outlet. The two sets of terminals are wired in parallel to allow the feed through of voltage for other uses.

\*To learn more about other utility outlets from Phoenix Contact, visit:

<http://www.phoenixcon.com/em-duo>

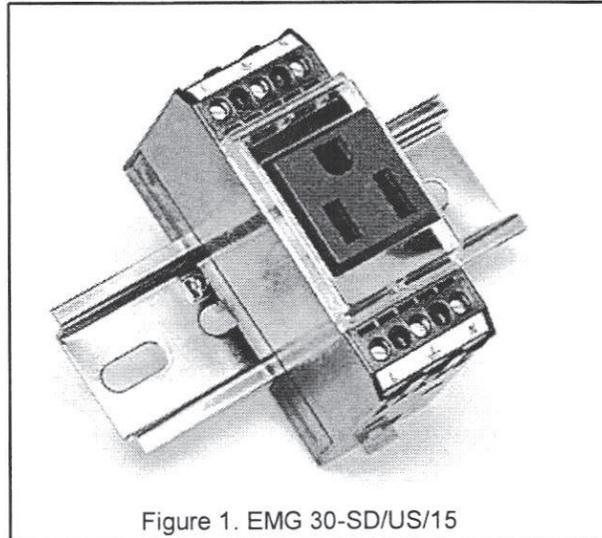


Figure 1. EMG 30-SD/US/15

### General Specification

#### Technical Data

Rated Voltage	120 Vac
Rated Current	15 A
Wire Size	30-12 AWG
Torque	5-7 lbs-ins

#### General Data

Color	Black
Material	Polycarbonate Fiber V0 (UL 94)
Temperature Range	-20°C to +50°C (-68°F to +122°F)

#### Dimensions

Height	2.95 in. (75 mm)
Width	1.18 in. (30 mm)
Depth	2.13 in. (54 mm)

Table 1. EMG 30-SD/US/15 Specifications

# EMG-30-SD/US/15A

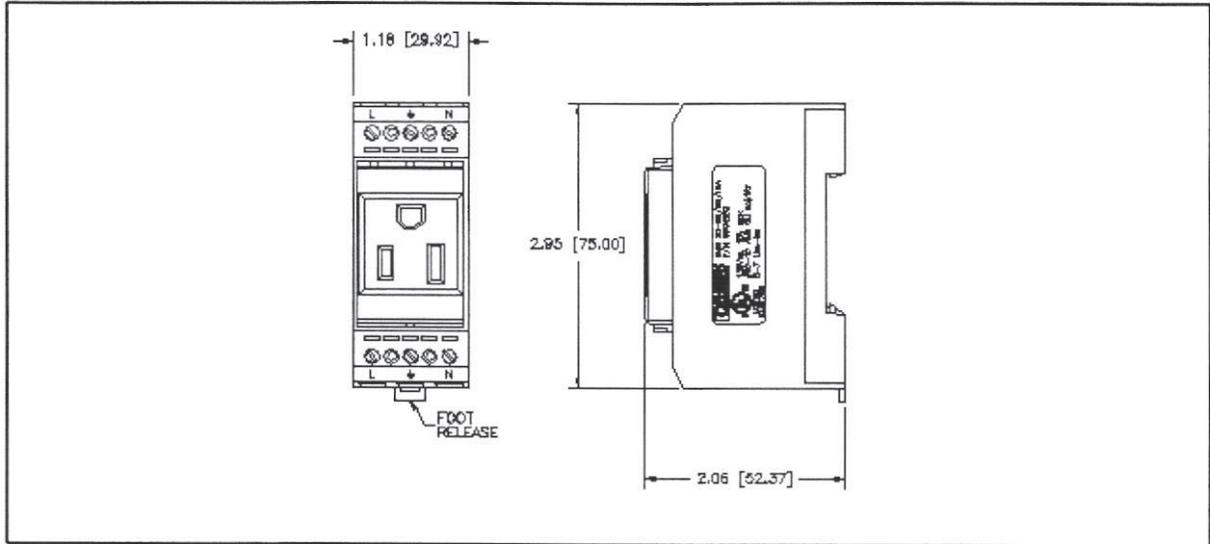


Figure 2. EMG 30-SD/US/15 Dimensions

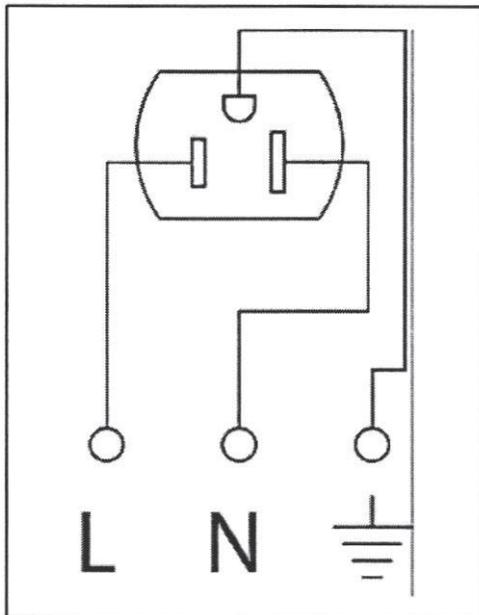


Figure 3. EMG 30-SD/US/15 Block Diagram



## Ordering Information

EMG 30-SD/US/15 56 04 25 3  
Single DIN-Rail Mounted Outlet

### Headquarter, U.S.

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Fax-On-Demand: (800) 944-9901  
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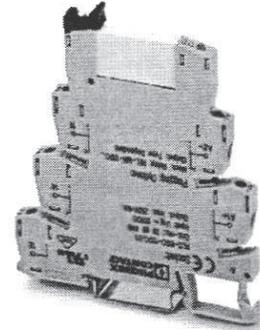
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# PLC-RSC-120UC/21

Order No.: 2966197

The illustration shows the version PLC-RSC-24DC/21



<http://eshop.phoenixcontact.de/phoenix/treeViewClick.do?UID=2966197>

PLC relay, consisting of base terminal block PLC-BSC.../21 with screw connection and pluggable miniature relay with power contact, for assembly on DIN rail NS 35/7.5, 1 PDT, input voltage 120 V AC / 110 V DC

Commercial data	
EAN	4017918130718
Pack	10 pcs.
Customs tariff	85364900
Weight/Piece	0.035 KG
Catalog page information	Page 76 (IF-2009)

**Product notes**

WEEE/RoHS-compliant since:  
03/30/2006



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Technical data	
<b>Coil side</b>	
Nominal input voltage $U_N$	120 V AC (110 V DC)
	110 V DC

Nominal input current at $U_N$	3.5 mA (at $U_N = 120$ V AC) 3 mA (at $U_N = 110$ V DC)
Typical response time	6 ms
Typical release time	15 ms
Operating voltage display	Yellow LED
Name of protection	Bridge rectifier
Protective circuit/component	Bridge rectifier

#### Contact side

Contact type	Single contact, 1-PDT
Contact material	AgSnO
Maximum switching voltage	250 V AC/DC (The separating plate PLC-ATP should be installed for voltages larger than 250 V (L1, L2, L3) between identical terminal blocks in adjacent modules. Potential bridging is then carried out with FBST 8-PLC... or ...FBST 500...)
Minimum switching voltage	12 V AC/DC
Maximum inrush current	(on request)
Min. switching current	10 mA
Limiting continuous current	6 A
Interrupting rating (ohmic load) max.	140 W (for 24 V DC) 20 W (for 48 V DC) 18 W (for 60 V DC) 23 W (for 110 V DC) 40 W (for 220 V DC) 1500 VA (for 250 V AC)

#### General data

Width	6.2 mm
Height	94 mm
Depth	80 mm
Test voltage relay winding/relay contact	4 kV AC (50 Hz, 1 min)
Ambient temperature (operation)	-25 °C ... 55 °C
Ambient temperature (storage/transport)	-40 °C ... 85 °C
Operating mode	100% operating factor
Service life mechanical	$2 \times 10^7$ cycles
Inflammability class in acc. with UL 94 (housing)	V0
Standard designation	Standards/regulations

Standards/regulations	IEC 60664
	IEC 60664 A
	DIN VDE 0110
	DIN EN 50178/DIN VDE 0160 (in relevant parts)
	DIN EN 50178/VDE 0160
	IEC 60255/DIN VDE 0435 (in relevant parts)
Pollution degree	3
Surge voltage category	III
Mounting position	Any
Assembly instructions	In rows with zero spacing

#### Connection data

Type of connection	Screw connection
Conductor cross section solid min.	0.14 mm <sup>2</sup>
Conductor cross section solid max.	2.5 mm <sup>2</sup>
Conductor cross section stranded min.	0.14 mm <sup>2</sup>
Conductor cross section stranded max.	2.5 mm <sup>2</sup>
Conductor cross section AWG/kcmil min.	26
Conductor cross section AWG/kcmil max	14
Stripping length	8 mm
Screw thread	M3

#### Certificates / Approvals



Certification CUL, CUL Listed, GL, GOST, UL, UL Listed

#### Accessories

Item	Designation	Description
<b>Assembly</b>		
0801762	NS 35/ 7,5 CU UNPERF 2000MM	DIN rail, material: Copper, unperforated, height 7.5 mm, width 35 mm, length: 2 m
0801733	NS 35/ 7,5 PERF 2000MM	DIN rail, material: Steel, galvanized and passivated with a thick layer, perforated, height 7.5 mm, width 35 mm, length: 2 m

0801681	NS 35/ 7,5 UNPERF 2000MM	DIN rail, material: Steel, unperforated, height 7.5 mm, width 35 mm, length: 2 m
0801377	NS 35/ 7,5 V2A UNPERF 2000MM	DIN rail, Width: 35 mm, Height: 7.5 mm, Length: 2000 mm, Color: silver
1201756	NS 35/15 AL UNPERF 2000MM	DIN rail, deep-drawn, high profile, unperforated, 1.5 mm thick, material: Aluminum, height 15 mm, width 35 mm, length 2 m
1201895	NS 35/15 CU UNPERF 2000MM	DIN rail, material: Copper, unperforated, 1.5 mm thick, height 15 mm, width 35 mm, length: 2 m
1201730	NS 35/15 PERF 2000MM	DIN rail, material: Steel, perforated, height 15 mm, width 35 mm, length: 2 m
1201714	NS 35/15 UNPERF 2000MM	DIN rail, material: Steel, unperforated, height 15 mm, width 35 mm, length: 2 m
1201798	NS 35/15-2,3 UNPERF 2000MM	DIN rail, material: Steel, unperforated, 2.3 mm thick, height 15 mm, width 35 mm, length: 2 m
2966841	PLC-ATP BK	Separating plate, 2 mm thick, required at the start and end of a PLC terminal strip. Furthermore, it is used for: visual separation of groups, safe isolation of different voltages of neighboring PLC relays in acc. with DIN VDE 0106-101, isolation

#### Bridges

2966812	FBST 6-PLC BU	Single plug-in bridges, Length: 6 mm, Number of positions: 2, Color: blue
2966825	FBST 6-PLC GY	Single plug-in bridges, Length: 6 mm, Number of positions: 2, Color: gray
2966236	FBST 6-PLC RD	Single plug-in bridges, Length: 6 mm, Number of positions: 2, Color: red
2967688	FBST 8-PLC GY	Single plug-in bridges, Length: 8 mm, Number of positions: 2, Color: gray
2966692	FBST 500-PLC BU	Continuous plug-in bridge, Length: 500 mm, Color: blue
2966838	FBST 500-PLC GY	Continuous plug-in bridge, Length: 500 mm, Color: gray
2966786	FBST 500-PLC RD	Continuous plug-in bridge, Length: 500 mm, Color: red

#### General

2966508	PLC-ESK GY	Power terminal block, for the input of up to four potentials, for mounting on NS 35/7.5
---------	------------	---

#### Marking

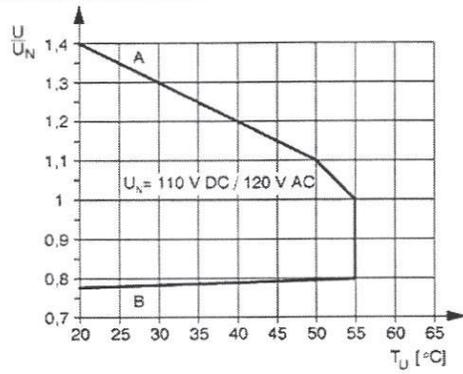
1051016	ZB 6,LGS:FORTL.ZAHLEN	Zack strip, 10-section, printed horizontally: with the numbers, 1-10, 11-20 etc. up to 991-1000, color: white
1051003	ZB 6:UNBEDRUCKT	Zack strip, unprinted, strips with 10 labels for individual labeling with M-PEN or CMS system, for terminal block width: 6.2 mm, color: white

Tools

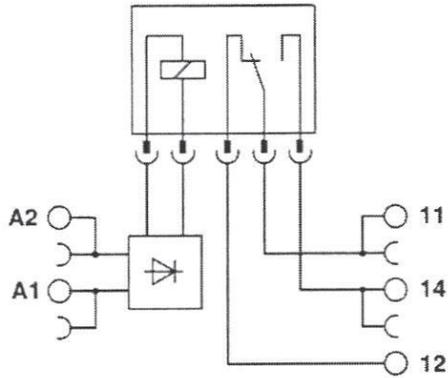
1204517	SZF 1-0,6X3,5	Screwdriver, blade: 0.6 x 3.5 x 100 mm, length 180 mm
---------	---------------	---

Drawings

Diagram



Circuit diagram



**Address**

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586 Fulling Mill Road  
Middletown, PA 17057, USA  
Phone (800) 888-7388  
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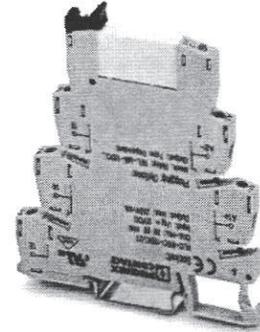
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# PLC-RSC- 12DC/21

Order No.: 2966906

The illustration shows the version PLC-RSC-24DC/21



<http://eshop.phoenixcontact.de/phoenix/treeViewClick.do?UID=2966906>

PLC relay, consisting of base terminal block PLC-BSC.../21 with screw connection and pluggable miniature relay with power contact, for assembly on DIN rail NS 35/7.5, 1 PDT, input voltage 12 V DC



### Commercial data

EAN	4017918159580
Pack	10 pcs.
Customs tariff	85364190
Weight/Piece	0.03499 KG
Catalog page information	Page 76 (IF-2009)

### Product notes

WEEE/RoHS-compliant since:  
03/24/2006



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### Technical data

#### Coil side

Nominal input voltage $U_N$	12 V DC
Nominal input current at $U_N$	15.3 mA
Typical response time	5 ms

Typical release time	8 ms
Operating voltage display	Yellow LED
Name of protection	Polarity protection
Protective circuit/component	Polarity protection diode

**Contact side**

Contact type	Single contact, 1-PDT
Contact material	AgSnO
Maximum switching voltage	250 V AC/DC (The separating plate PLC-ATP should be installed for voltages larger than 250 V (L1, L2, L3) between identical terminal blocks in adjacent modules. Potential bridging is then carried out with FBST 8-PLC... or ...FBST 500...)
Minimum switching voltage	12 V AC/DC
Maximum inrush current	(on request)
Min. switching current	10 mA
Limiting continuous current	6 A
Interrupting rating (ohmic load) max.	140 W (for 24 V DC) 20 W (for 48 V DC) 18 W (for 60 V DC) 23 W (for 110 V DC) 40 W (for 220 V DC) 1500 VA (for 250 V AC)

**General data**

Width	6.2 mm
Height	94 mm
Depth	80 mm
Test voltage relay winding/relay contact	4 kV AC (50 Hz, 1 min)
Ambient temperature (operation)	-25 °C ... 60 °C
Ambient temperature (storage/transport)	-40 °C ... 85 °C
Operating mode	100% operating factor
Service life mechanical	2 x 10 <sup>7</sup> cycles
Inflammability class in acc. with UL 94 (housing)	V0
Standard designation	Standards/regulations

Standards/regulations	IEC 60664 IEC 60664 A DIN VDE 0110 DIN EN 50178/DIN VDE 0160 (in relevant parts) DIN EN 50178/VDE 0160 IEC 60255/DIN VDE 0435 (in relevant parts)
Pollution degree	3
Surge voltage category	III
Mounting position	Any
Assembly instructions	In rows with zero spacing

**Connection data**

Type of connection	Screw connection
Conductor cross section solid min.	0.14 mm <sup>2</sup>
Conductor cross section solid max.	2.5 mm <sup>2</sup>
Conductor cross section stranded min.	0.14 mm <sup>2</sup>
Conductor cross section stranded max.	2.5 mm <sup>2</sup>
Conductor cross section AWG/kcmil min.	26
Conductor cross section AWG/kcmil max	14
Stripping length	8 mm
Screw thread	M3

**Certificates / Approvals**



Certification

CUL, CUL Listed, GL, GOST, UL, UL Listed

**Accessories**

Item	Designation	Description
<b>Assembly</b>		
0801762	NS 35/ 7,5 CU UNPERF 2000MM	DIN rail, material: Copper, unperforated, height 7.5 mm, width 35 mm, length: 2 m
0801733	NS 35/ 7,5 PERF 2000MM	DIN rail, material: Steel, galvanized and passivated with a thick layer, perforated, height 7.5 mm, width 35 mm, length: 2 m

0801681	NS 35/ 7,5 UNPERF 2000MM	DIN rail, material: Steel, unperforated, height 7.5 mm, width 35 mm, length: 2 m
0801377	NS 35/ 7,5 V2A UNPERF 2000MM	DIN rail, Width: 35 mm, Height: 7.5 mm, Length: 2000 mm, Color: silver
1201756	NS 35/15 AL UNPERF 2000MM	DIN rail, deep-drawn, high profile, unperforated, 1.5 mm thick, material: Aluminum, height 15 mm, width 35 mm, length 2 m
1201895	NS 35/15 CU UNPERF 2000MM	DIN rail, material: Copper, unperforated, 1.5 mm thick, height 15 mm, width 35 mm, length: 2 m
1201730	NS 35/15 PERF 2000MM	DIN rail, material: Steel, perforated, height 15 mm, width 35 mm, length: 2 m
1201714	NS 35/15 UNPERF 2000MM	DIN rail, material: Steel, unperforated, height 15 mm, width 35 mm, length: 2 m
1201798	NS 35/15-2,3 UNPERF 2000MM	DIN rail, material: Steel, unperforated, 2.3 mm thick, height 15 mm, width 35 mm, length: 2 m
2966841	PLC-ATP BK	Separating plate, 2 mm thick, required at the start and end of a PLC terminal strip. Furthermore, it is used for: visual separation of groups, safe isolation of different voltages of neighboring PLC relays in acc. with DIN VDE 0106-101, isolation

#### Bridges

2966812	FBST 6-PLC BU	Single plug-in bridges, Length: 6 mm, Number of positions: 2, Color: blue
2966825	FBST 6-PLC GY	Single plug-in bridges, Length: 6 mm, Number of positions: 2, Color: gray
2966236	FBST 6-PLC RD	Single plug-in bridges, Length: 6 mm, Number of positions: 2, Color: red
2967688	FBST 8-PLC GY	Single plug-in bridges, Length: 8 mm, Number of positions: 2, Color: gray
2966692	FBST 500-PLC BU	Continuous plug-in bridge, Length: 500 mm, Color: blue
2966838	FBST 500-PLC GY	Continuous plug-in bridge, Length: 500 mm, Color: gray
2966786	FBST 500-PLC RD	Continuous plug-in bridge, Length: 500 mm, Color: red

#### General

2966508	PLC-ESK GY	Power terminal block, for the input of up to four potentials, for mounting on NS 35/7.5
---------	------------	---

#### Marking

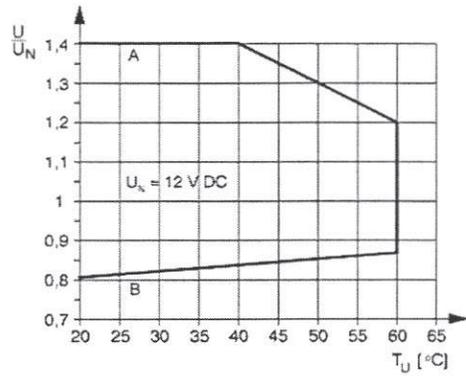
1051016	ZB 6,LGS:FORTL.ZAHLEN	Zack strip, 10-section, printed horizontally: with the numbers, 1-10, 11-20 etc. up to 991-1000, color: white
1051003	ZB 6:UNBEDRUCKT	Zack strip, unprinted, strips with 10 labels for individual labeling with M-PEN or CMS system, for terminal block width: 6.2 mm, color: white

Tools

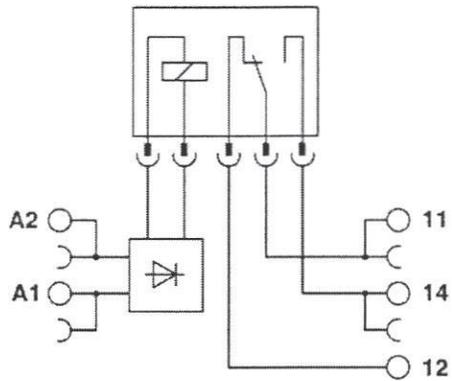
1204517	SZF 1-0,6X3,5	Screwdriver, blade: 0.6 x 3.5 x 100 mm, length 180 mm
---------	---------------	---

Drawings

Diagram



Circuit diagram



**Address**

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## ▶ Extract from the online catalog



PLC relay, consisting of base terminal block PLC-BSC.../21 with screw connection and pluggable miniature relay with power contact, for assembly on mounting rail NS 35/7.5, 2 PDT, input voltage 120 V AC / 110 V DC

The illustration shows the version PLC-RSC- 24DC/21-21

Order No.	2967086
Ord designation	PLC-RSC-120UC/21-21
EAN	4017918156398
Pack	10 Pcs.
Customs tariff	85364900
Weight/Piece	0,06949 KG
Catalog page information	Page 67 (IF-2007)

## ▶ Product notes

WEEE/RoHS-compliant since: 12/20/2006



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▶ **Technical data**

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**Coil side**

Nominal input voltage $U_N$	120 V AC (110 V DC)
Nominal input voltage $U_N$	110 V DC
Nominal input current at $U_N$	4.5 mA (at $U_N = 120$ V AC)
Nominal input current at $U_N$	4.2 mA (at $U_N = 110$ V DC)
Typical response time	7 ms
Typical release time	10 ms
Operating voltage display	Yellow LED
Name of protection	Bridge rectifier
Protective circuit/component	Bridge rectifier

**Contact side**

Contact type	Single contact, 2 PDT
Contact material	AgNi
Maximum switching voltage	250 V AC/DC (The separating plate PLC-ATP should be installed for voltages larger than 250 V (L1, L2, L3) between identical terminal blocks in adjacent modules. Potential bridging is then carried out with FBST 8-PLC... or ...FBST 500...)
Minimum switching voltage	5 V AC/DC
Maximum inrush current	15 A (300 ms)
Min. switching current	10 mA
Limiting continuous current	6 A
Power rating (ohmic load) max.	140 W (for 24 V DC)
Power rating (ohmic load) max.	85 W (for 48 V DC)
Power rating (ohmic load) max.	60 W (for 60 V DC)
Power rating (ohmic load) max.	44 W (for 110 V DC)
Power rating (ohmic load) max.	60 W (for 220 V DC)
Power rating (ohmic load) max.	1500 VA (for 250 V AC)

**General data**

Length	80 mm
Height	94 mm
Width	14 mm
Test voltage relay winding/relay contact	4 kV AC (50 Hz, 1 min)
Test voltage PDT/PDT	2.5 kV AC (50 Hz, 1 min)
Ambient temperature (operation)	-25 °C ... 60 °C
Operating mode	100% operating factor
Service life mechanical	$3 \times 10^7$ cycles
Standard designation	Standards/regulations
Standards/regulations	IEC 60664
Standards/regulations	IEC 60664 A
Standards/regulations	DIN VDE 0110
Standards/regulations	DIN EN 50178/DIN VDE 0160 (in relevant parts)
Standards/regulations	IEC 60255/DIN VDE 0435 (in relevant parts)
Standards/regulations	DIN EN 50178/VDE 0160
Contamination class	3
Surge voltage category	III

**Connection data**

Type of connection	Screw connection
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## PLC-RSC-120UC/21-21



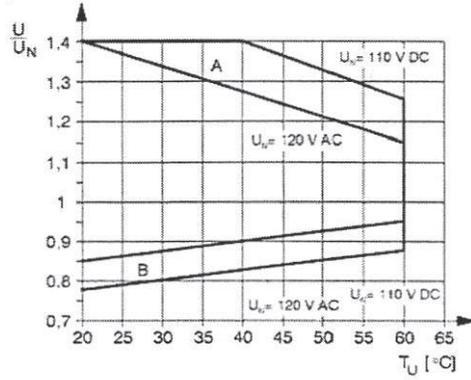
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Conductor cross section solid min.	0.14 mm <sup>2</sup>
Conductor cross section solid max.	2.5 mm <sup>2</sup>
Conductor cross section stranded min.	0.14 mm <sup>2</sup>
Conductor cross section stranded max.	2.5 mm <sup>2</sup>
Conductor cross section AWG/kcmil min.	26
Conductor cross section AWG/kcmil max.	14
Stripping length	8 mm
Screw thread	M 3

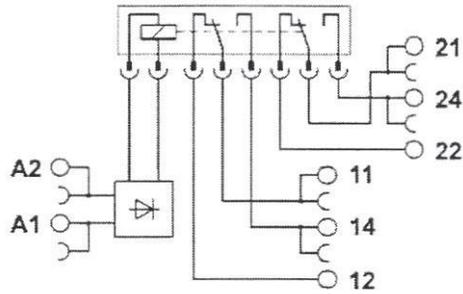


► Drawings

Diagram



Circuit diagram



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► **Address**

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▶ Extract from the online catalog



PLC relay, consisting of base terminal block PLC-BSC.../21 with screw connection and pluggable miniature relay with power contact, for assembly on mounting rail NS 35/7.5, 2 PDT, input voltage 12 V DC

The illustration shows the version PLC-RSC- 24DC/21-21

Order No.	2967235
Ord designation	PLC-RSC- 12DC/21-21
EAN	4017918 163501
Pack	10 Pcs.
Customs tariff	85364190
Weight/Piece	0,06952 KG
Catalog page information	Page 67 (IF-2007)

▶ Product notes

WEEE/RoHS-compliant since: 04/06/2006



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**Coil side**

Nominal input voltage $U_N$	12 V DC
Nominal input current at $U_N$	33 mA
Typical response time	8 ms
Typical release time	10 ms
Operating voltage display	Yellow LED
Name of protection	Polarity protection
Protective circuit/component	Polarity protection diode

**Contact side**

Contact type	Single contact, 2 PDT
Contact material	AgNi
Maximum switching voltage	250 V AC/DC (The separating plate PLC-ATP should be installed for voltages larger than 250 V (L1, L2, L3) between identical terminal blocks in adjacent modules. Potential bridging is then carried out with FBST 8-PLC... or ...FBST 500...)
Minimum switching voltage	5 V AC/DC
Maximum inrush current	15 A (300 ms)
Min. switching current	10 mA
Limiting continuous current	6 A
Power rating (ohmic load) max.	140 W (for 24 V DC)
Power rating (ohmic load) max.	85 W (for 48 V DC)
Power rating (ohmic load) max.	60 W (for 60 V DC)
Power rating (ohmic load) max.	44 W (for 110 V DC)
Power rating (ohmic load) max.	60 W (for 220 V DC)
Power rating (ohmic load) max.	1500 VA (for 250 V AC)

**General data**

Length	80 mm
Height	94 mm
Width	14 mm
Test voltage relay winding/relay contact	4 kV AC (50 Hz, 1 min)
Test voltage PDT/PDT	2.5 kV AC (50 Hz, 1 min)
Ambient temperature (operation)	-25 °C ... 60 °C
Operating mode	100% operating factor
Service life mechanical	3 x 10 <sup>7</sup> cycles
Standard designation	Standards/regulations
Standards/regulations	IEC 60664
Standards/regulations	IEC 60664 A
Standards/regulations	DIN VDE 0110
Standards/regulations	DIN EN 50178/DIN VDE 0160 (in relevant parts)
Standards/regulations	IEC 60255/DIN VDE 0435 (in relevant parts)
Standards/regulations	DIN EN 50178/VDE 0160
Contamination class	3
Surge voltage category	III

**Connection data**

Type of connection	Screw connection
Conductor cross section solid min.	0.14 mm <sup>2</sup>
Conductor cross section solid max.	2.5 mm <sup>2</sup>

## PLC-RSC- 12DC/21-21

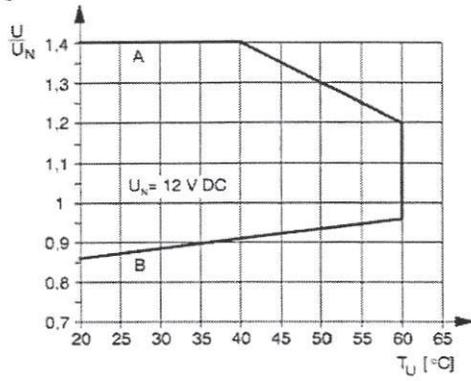


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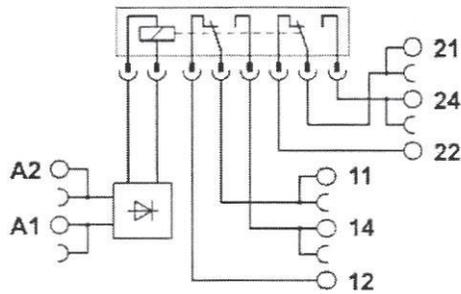
Conductor cross section stranded min.	0.14 mm <sup>2</sup>
Conductor cross section stranded max.	2.5 mm <sup>2</sup>
Conductor cross section AWG/kcmil min.	26
Conductor cross section AWG/kcmil max	14
Stripping length	8 mm
Screw thread	M 3

► Drawings

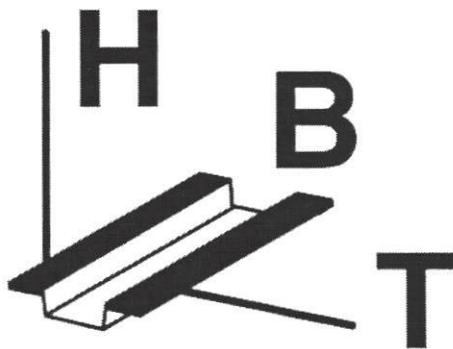
Diagram



Circuit diagram



Logo



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► **Address**

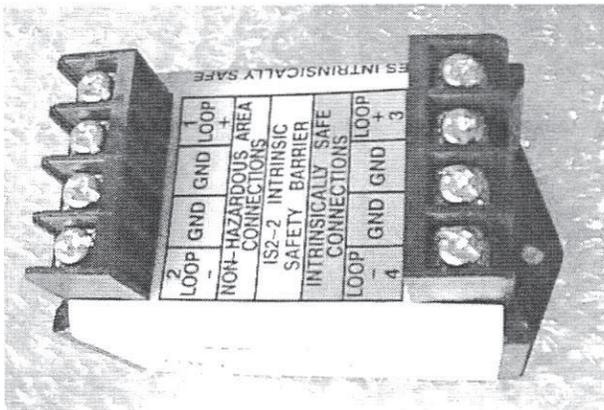
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The IS2-2 is a Zener type barrier rated for Class I Div 1, Groups C, D, Class II, and Class III. It is used with the A1000i submersible level transmitter in hazardous locations such as sewage lift station wet wells. This barrier is UL listed under file E123925. Refer to installation drawing AIM 7360 for entity parameter details.

Part Number	Description
6013150006	IS2-2, Two channel 4-20 MA Intrinsicly Safe Barrier, A1000i Compatible.



## Specifications

### Physical

Dimensions	2"W x 3"H x 2"D
Mounting	Panel Mount, 2 screws

### Electrical

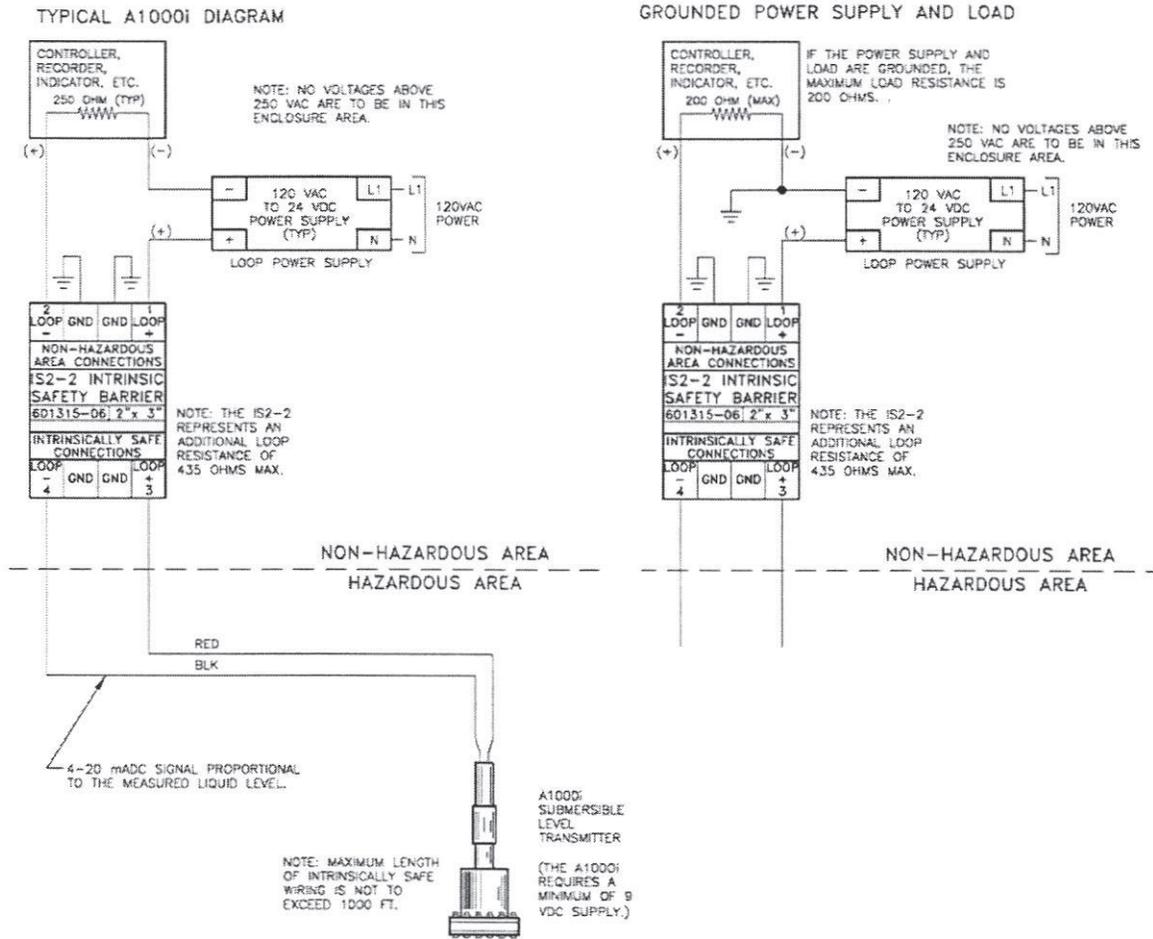
Power Supply Requirements	Max Loop Supply – 24 VDC
Signal Input/Output	4 – 20 mA
Max Loop Resistance of Barrier	435 ohms

### Terminal Description

Terminal Type	Clamp Type, 14-22 AWG wire
Terminal 1:	(+) Loop Supply, (24.0 VDC)
Terminal 2:	(-) 4-20mA Output
Terminal GNDs:	Earth Ground to approved IS ground
Terminal 3:	(+) Loop Supply to hazardous area
Terminal 4:	(-) 4-20 MA Return from hazardous area

Calibration Adjustments: None

Wiring Diagrams



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NOTES:

- 1 THE IS1-2 INTRINSIC SAFETY BARRIER SHALL NOT BE CONNECTED TO ANY EQUIPMENT WHICH USES OR GENERATES GREATER THAN 250 V.
- 2 EACH GROUND TERMINAL SHALL BE CONNECTED TO A SUITABLE SYSTEM EARTH GROUND. THE DC RESISTANCE BETWEEN THE GROUND TERMINAL AND EARTH GROUND SHALL BE LESS THAN 1 OHM. REFERENCE NFPA 70, NEC ARTICLES 250 AND 504 FOR PROPER GROUNDING AND INTRINSIC SAFETY BARRIER INSTALLATION INFORMATION.
- 3 INTRINSICALLY SAFE WIRING MUST BE POSITIVELY SEGREGATED FROM NON-INTRINSICALLY SAFE WIRING BY SEPARATE CONDUITS, HOUSINGS AND GROUNDED METAL BARRIERS. PER ANSI/ISA RP12.6, AND NFPA 70, NEC ARTICLES 500-516.
- 4 FIELD DEVICES LOCATED IN A HAZARDOUS AREA MUST BE RUN THROUGH SEALED CONDUITS WHICH ONLY CONTAIN INTRINSICALLY SAFE WIRING. PER ANSI/ISA RP12.6, AND NFPA 70, NEC ARTICLES 500-516.

7 THE ENTITY PARAMETERS

TERMINALS	Voc(V)	Isc(mA)	Po	GROUPS	Ca(uF)	La(mH)
3-4	27.8	93	0.65W	C,D	0.3	0.5
				E,F,G	3	7

- 5 TO DETERMINE THE CABLE LENGTHS USE THE FOLLOWING FORMULAS:

LENGTH X(FT)  $\leq \frac{Co-Ci}{60pF}$  AND

LENGTH X(FT)  $\leq \frac{Lo-Li}{0.2uH}$

THE MAXIMUM CABLE LENGTH IS DETERMINED BY THE LESSOR OF THE TWO VALUES.

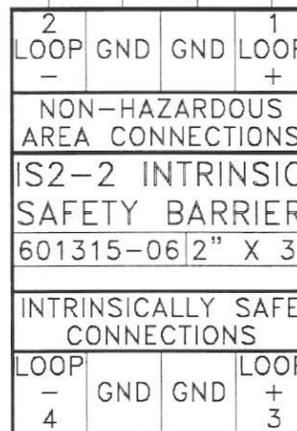
NOTE; THE ABOVE CAPACITANCE AND INDUCTANCE VALUES ARE APPROXIMATE VALUES. REFER TO THE CABLE THAT IS GOING TO BE INSTALLED FOR SPECIFIC CAPACITANCE AND INDUCTANCE VALUES.

- 6 THE INTRINSICALLY SAFE DEVICE SHALL HAVE ENTITY PARAMETERS WHICH ARE IN ACCORDANCE WITH THE FOLLOWING:

$Voc \leq Vmax$   
 $Isc \leq Imax$   
 $Ca \geq Ci + \text{Cable Capacitance}$   
 $La \geq Li + \text{Cable Inductance}$

NON-HAZARDOUS AREA

HAZARDOUS AREA  
 CLASS I, GROUPS C, D  
 CLASS II, GROUPS E, F, G  
 CLASS III



					TITLE		INSTALLATION INSTRUCTIONS - IS2-2				
A	11075	11/04	IS2-2	DBS	DSGN		DBS	DWN MB	CHK	DATE	11/8/04
REV	C.O. NO.	DATE	DESCRIPTION	CHK	APR	JOB NAMF			STANDARD		
US Filter CONTROL SYSTEMS						SHOP ORDR		DWG. NO.		REV A	
1239 WILLOW LAKE BLVD., VADNAIS HEIGHTS, MN 55110						AIM07360					

ASD00304-A

**PUBLICATION DIVIDER**

# IS6 INTRINSIC SAFETY BARRIER

## NEC DEFINITION OF HAZARDOUS LOCATIONS

The NEC Handbook defines hazardous locations by Class, Division and Group as follows:

**Class I Locations** – Are those in which flammable gasses or vapors are or may be present in the air in quantities sufficient to produce explosive or ignitable mixtures.

**Class II Locations** – Are those which are hazardous because of the presence of combustible dust.

**Class III Locations** – Are those which are hazardous because of the presence of easily ignitable fibers or flyings, but in which such fibers or flyings are not likely to be in suspension in air in quantities sufficient to produce ignitable mixtures.

**Division 1** – Locations in which hazardous concentrations in the air exist continuously, intermittently, or periodically under normal operating conditions.

**Division 2** – Locations in which hazardous concentrations are handled, processed, or used but are normally confined within closed containers or closed systems from which they can escape only in case of accidental rupture or breakdown.

**Group A** – Atmospheres containing acetylene.

**Group B** – Atmospheres containing hydrogen, or gasses or vapors of equivalent hazard, such as manufactured gas.

**Group C** – Atmospheres containing ethyl-ether vapors, ethylene, or cyclopropane.

**Group D** – Atmospheres containing gasoline, hexane, naphtha, benzene, butane, propane, alcohol, acetone, benzol, lacquer solvent vapors, or natural gas.

**Group E** – Atmospheres containing metal dust, including aluminum, magnesium, and their commercial alloys, and other metals of similarly hazardous characteristics.

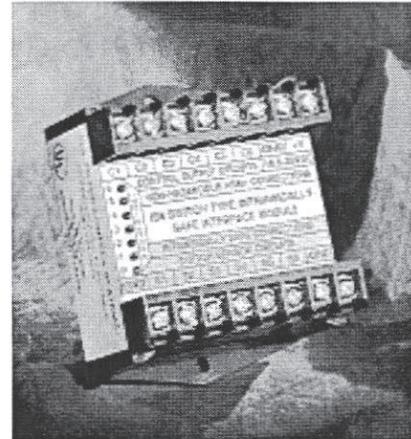
**Group F** – Atmospheres containing carbon black, coal, or coke dust.

**Group G** – Atmospheres containing flour, starch, or grain dusts.

The IS6 Intrinsic Safety Barrier is a six-circuit, shunt-diode barrier ON/OFF switch circuit interface that is used between Monitoring and Pump/Alarm Controller Equipment and its level sensor float switch circuitry to render such circuitry “intrinsically safe” and thus suited for installation in a hazardous location such as a sewage or freeway stormwater-handling pump station collection sump.

Powered by the associated Monitor/Controller, the IS6 Barrier has open-collector drivers that provide input sensor signals to the controller in response to the operation of level-sensing float switches in the hazardous location. The IS6 Barrier is most commonly used with our LS and 9G Float Switches, but it can be used with any general purpose simple switch device with N.O. or N.C. non-powered contacts within its application parameters.

The IS6 module is designed to make its associated switches and circuitry suited



for Class I, Division 1 or 2, Groups A, B, C and D, and Class II, Division 1 or 2, Groups E, F, and G hazardous locations as defined by the NEC (National Electrical Code).

The IS6 is ideally suited for applications requiring compliance with UL 913 procedures pertaining to electrical control panels with intrinsically safe extensions to hazardous areas. It includes LED indicators for power and circuit activation.

## IS6 PRODUCT SPECIFICATIONS

**Cable Lengths:** Cable lengths from the module to the switches are to be limited to 300 feet each, or a maximum of 18,000 pF and 60 uH per circuit.

**Hazardous Area Connections:** Entity parameters (per channel):

- Maximum voltage: 12.6 volts
- Maximum output current: 1.3 mA
- Maximum allowable capacitance: 0.018 uF
- Maximum allowable inductance: 0.06 mH

**IS6 Power:** The IS6 Module is typically powered by +10.5 to 25 VDC and requires a maximum of 50 mA from an associated monitor/controller, such as our CB1T, CMC15, CB2D, CB23, CB234 or DC power supply. The outputs of the IS6 are open-collectors capable of sinking up to 150 mA and withstanding up to 50 VDC.

**Operating Temperature Ranges:** -29° to +149° F (-20° to +65° C)

**Outside Dimensions:** 4" high x 3" wide x 2-1/4" deep

## IS6 TYPICAL SPECIFICATIONS

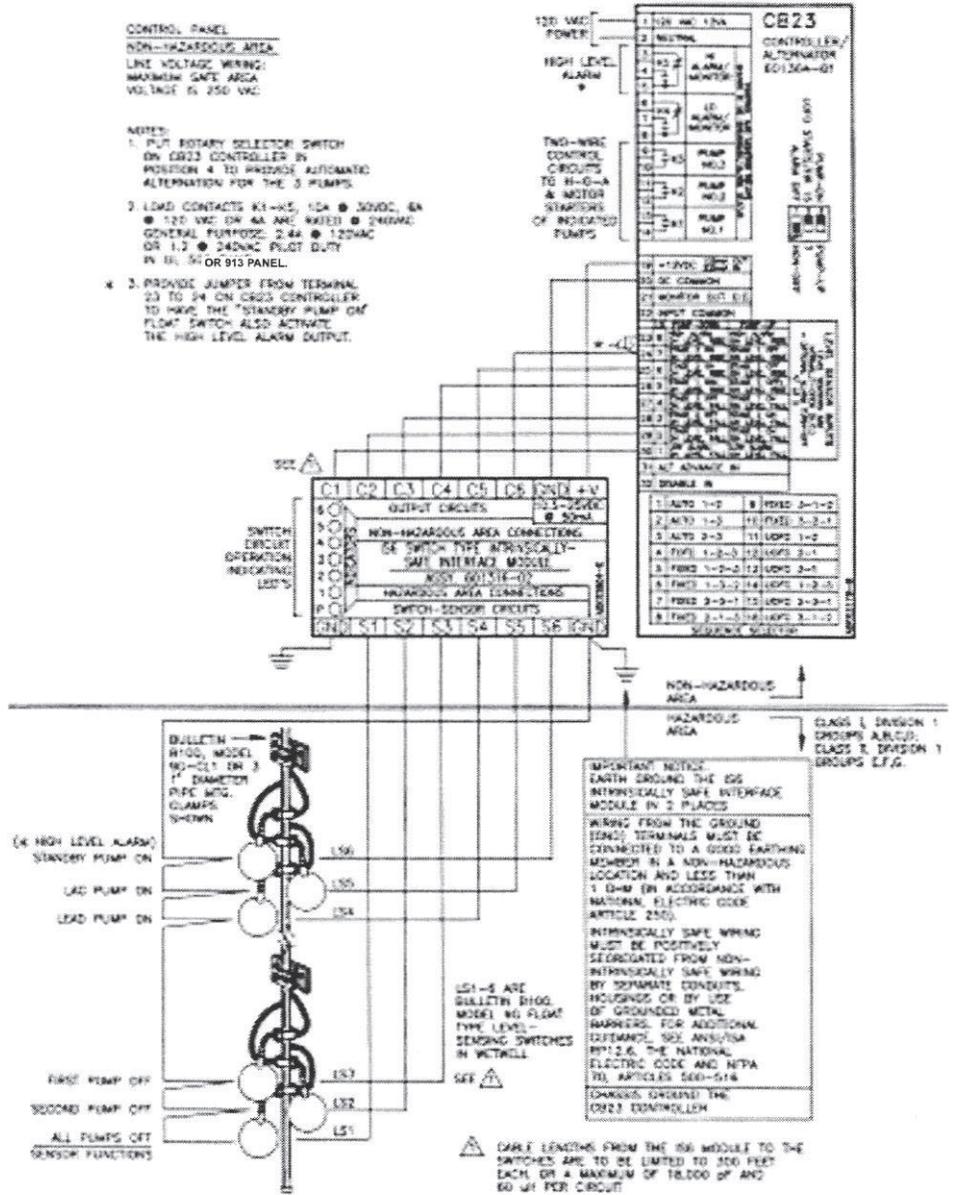
The float switch level sensors shall interface to the control circuitry via an intrinsic safety barrier. The barrier shall provide an intrinsically safe interface for up to six sensors located in a hazardous area rated Class 1, Division 1 or 2, Group A, B, C, and D, and Class II, Division 1 or 2, Groups E, F, and G. The barrier shall contain an LED indicator for each of up to six sensor inputs, providing visible indication of sensor actuation as well as an LED to indicate barrier “Power On” status. The intrinsic safety barrier shall be UL-listed for use in hazardous locations.

DESCRIPTION	PART NO.
Model IS6 six circuit intrinsically safe (switch circuit) barrier; 12/24 VDC powered	601316-02



# IS6 INTRINSIC SAFETY BARRIER

*Interconnection Diagram of IS6 Intrinsic Safety Barrier with CB23 Pump Controller/ Alternator showing Intrinsically Safe Level Sensor Float Switch Circuitry*



COMPLETE CONTROL CAPABILITIES

USFilter Control Systems offers a single, high-quality source for everything from simple level sensors to telemetry systems to complex system control engineering and software. Based in St. Paul, Minnesota, USFilter Control Systems is part of United States Filter Corporation, the leading global provider of industrial, municipal and residential water and wastewater treatment systems, products and services. As a major manufacturer/integrator with an extensive selection of specialized product lines in the areas of SCADA and telemetry, power equipment integration, automation and measurement, USFilter Control Systems is uniquely positioned to provide cost-effective, comprehensive solutions for water, wastewater, and process control and telemetry applications.



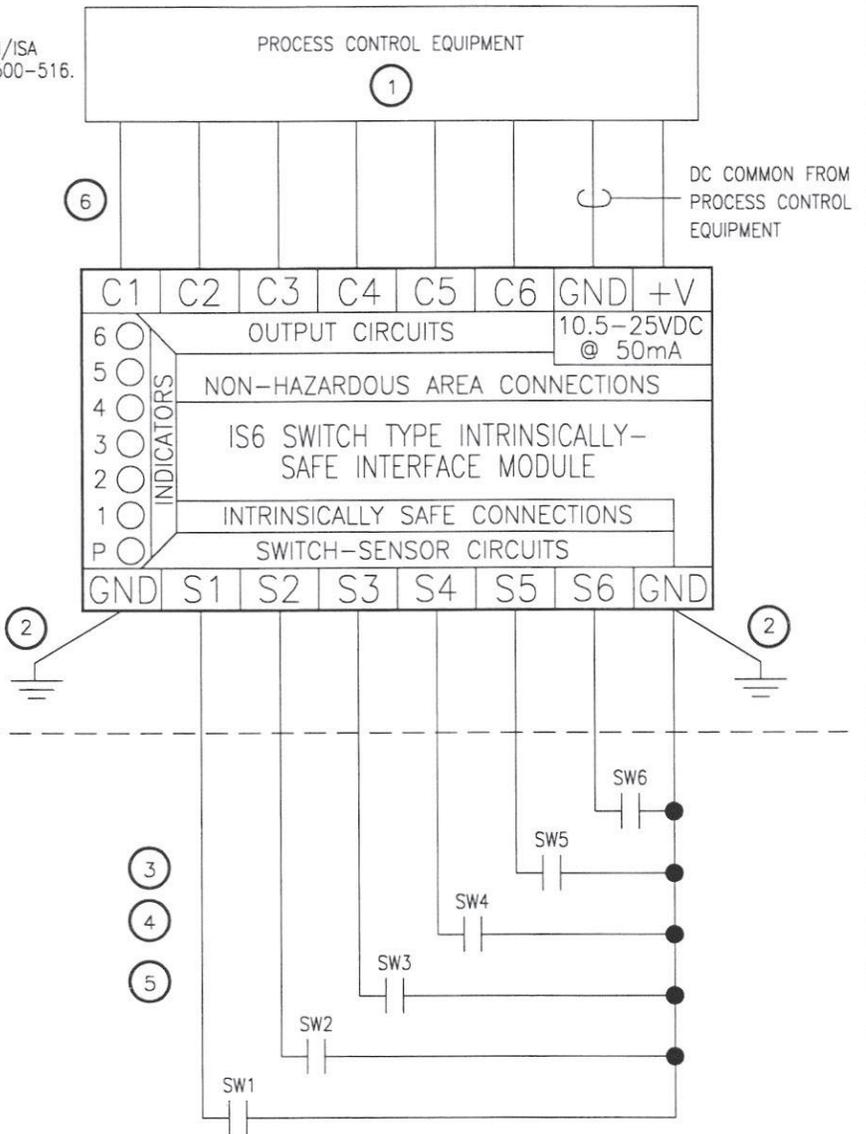
Control Systems  
1239 Willow Lake Boulevard  
Vadnais Heights, MN 55110  
800.224.9474 phone  
651.766.2700 phone  
651.766.2701 fax

[www.controlsystems.usfilter.com](http://www.controlsystems.usfilter.com)  
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**NOTES:**

- ① THE IS6 INTRINSIC SAFETY BARRIER SHALL NOT BE CONNECTED TO ANY EQUIPMENT WHICH USES OR GENERATES GREATER THAN 250 V.
- ② BOTH GROUND TERMINALS SHALL BE CONNECTED TO A SUITABLE EARTH GROUND MEMBER IN A NON-HAZARDOUS AREA. THE DC RESISTANCE BETWEEN THE GROUND TERMINAL AND EARTH GROUND SHALL BE LESS THAN 1 OHM. REFERENCE NFPA 70, NEC ARTICLES 250 AND 504 FOR PROPER GROUNDING AND INTRINSIC SAFETY BARRIER INSTALLATION INFORMATION.
- ③ INTRINSICALLY SAFE WIRING MUST BE POSITIVELY SEGREGATED FROM NON-INTRINSICALLY SAFE WIRING BY SEPARATE CONDUITS, HOUSINGS AND GROUNDED METAL BARRIERS. PER ANSI/ISA RP12.6, AND NFPA 70, NEC ARTICLES 500-516.
- ④ INTRINSICALLY SAFE WIRING FROM THE IS6 TO THE SWITCHES (SW1-SW6) LOCATED IN THE HAZARDOUS AREA MUST BE THROUGH SEALED CONDUITS WHICH ONLY CONTAIN THE IS6 CIRCUIT EXTENSIONS. PER ANSI/ISA RP12.6, AND NFPA 70, NEC ARTICLES 500-516.
- ⑤ THE MAXIMUM LENGTH OF EACH CABLE MUST NOT EXCEED 300 FEET OR A MAXIMUM OF 18,000 pF CAPACITANCE AND 60 μH INDUCTANCE.
- ⑥ THE IS6 OUTPUTS (C1-C6) ARE TRANSISTOR OPEN-COLLECTORS WHICH ARE CAPABLE OF SINKING 150mA EACH AT UP TO 50 VDC.



NON-HAZARDOUS AREA

HAZARDOUS AREA  
(PER NEC ARTICAL 500)

CLASS I, DIVISION 1  
GROUPS A, B, C, D:  
CLASS II, DIVISION 1  
GROUPS E, F, G  
CLASS III, DIVISION 1

C	11040	11/8/01	UPDATED NOTES	MRB	
B	11026	2/13/01	PER ECO	TP	
A	10024		RELEASED	REW	
REV	C.O. NO.	DATE	DESCRIPTION	CHK	APR

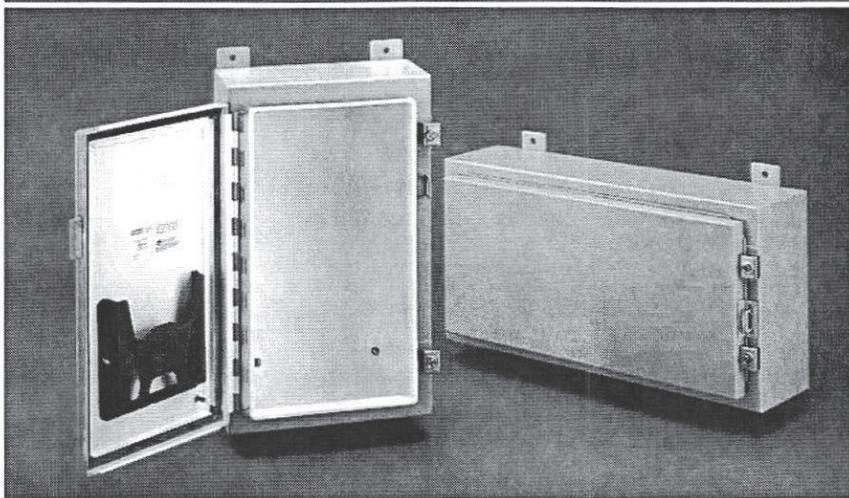
TITLE						INSTALLATION INSTRUCTIONS - IS6																	
DSGN	REW	DWN	MG	CHK	DATE	6/28/94																	
JOB NAME												STANDARD											
SHOP ORDER						DWG. NO.						AIM08916						REV C					

**USFilter** CONTROL SYSTEMS

1239 WILLOW LAKE BLVD., VADNAIS HEIGHTS, MN 55110



## Single-Door Type 12 and Type 13 Enclosures



### Application

For use in housing electrical and electronic controls, instruments, components, and associated wiring, these enclosures incorporate hinged doors that provide convenient access. Designed for indoor use in protecting components from dust, dirt, oil, and water.

### Construction

- Enclosure bodies are either 14 gauge or 16 gauge steel (see table). All doors are 14 gauge steel.
- Seams continuously welded and ground smooth, no holes or knockouts
- External wall-mounting brackets
- Rolled flanges around three sides of door and all sides of enclosure opening exclude liquids and contaminants
- Newly designed door clamps are quick and easy to operate
- Removable heavy gauge continuous hinge pin
- Hasp and staple for padlocking
- Data pocket is high-impact thermoplastic
- Oil-resistant gasket attached with oil-resistant adhesive
- Collar studs provided for mounting optional panels
- Bonding provision on door
- Optional panels are 12 gauge steel

See Chapter 11, EMC Enclosures, for information on a related EMC-shielded product.

### Finish

White inside with ANSI 61 gray outside finish over phosphatized surfaces. Optional panels are white.

### Industry Standards

UL 508A, 508, File No. E61997: Type 12 and Type 13  
NEMA/EEMAC Type 12 and Type 13  
JIC standard EGP-1-1967 (14 gauge only)  
CSA, File No. LR42186, Type 12  
IEC 60529, IP65

### Accessories

See Chapter 12, General Accessories.

Blower Package  
Clamp Kit  
Corrosion Inhibitors  
Door Stop Kit  
Drip Shield Kit  
Electric Heater  
Electrical Interlocks  
Enclosure Stabilizers  
Fan Cooling Products  
Fast Operating Clamp Assembly  
Floor Stand Kit  
Folding Shelf  
Keyboard Kit  
Latch Kits and Lock Kit  
Lighting Kit  
Panel Support Kit  
Panels (see table)  
Rack Mounting Angle Kit  
Swing-Out Panel Kit  
Terminal Block Kit Assembly  
Touch-Up Paint, gray (ATPH561, except order ATPG15GLS for catalog number A723612LP)  
Window Kit  
Wiring Duct

### Modification Services Program

You can customize this product to your unique requirements by specifying from these options:

- Enclosure height, width, depth
- Over 100 standard finish colors and textures
- Holes and cutouts in body, doors, subpanels
- Tapped holes, fasteners in enclosure or subpanel
- Mounting
- Doors
- Subpanels
- Structural changes
- Environmental control (louvers, fans, filters)
- Windows
- Standard accessories

For details, see Modification Services at [www.hoffmanonline.com](http://www.hoffmanonline.com).

To order, contact your local Hoffman sales representative.

NOTE: For information about modifications outside the scope of the Modification Services program, contact your Hoffman sales representative.



**Standard Sizes Single-Door Type 12 and Type 13 Enclosures**

Enclosure Catalog Number	Body Gauge	Enclosure Size A x B x C		* Panel Catalog Number	Panel Size D x E		F		Number of Clamps	Data Pocket
		inch	(millimeter)		inch	(mm)	inch	(mm)		
A122406LP	16	12.00 x 24.00 x 6.00	(305 x 610 x 152)	A12P24	9.00 x 21.00	(229 x 533)	3.00	(76)	2	Small
A161206LP	16	16.00 x 12.00 x 6.00	(406 x 305 x 152)	A16P12	13.00 x 9.00	(330 x 229)	1.25	(32)	2	Small
A161606LP	16	16.00 x 16.00 x 6.00	(406 x 406 x 152)	A16P16	13.00 x 13.00	(330 x 330)	3.00	(76)	2	Small
A162006LP	16	16.00 x 20.00 x 6.00	(406 x 508 x 152)	A20P16	17.00 x 13.00	(432 x 330)	3.00	(76)	2	Small
A201206LP	16	20.00 x 12.00 x 6.00	(508 x 305 x 152)	A20P12	17.00 x 9.00	(432 x 229)	1.25	(32)	2	Small
A201606LP	16	20.00 x 16.00 x 6.00	(508 x 406 x 152)	A20P16	17.00 x 13.00	(432 x 330)	3.00	(76)	2	Small
A202006LP	16	20.00 x 20.00 x 6.00	(508 x 508 x 152)	A20P20	17.00 x 17.00	(432 x 432)	3.00	(76)	2	Small
A202406LP	16	20.00 x 24.00 x 6.00	(508 x 610 x 152)	A24P20	21.00 x 17.00	(533 x 432)	3.00	(76)	2	Small
A241206LP	16	24.00 x 12.00 x 6.00	(610 x 305 x 152)	A12P24	9.00 x 21.00	(229 x 533)	1.25	(32)	2	Small
A241606LP	16	24.00 x 16.00 x 6.00	(610 x 406 x 152)	A24P16	21.00 x 13.00	(533 x 330)	3.00	(76)	2	Small
A242006LP	16	24.00 x 20.00 x 6.00	(610 x 508 x 152)	A24P20	21.00 x 17.00	(533 x 432)	3.00	(76)	2	Small
A242406LP	16	24.00 x 24.00 x 6.00	(610 x 610 x 152)	A24P24	21.00 x 21.00	(533 x 533)	3.00	(76)	2	Small
A301606LP	14	30.00 x 16.00 x 6.00	(762 x 406 x 152)	A30P16	27.00 x 13.00	(686 x 330)	3.00	(76)	2	Small
A302006LP	14	30.00 x 20.00 x 6.00	(762 x 508 x 152)	A30P20	27.00 x 17.00	(686 x 432)	3.00	(76)	2	Small
A302406LP	14	30.00 x 24.00 x 6.00	(762 x 610 x 152)	A30P24	27.00 x 21.00	(686 x 533)	3.00	(76)	2	Large
A362406LP	14	36.00 x 24.00 x 6.00	(914 x 610 x 152)	A36P24	33.00 x 21.00	(838 x 533)	3.00	(76)	2	Large
A363006LP	14	36.00 x 30.00 x 6.00	(914 x 762 x 152)	A36P30	33.00 x 27.00	(838 x 686)	3.00	(76)	2	Large
A122408LP	16	12.00 x 24.00 x 8.00	(305 x 610 x 203)	A12P24	9.00 x 21.00	(229 x 533)	3.00	(76)	2	Small
A161208LP	16	16.00 x 12.00 x 8.00	(406 x 305 x 203)	A16P12	13.00 x 9.00	(330 x 229)	1.25	(32)	2	Small
A161608LP	16	16.00 x 16.00 x 8.00	(406 x 406 x 203)	A16P16	13.00 x 13.00	(330 x 330)	3.00	(76)	2	Small
A162008LP	16	16.00 x 20.00 x 8.00	(406 x 508 x 203)	A20P16	17.00 x 13.00	(432 x 330)	3.00	(76)	2	Small
A201208LP	16	20.00 x 12.00 x 8.00	(508 x 305 x 203)	A20P12	17.00 x 9.00	(432 x 229)	1.25	(32)	2	Small
A201608LP	16	20.00 x 16.00 x 8.00	(508 x 406 x 203)	A20P16	17.00 x 13.00	(432 x 330)	3.00	(76)	2	Small
A202008LP	16	20.00 x 20.00 x 8.00	(508 x 508 x 203)	A20P20	17.00 x 17.00	(432 x 432)	3.00	(76)	2	Small
A202408LP	16	20.00 x 24.00 x 8.00	(508 x 610 x 203)	A24P20	21.00 x 17.00	(533 x 432)	3.00	(76)	2	Small
A241208LP	16	24.00 x 12.00 x 8.00	(610 x 305 x 203)	A12P24	9.00 x 21.00	(229 x 533)	1.25	(32)	2	Small
A241608LP	16	24.00 x 16.00 x 8.00	(610 x 406 x 203)	A24P16	21.00 x 13.00	(533 x 330)	3.00	(76)	2	Small
A242008LP	14	24.00 x 20.00 x 8.00	(610 x 508 x 203)	A24P20	21.00 x 17.00	(533 x 432)	3.00	(76)	2	Small
A242408LP	16	24.00 x 24.00 x 8.00	(610 x 610 x 203)	A24P24	21.00 x 21.00	(533 x 533)	3.00	(76)	2	Small
A243008LP	14	24.00 x 30.00 x 8.00	(610 x 762 x 203)	A30P24	27.00 x 21.00	(686 x 533)	3.00	(76)	2	Small
A302008LP	14	30.00 x 20.00 x 8.00	(765 x 508 x 203)	A30P20	27.00 x 17.00	(686 x 432)	3.00	(76)	2	Small
A302408LP	14	30.00 x 24.00 x 8.00	(762 x 610 x 203)	A30P24	27.00 x 21.00	(686 x 533)	3.00	(76)	2	Large
A303008LP	14	30.00 x 30.00 x 8.00	(762 x 762 x 203)	A30P30	27.00 x 27.00	(686 x 686)	3.00	(76)	2	Large
A303608LP	14	30.00 x 36.00 x 8.00	(762 x 914 x 203)	A36P30	33.00 x 27.00	(838 x 686)	3.00	(76)	2	Large
A362408LP	14	36.00 x 24.00 x 8.00	(914 x 610 x 203)	A36P24	33.00 x 21.00	(838 x 533)	3.00	(76)	2	Large
A363008LP	14	36.00 x 30.00 x 8.00	(914 x 762 x 203)	A36P30	33.00 x 27.00	(838 x 686)	3.00	(76)	2	Large
A363608LP	14	36.00 x 36.00 x 8.00	(914 x 914 x 203)	A36P36	33.00 x 33.00	(838 x 838)	3.00	(76)	2	Large
A422408LP	14	42.00 x 24.00 x 8.00	(1097 x 610 x 203)	A42P24	39.00 x 21.00	(991 x 533)	3.00	(76)	2	Large
A423008LP	14	42.00 x 30.00 x 8.00	(1967 x 762 x 203)	A42P30	39.00 x 27.00	(991 x 686)	3.00	(76)	2	Small
A423608LP	14	42.00 x 36.00 x 8.00	(1067 x 914 x 203)	A42P36	39.00 x 33.00	(991 x 838)	3.00	(76)	2	Large
A482408LP	14	48.00 x 24.00 x 8.00	(1219 x 610 x 203)	A48P24	45.00 x 21.00	(1143 x 533)	3.00	(76)	3	Large
A483008LP	14	48.00 x 30.00 x 8.00	(1219 x 762 x 203)	A48P30	45.00 x 27.00	(1143 x 686)	3.00	(76)	3	Small
A483608LP	14	48.00 x 36.00 x 8.00	(1219 x 914 x 203)	A48P36	45.00 x 33.00	(1143 x 838)	3.00	(76)	3	Large
A603608LP	14	60.00 x 36.00 x 8.00	(1524 x 914 x 203)	A60P36	57.00 x 33.00	(1448 x 838)	3.00	(76)	3	Large

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# Single-Door Type 12 and Type 13 Enclosures

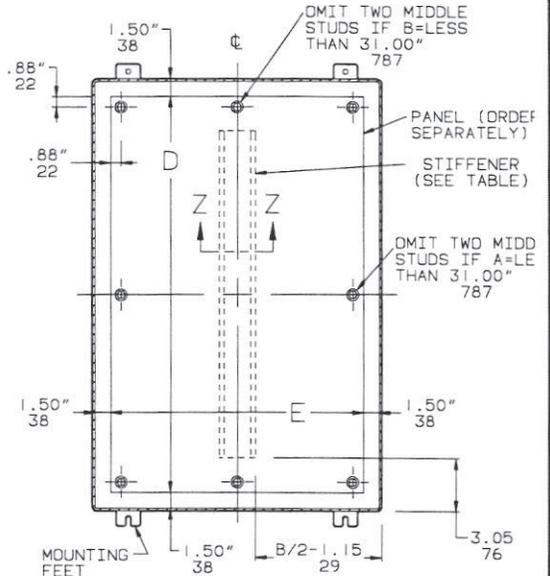
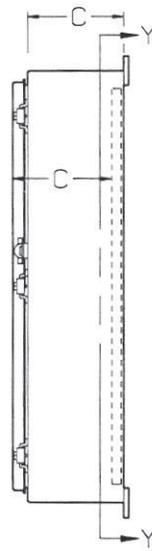
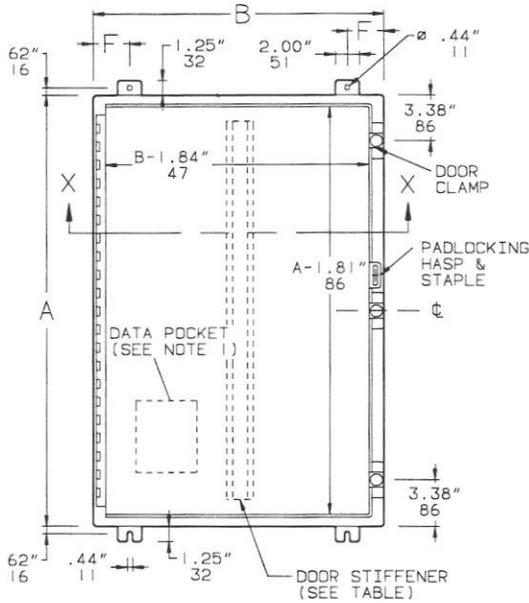
Standard Sizes Single-Door Type 12 and Type 13 Enclosures (Cont.)

Enclosure Catalog Number	Body Gauge	Enclosure Size A x B x C*		Panel Catalog Number	Panel Size D x E		F		Number of Clamps	Data Pocket
		inch	(millimeter)		inch	(mm)	inch	(mm)		
A161210LP	14	16.00 x 12.00 x 10.00	(406 x 305 x 254)	A16P12	13.00 x 9.00	(330 x 229)	1.25	(32)	2	Small
A201610LP	14	20.00 x 16.00 x 10.00	(508 x 406 x 254)	A20P16	17.00 x 13.00	(432 x 330)	3.00	(76)	2	Small
A202010LP	14	20.00 x 20.00 x 10.00	(508 x 508 x 254)	A20P20	17.00 x 17.00	(432 x 432)	3.00	(76)	2	Small
A241210LP	14	24.00 x 12.00 x 10.00	(610 x 305 x 254)	A12P24	9.00 x 21.00	(229 x 533)	1.25	(32)	2	Small
A242010LP	14	24.00 x 20.00 x 10.00	(610 x 508 x 254)	A24P20	21.00 x 17.00	(533 x 432)	3.00	(76)	2	Small
A242410LP	14	24.00 x 24.00 x 10.00	(610 x 610 x 254)	A24P24	21.00 x 21.00	(533 x 533)	3.00	(76)	2	Small
A302010LP	14	30.00 x 20.00 x 10.00	(762 x 508 x 254)	A30P20	27.00 x 17.00	(686 x 432)	3.00	(76)	2	Small
A302410LP	14	30.00 x 24.00 x 10.00	(762 x 610 x 254)	A30P24	27.00 x 21.00	(686 x 533)	3.00	(76)	2	Large
A362410LP	14	36.00 x 24.00 x 10.00	(914 x 610 x 254)	A36P24	33.00 x 21.00	(838 x 533)	3.00	(76)	2	Large
A363010LP	14	36.00 x 30.00 x 10.00	(914 x 762 x 254)	A36P30	33.00 x 27.00	(838 x 686)	3.00	(76)	2	Large
A423010LP	14	42.00 x 30.00 x 10.00	(1067 x 762 x 254)	A42P30	39.00 x 27.00	(991 x 686)	3.00	(76)	2	Small
A423610LP	14	42.00 x 36.00 x 10.00	(1067 x 914 x 254)	A42P36	39.00 x 33.00	(991 x 838)	3.00	(76)	2	Large
A483010LP	14	48.00 x 30.00 x 10.00	(1219 x 762 x 254)	A48P30	45.00 x 27.00	(1143 x 686)	3.00	(76)	3	Small
A483610LP	14	48.00 x 36.00 x 10.00	(1219 x 914 x 254)	A48P36	45.00 x 33.00	(1143 x 838)	3.00	(76)	3	Large
A603610LP	14	60.00 x 36.00 x 10.00	(1524 x 914 x 254)	A60P36	57.00 x 33.00	(1448 x 838)	3.00	(76)	3	Large
A201612LP	14	20.00 x 16.00 x 12.00	(508 x 406 x 305)	A20P16	17.00 x 13.00	(432 x 330)	3.00	(76)	2	Small
A242012LP	14	24.00 x 20.00 x 12.00	(610 x 508 x 305)	A24P20	21.00 x 17.00	(533 x 432)	3.00	(76)	2	Small
A242412LP	14	24.00 x 24.00 x 12.00	(610 x 610 x 305)	A24P24	21.00 x 21.00	(533 x 533)	3.00	(76)	2	Small
A302412LP	14	30.00 x 24.00 x 12.00	(762 x 610 x 305)	A30P24	27.00 x 21.00	(686 x 533)	3.00	(76)	2	Large
A303012LP	14	30.00 x 30.00 x 12.00	(762 x 762 x 305)	A30P30	27.00 x 27.00	(686 x 686)	3.00	(76)	2	Large
A362412LP	14	36.00 x 24.00 x 12.00	(914 x 610 x 305)	A36P24	33.00 x 21.00	(838 x 533)	3.00	(76)	2	Large
A363012LP	14	36.00 x 30.00 x 12.00	(914 x 762 x 305)	A36P30	33.00 x 27.00	(838 x 686)	3.00	(76)	2	Large
A363612LP	14	36.00 x 36.00 x 12.00	(914 x 914 x 305)	A36P36	33.00 x 33.00	(838 x 838)	3.00	(76)	2	Large
A423012LP	14	42.00 x 30.00 x 12.00	(1067 x 762 x 305)	A42P30	39.00 x 27.00	(991 x 686)	3.00	(76)	2	Small
A423612LP	14	42.00 x 36.00 x 12.00	(1067 x 914 x 305)	A42P36	39.00 x 33.00	(991 x 838)	3.00	(76)	2	Large
A483612LP	14	48.00 x 36.00 x 12.00	(1219 x 914 x 305)	A48P36	45.00 x 33.00	(1143 x 838)	3.00	(76)	3	Large
A603612LP	14	60.00 x 36.00 x 12.00	(1524 x 914 x 305)	A60P36	57.00 x 33.00	(1448 x 838)	3.00	(76)	3	Large
A723612LP	14	72.00 x 36.00 x 12.00	(1829 x 914 x 305)	A72P36	69.00 x 33.00	(1753 x 838)	3.00	(76)	3	Large
A242016LP	14	24.00 x 20.00 x 16.00	(610 x 508 x 406)	A24P20	21.00 x 17.00	(533 x 432)	3.00	(76)	2	Small
A242416LP	14	24.00 x 24.00 x 16.00	(610 x 610 x 406)	A24P24	21.00 x 21.00	(533 x 533)	3.00	(76)	2	Small
A302416LP	14	30.00 x 24.00 x 16.00	(762 x 610 x 406)	A30P24	27.00 x 21.00	(686 x 533)	3.00	(76)	2	Large
A363016LP	14	36.00 x 30.00 x 16.00	(914 x 762 x 406)	A36P30	33.00 x 27.00	(838 x 686)	3.00	(76)	2	Large
A423616LP	14	42.00 x 36.00 x 16.00	(1067 x 914 x 406)	A42P36	39.00 x 33.00	(991 x 838)	3.00	(76)	2	Large
A483616LP	14	48.00 x 36.00 x 16.00	(1219 x 914 x 406)	A48P36	45.00 x 33.00	(1143 x 838)	3.00	(76)	3	Large
A603616LP	14	60.00 x 36.00 x 16.00	(1524 x 914 x 406)	A60P36	57.00 x 33.00	(1448 x 838)	3.00	(76)	3	Large
A302420LP	14	30.00 x 24.00 x 20.00	(762 x 610 x 508)	A30P24	27.00 x 21.00	(686 x 533)	3.00	(76)	2	Large
A363020LP	14	36.00 x 30.00 x 20.00	(914 x 762 x 508)	A36P30	33.00 x 27.00	(838 x 686)	3.00	(76)	2	Large
A483620LP	14	48.00 x 36.00 x 20.00	(1219 x 914 x 508)	A48P36	45.00 x 33.00	(1143 x 838)	3.00	(76)	3	Large
A603620LP	14	60.00 x 36.00 x 20.00	(1524 x 914 x 508)	A60P36	57.00 x 33.00	(1448 x 838)	3.00	(76)	3	Large
A302424LP	14	30.00 x 24.00 x 24.00	(762 x 610 x 610)	A30P24	27.00 x 21.00	(686 x 533)	3.00	(76)	2	Large

Millimeter dimensions ( ) are for reference only; do not convert metric dimensions to inch.

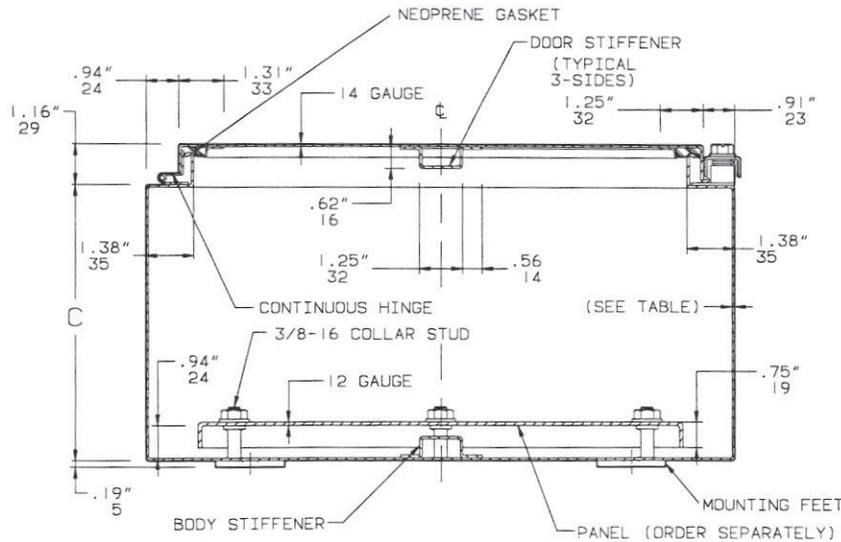
\* Panels must be ordered separately. Optional stainless steel, zinc-plated, composite, and aluminum panels are available for most sizes. See Chapter 12, General Accessories.

NOTE: Panels have a formed flange on any side that is longer than 21.00 in. (533mm). Panels A24P20 and A24P24 have a flange on all four sides.

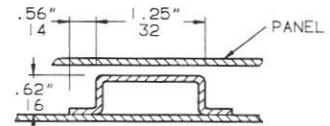


SECTION Y-Y

Number of Body Studs		
Enclosure Size A	Enclosure Size B	Qty of Studs
>31.00 (787)	Any	6
Any	>31.00 (787)	6



SECTION X-X



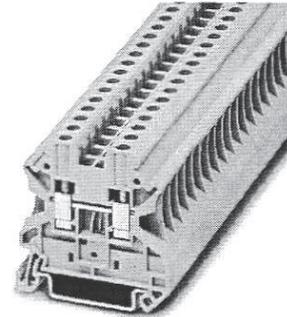
SECTION Z-Z

C2482



## Terminal block UT

<b>Article description</b>	UT 4 *
Article no.	3044102 *
<b>EC-TYPE EXAMINATION CERTIFICATE</b>	KEMA 04ATEX2048 U *
Marking	Ex e II KEMA 04ATEX2048 U
Assembly on mounting rails	NS 35 acc. to EN 60715-TH 35
Stripping length	9 mm
Torque	0,6 - 0,8 Nm
Assembly instructions	See page 2
Operating temperature range	-50 °C ... +110 °C



### Technical data according to EN 60079-7 (increased safety „e“)

Rated insulation voltage	630 V
Rated voltage	690 V
Nominal current	30 A
Max. rated current	38 A

### Connection capacity

Rated cross-section	4 mm <sup>2</sup>	AWG 12
Max. conductor cross-section	6 mm <sup>2</sup>	AWG 10
Connectable conductor cross-section	0,14 - 6 mm <sup>2</sup> rigid	AWG 26 - 10
	0,14 - 4 mm <sup>2</sup> flexible	AWG 26 - 12

### Multi-conductor connection (2 conductors of the same cross-section)

Rigid / flexible	0,14 - 1,5 mm <sup>2</sup>	AWG 26 - 16
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### Insulation material

Description	PA 6.6
Creep resistance acc. to IEC 60112 / material group	CTI 600 / I

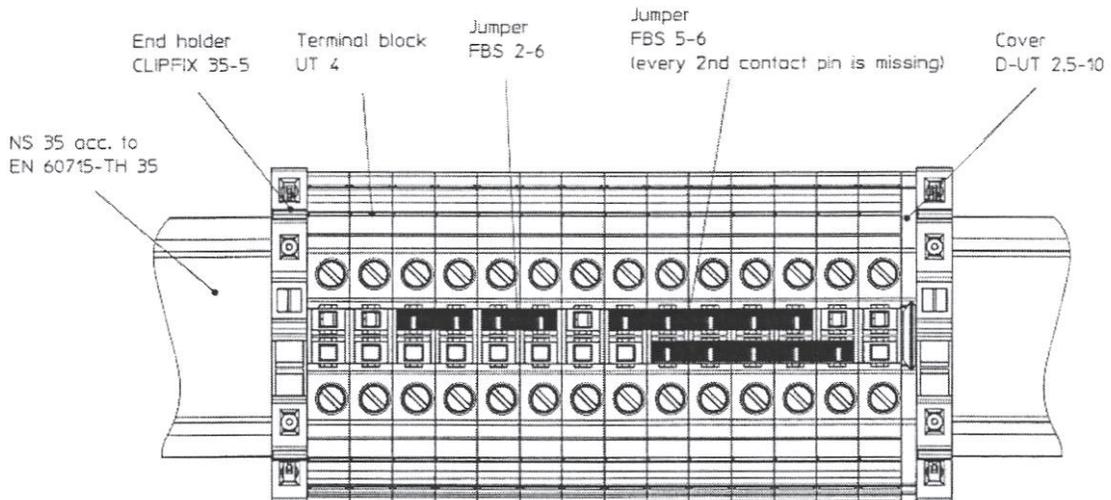
Accessories	Description	Article no.	
Cover	D-UT 2,5-10	3047028	
	FBS 2-6	3030336	
	FBS 3-6	3030242	
	FBS 4-6	3030255	
	FBS 5-6	3030349	
Jumper	FBS 10-6	3030271	Max. 27 A / 4 mm <sup>2</sup>
	FBS 20-6	3030365	

\* valid for colour variants

### Important assembly instructions – increased safety „e“

When assembling with other certified series and sizes of terminal blocks and using belonging accessories, the required creepage distances and clearances have to be observed.

When using the jumpers to achieve a skipped bridging the rated voltage is reduced to 352 V.



### Operational instructions – Intrinsic safety “i”

EN 60079-14 Clause 12 describes modular terminal blocks as simple apparatus when used in intrinsically-safe circuits. Testing by a notified body and marking is not required. If terminal blocks be identifiable as part of an intrinsically circuit are marked by a colour, the colour used shall be light blue.

Testing for compliance to intrinsically safe requirements including clearance, creepage, and solid insulation distances specified in EN 60079-0 (EN 50014) and EN 60079-11 (EN 50020) have been performed for circuits up to 60 V.

Compliance with distance requirements of EN 60079-14 Clause 12.2.3 for the connection of separated intrinsically-safe circuit accessories is met. A minimum distance of 50 mm to separate clamping units of intrinsically-safe and non intrinsically-safe circuits is required through the use of a separating plate or similar device.

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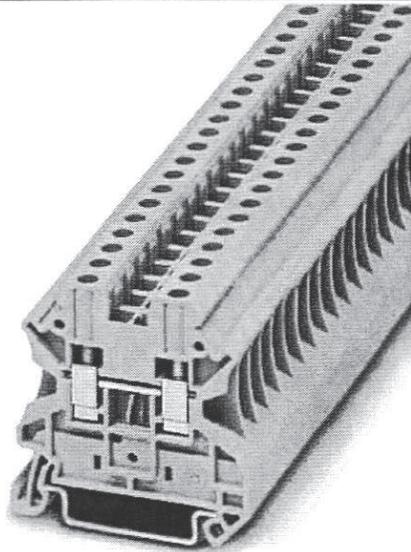
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### ► Extract from the online catalog



Universal terminal block with screw connection, cross section: 0,14 - 4 mm<sup>2</sup>, AWG: 26 - 10, width: 6.2 mm, color: Gray

Order No.	3044 102
Ord designation	UT 4
EAN	4017918960391
Pack	50 Pcs.
Customs tariff	85369010
Weight/Piece	0,00948 KG
Catalog page information	Page 13 (NTK-2005)

### ► Product notes

WEEE/RoHS-compliant since: 01/01/2003



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**General**

Number of levels	1
Number of connections	2
Color	gray
Insulating material	PA
Inflammability class acc. to UL 94	V0

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**Dimensions**

Width	6.2 mm
Length	47.7 mm
Height NS 35/7,5	47.5 mm
Height NS 35/15	55 mm

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**Technical data**

Maximum load current	41 A (with 6 mm <sup>2</sup> conductor cross section)
Rated surge voltage	8 kV
Contamination class	3
Surge voltage category	III
Insulating material group	I
Connection in acc. with standard	IEC 60 947-7-1
Nominal current I <sub>N</sub>	41 A
Nominal voltage U <sub>N</sub>	1000 V
Open side panel	ja

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**Connection data**

Conductor cross section solid min.	0.14 mm <sup>2</sup>
Conductor cross section solid max.	6 mm <sup>2</sup>
Conductor cross section stranded min.	0.14 mm <sup>2</sup>
Conductor cross section stranded max.	6 mm <sup>2</sup>
Conductor cross section AWG/kcmil min.	26
Conductor cross section AWG/kcmil max.	10
Conductor cross section stranded, with ferrule without plastic sleeve min.	0.25 mm <sup>2</sup>
Conductor cross section stranded, with ferrule without plastic sleeve max.	4 mm <sup>2</sup>
Conductor cross section stranded, with ferrule with plastic sleeve min.	0.25 mm <sup>2</sup>
Conductor cross section stranded, with ferrule with plastic sleeve max.	4 mm <sup>2</sup>
2 conductors with same cross section, solid min.	0.14 mm <sup>2</sup>
2 conductors with same cross section, solid max.	1.5 mm <sup>2</sup>
2 conductors with same cross section, stranded min.	0.14 mm <sup>2</sup>
2 conductors with same cross section, stranded max.	1.5 mm <sup>2</sup>
2 conductors with same cross section, stranded, TWIN ferrules with plastic sleeve, min.	0.5 mm <sup>2</sup>
2 conductors with same cross section, stranded, TWIN ferrules with plastic sleeve, max.	2.5 mm <sup>2</sup>
2 conductors with same cross section, stranded, ferrules without plastic sleeve, min.	0.25 mm <sup>2</sup>
2 conductors with same cross section, stranded, ferrules without plastic sleeve, max.	1.5 mm <sup>2</sup>

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**► Certificates / Approvals**

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## Certificate logos



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**CSA**

Nominal voltage $U_N$	600 V
Nominal current $I_N$	30 A
AWG/kcmil	26-10

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**CUL**

Nominal voltage $U_N$	600 V
Nominal current $I_N$	30 A
AWG/kcmil	26-10

---

**UL**

Nominal voltage $U_N$	600 V
Nominal current $I_N$	30 A
AWG/kcmil	26-10

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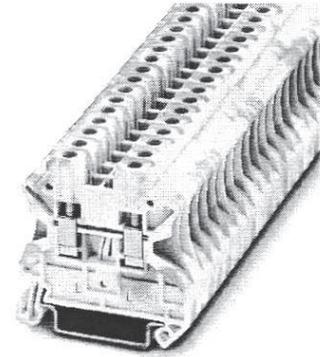
## ► Accessories

Item	Designation	Description
<b>Assembly</b>		
3047167	ATP-UT	Partition plate, for visual and electrical separation of terminal groups, width: 2 mm, color: gray
3047028	D-UT 2,5/10	Cover, for terminal block UT and UT...-PE, width 2.2 mm, color: Gray
0801762	NS 35/ 7,5 CU UNPERF 2000MM	DIN rail, material: Copper, unperforated, height 7.5 mm, width 35 mm, length: 2 m
1207640	NS 35/ 7,5 PERF 755MM	NS 35 DIN rail, height 7.5 mm, length 755 mm
1207653	NS 35/ 7,5 PERF 955MM	NS35 DIN rail, height 7.5 mm, length 955 mm
1207666	NS 35/ 7,5 PERF 1155MM	NS 35 DIN rail, height 7.5 mm, length 1155 mm
0801733	NS 35/ 7,5 PERF 2000MM	DIN rail, material: Steel, perforated, height 7.5 mm, width 35 mm, length: 2 m
0801681	NS 35/ 7,5 UNPERF 2000MM	DIN rail, material: Steel, unperforated, height 7.5 mm, width 35 mm, length: 2 m
1201756	NS 35/15 AL UNPERF 2000MM	DIN rail, deep-drawn, high profile, unperforated, 1.5 mm thick, material: Aluminum, height 15 mm, width 35 mm, length 2 m
1201895	NS 35/15 CU UNPERF 2000MM	DIN rail, material: Copper, unperforated, 1.5 mm thick, height 15 mm, width 35 mm, length: 2 m
1207679	NS 35/15 PERF 755MM	NS 35 DIN rail, height 15 mm, length 755 mm
1207682	NS 35/15 PERF 955MM	NS 35 DIN rail, height 15 mm, length 955 mm
1207695	NS 35/15 PERF 1155MM	NS 35 DIN rail, height 15 mm, length 1155 mm
1201730	NS 35/15 PERF 2000MM	DIN rail, material: Steel, perforated, height 15 mm, width 35 mm, length: 2 m
1201714	NS 35/15 UNPERF 2000MM	DIN rail, material: Steel, unperforated, height 15 mm, width 35 mm, length: 2 m
1201798	NS 35/15-2,3 UNPERF 2000MM	DIN rail, material: Steel, unperforated, 2.3 mm thick, height 15 mm, width 35 mm, length: 2 m
<b>Bridges</b>		
3030336	FBS 2-6	Plug-in bridge for cross-connections in the terminal center, 2-pos., color: Red
3030242	FBS 3-6	Plug-in bridge for cross-connections in the terminal center, 3-pos., color: Red
3030255	FBS 4-6	Plug-in bridge for cross-connections in the terminal center, 4-pos., color: Red
3030349	FBS 5-6	Plug-in bridge for cross-connections in the terminal center, 5-pos., color: Red
3030271	FBS 10-6	Plug-in bridge for cross-connections in the terminal center, 10-pos., color: Red
3030365	FBS 20-6	Plug-in bridge for cross-connections in the terminal center, 20-pos., color: Red
3032224	FBS 50-6	Plug-in bridge for cross-connections in the terminal center, 50-pos., color: Red
<b>Marking</b>		
0811228	X-PEN 0,35	Marker pen without ink cartridge, for manual labeling of markers, labeling extremely wipe-proof, line thickness 0.35 mm



## Protective conductor terminal block UT

<b>Article description</b>	<b>UT 4-PE</b>
Article no.	3044128
<b>EC-TYPE EXAMINATION CERTIFICATE</b>	<b>KEMA 04ATEX2048 U</b>
Marking	Ex e II KEMA 04ATEX2048 U
Assembly on mounting rails	NS 35 acc. to EN 60715-TH 35
Stripping length	9 mm
Torque	0,6 - 0,8 Nm
Assembly instructions	See page 2
Operating temperature range	-50 °C ... +110 °C



### Technical data according to EN 60079-7 (increased safety „e“)

#### Connection capacity

Rated cross-section	4 mm <sup>2</sup>	AWG 12
Max. conductor cross-section	6 mm <sup>2</sup>	AWG 10
Connectable conductor cross-section	0,14 - 6 mm <sup>2</sup> rigid	AWG 26 - 10
	0,14 - 4 mm <sup>2</sup> flexible	AWG 26 - 12

#### Data to the explosion protection

Rated voltage	690 V	to the adjacent UT 4
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#### Insulation material

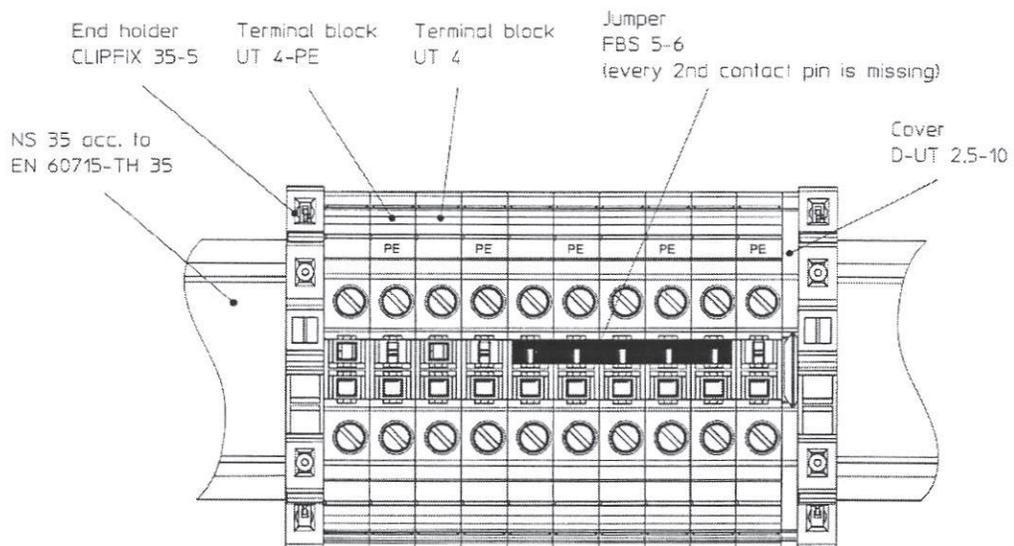
Description	PA 6.6
Creep resistance acc. to IEC 60112 / material group	CTI 600 / I

Accessories	Description	Article no.
Cover	D-UT 2,5-10	3047028

## Important assembly instructions – increased safety „e“

When assembling with other certified series and sizes of terminal blocks and using belonging accessories, the required creepage distances and clearances have to be observed.

When using the jumpers to achieve a skipped bridging of protective terminal block UT 4-PE the rated voltage is reduced to 275 V.



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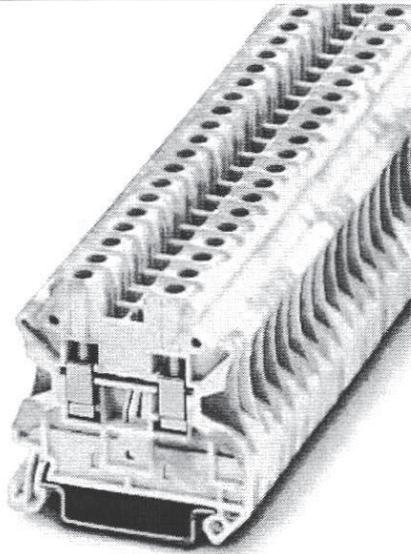
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### ► Extract from the online catalog



Universal terminal block with screw connection, cross section: 0.14 - 4 mm<sup>2</sup>, AWG: 26 - 10, width: 6.2 mm, color: Green-yellow

Order No.	3044128
Ord designation	UT 4-PE
EAN	4017918960407
Pack	50 Pcs.
Customs tariff	85369010
Weight/Piece	0,01325 KG
Catalog page information	Page 13 (NTK-2005)

### ► Product notes

WEEE/RoHS-compliant since: 01/01/2003



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**General**

Number of levels	1
Number of connections	2
Color	green-yellow
Insulating material	PA
Inflammability class acc. to UL 94	V0

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**Dimensions**

Width	6.2 mm
Length	47.7 mm
Height NS 35/7,5	47.5 mm
Height NS 35/15	55 mm

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**Technical data**

Rated surge voltage	8 kV
Contamination class	3
Surge voltage category	III
Insulating material group	I
Connection in acc. with standard	IEC 60 947-7-2
Open side panel	ja

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**Connection data**

Conductor cross section solid min.	0.14 mm <sup>2</sup>
Conductor cross section solid max.	6 mm <sup>2</sup>
Conductor cross section stranded min.	0.14 mm <sup>2</sup>
Conductor cross section stranded max.	6 mm <sup>2</sup>
Conductor cross section AWG/kcmil min.	26
Conductor cross section AWG/kcmil max.	10
Conductor cross section stranded, with ferrule without plastic sleeve min.	0.25 mm <sup>2</sup>
Conductor cross section stranded, with ferrule without plastic sleeve max.	4 mm <sup>2</sup>
Conductor cross section stranded, with ferrule with plastic sleeve min.	0.25 mm <sup>2</sup>
Conductor cross section stranded, with ferrule with plastic sleeve max.	4 mm <sup>2</sup>
2 conductors with same cross section, solid min.	0.14 mm <sup>2</sup>
2 conductors with same cross section, solid max.	1.5 mm <sup>2</sup>
2 conductors with same cross section, stranded min.	0.14 mm <sup>2</sup>
2 conductors with same cross section, stranded max.	1.5 mm <sup>2</sup>
2 conductors with same cross section, stranded, TWIN ferrules with plastic sleeve, min.	0.5 mm <sup>2</sup>
2 conductors with same cross section, stranded, TWIN ferrules with plastic sleeve, max.	2.5 mm <sup>2</sup>
2 conductors with same cross section, stranded, ferrules without plastic sleeve, min.	0.25 mm <sup>2</sup>
2 conductors with same cross section, stranded, ferrules without plastic sleeve, max.	1.5 mm <sup>2</sup>
Type of connection	Screw connection
Stripping length	9 mm
Internal cylindrical gage	A4

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► Certificates / Approvals

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Certificate logos



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**CSA**

AWG/kcmil

26-10

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**CUL**

AWG/kcmil

26-10

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**UL**

AWG/kcmil

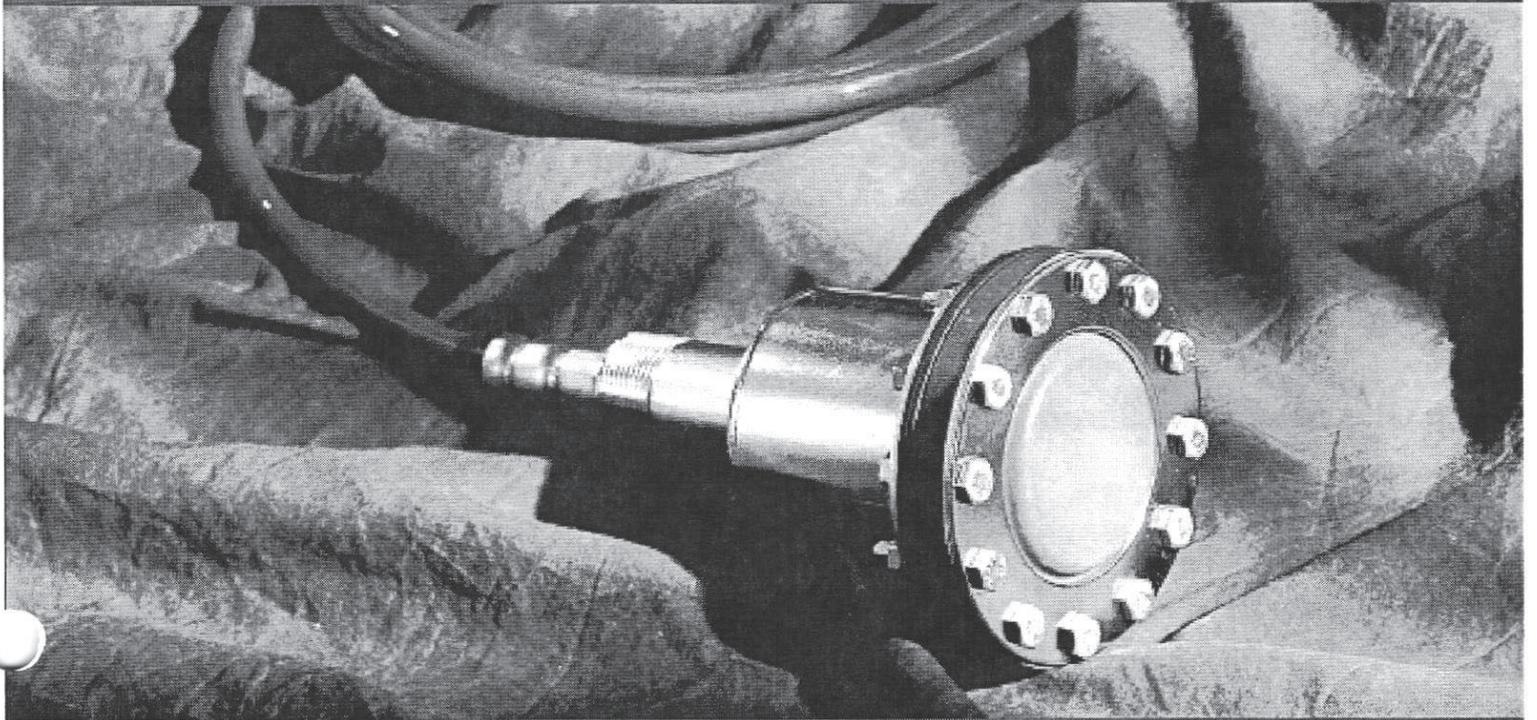
26-10

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## ► Accessories

Item	Designation	Description
<b>Assembly</b>		
3047167	ATP-UT	Partition plate, for visual and electrical separation of terminal groups, width: 2 mm, color: gray
3047028	D-UT 2,5/10	Cover, for terminal block UT and UT...-PE, width 2.2 mm, color: Gray
0801762	NS 35/ 7,5 CU UNPERF 2000MM	DIN rail, material: Copper, unperforated, height 7.5 mm, width 35 mm, length: 2 m
1207640	NS 35/ 7,5 PERF 755MM	NS 35 DIN rail, height 7.5 mm, length 755 mm
1207653	NS 35/ 7,5 PERF 955MM	NS35 DIN rail, height 7.5 mm, length 955 mm
1207666	NS 35/ 7,5 PERF 1155MM	NS 35 DIN rail, height 7.5 mm, length 1155 mm
0801733	NS 35/ 7,5 PERF 2000MM	DIN rail, material: Steel, perforated, height 7.5 mm, width 35 mm, length: 2 m
0801681	NS 35/ 7,5 UNPERF 2000MM	DIN rail, material: Steel, unperforated, height 7.5 mm, width 35 mm, length: 2 m
1201756	NS 35/15 AL UNPERF 2000MM	DIN rail, deep-drawn, high profile, unperforated, 1.5 mm thick, material: Aluminum, height 15 mm, width 35 mm, length 2 m
1201895	NS 35/15 CU UNPERF 2000MM	DIN rail, material: Copper, unperforated, 1.5 mm thick, height 15 mm, width 35 mm, length: 2 m
1207679	NS 35/15 PERF 755MM	NS 35 DIN rail, height 15 mm, length 755 mm
1207682	NS 35/15 PERF 955MM	NS 35 DIN rail, height 15 mm, length 955 mm
1207695	NS 35/15 PERF 1155MM	NS 35 DIN rail, height 15 mm, length 1155 mm
1201730	NS 35/15 PERF 2000MM	DIN rail, material: Steel, perforated, height 15 mm, width 35 mm, length: 2 m
1201714	NS 35/15 UNPERF 2000MM	DIN rail, material: Steel, unperforated, height 15 mm, width 35 mm, length: 2 m
1201798	NS 35/15-2,3 UNPERF 2000MM	DIN rail, material: Steel, unperforated, 2.3 mm thick, height 15 mm, width 35 mm, length: 2 m
<b>Bridges</b>		
3030336	FBS 2-6	Plug-in bridge for cross-connections in the terminal center, 2-pos., color: Red
3030242	FBS 3-6	Plug-in bridge for cross-connections in the terminal center, 3-pos., color: Red
3030255	FBS 4-6	Plug-in bridge for cross-connections in the terminal center, 4-pos., color: Red
3030349	FBS 5-6	Plug-in bridge for cross-connections in the terminal center, 5-pos., color: Red
3030271	FBS 10-6	Plug-in bridge for cross-connections in the terminal center, 10-pos., color: Red
3030365	FBS 20-6	Plug-in bridge for cross-connections in the terminal center, 20-pos., color: Red
3032224	FBS 50-6	Plug-in bridge for cross-connections in the terminal center, 50-pos., color: Red
<b>Marking</b>		
0811228	X-PEN 0,35	Marker pen without ink cartridge, for manual labeling of markers, labeling extremely wipe-proof, line thickness 0.35 mm





**A1000 SUBMERSIBLE  
LEVEL TRANSDUCER:  
PROVEN PERFORMANCE  
IN HIGH-SOLIDS  
ENVIRONMENTS.**

**STABLE, RELIABLE, SIMPLE**

**A1000 SUBMERSIBLE LEVEL TRANSDUCER**



**A1000 Features In Brief**

- 316 stainless steel construction with PVC and Buna-N isolation rings and 2-5/8" Teflon®-coated or Viton® coated Buna-N diaphragm.
- Easy-to-run 1/2" cable with integral breather tube.
- Sealed breather system.
- Analog output.
- Provides 1-5 VDC or 4-20 mADC outputs.
- Pressure range: 0-1, 0-5, 0-15, 0-30, 0-75, 0-150, 0-300 PSI.
- Factory-calibrated, with field recalibration available.
- Available in several standard cable lengths. Custom lengths up to 1000' available by special order.
- Intrinsically safe when used with optional IS1 Intrinsic Safety Barrier.
- Electronics are electrically isolated from sensed media.

*Teflon is a registered trademark of DuPont.*

The A1000/157GSC Submersible Level Transducer/Transmitter is a proven performer in high-solids environments, including sewage lift station wet wells and sludge sumps. It is equally effective in clean water level monitoring applications. The submersible system's rugged simplicity eliminates the cost, clogging and complexity of other types of level sensing.

The A1000 senses liquid level excursions over a factory-calibrated, customer-specified range. It provides a signal to telemeter or record liquid level, or to sense flow rate in flumes, weirs and rivers.

Calibrated to the specific gravity of the liquid in which it operates, the transducer measures the head-pressure imposed on its bottom diaphragm face by the height of the liquid above it and translates the information into an electronic signal.

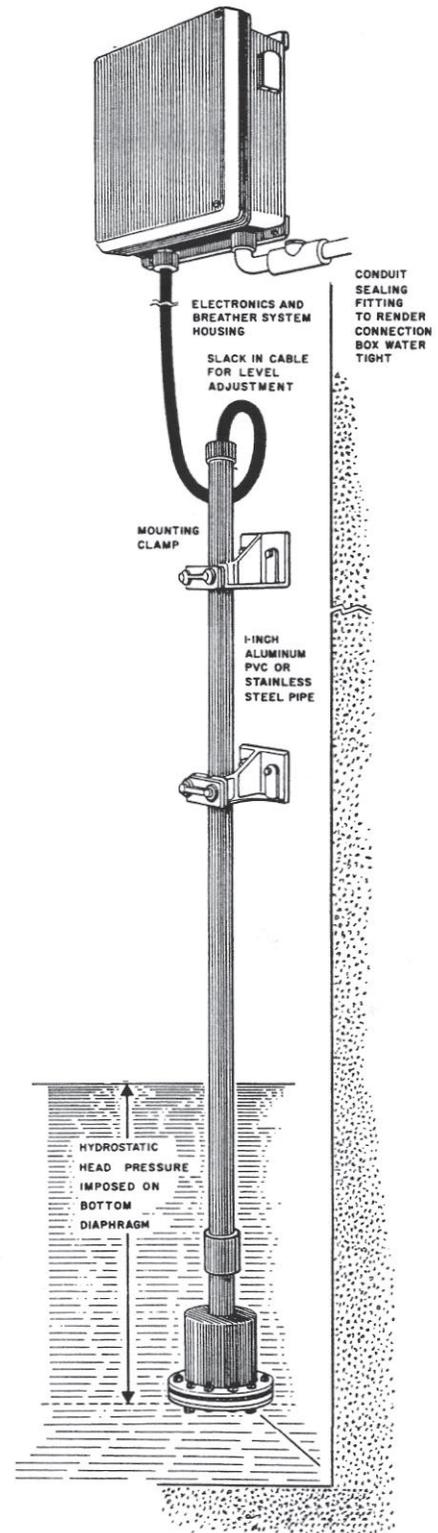
The 2-5/8" diameter Teflon-faced or Viton-faced diaphragm and state-of-the-art precision pressure transducer mechanism are located in the lower assembly. Mounted at a fixed, submerged level, the lower assembly has a type 316 stainless steel body.

The enclosed upper assembly houses system signal conditioning, protective electronics, the job connections terminal block, and the expansion bag of the sealed breathing system, a vital system which negates the effects of changes in atmospheric pressure and protects the sensor from environmental contaminants.

The connecting cable between the upper and lower assemblies has a 1/2" polyurethane jacket, a 3-conductor shielded AWG #16 cable, and an integral rigid breather tube that is part of the sealed breathing system.

Advantages of the system include:

- Solid-state electronics for accuracy, reliability and economy.
- Little or no maintenance required.
- Sealed breathing system that protects electronics from corrosive gases.
- Rigid breather tube that cannot be pinched as a result of installation, assuring barometric compensation.
- Integral transient protection.
- High proof pressure that allows system to withstand inadvertently excessive pressures on the sensing element.
- Seven pressure ranges (spannable down to 15% of element range).
- Easy field repair with stock parts.
- Field calibration possible in most applications.
- Many options are available, including level indication, special housing and environmental conditioning equipment.

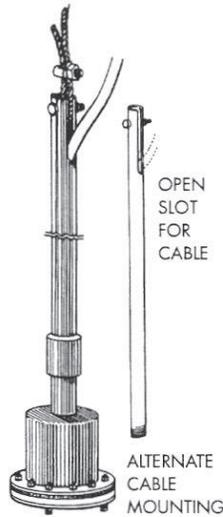


The lower assembly is generally either pipe-mounted (1" NPT) or suspended with a stainless steel cable in a vertical position in the sump or reservoir to be sensed. Although it can be specified and furnished for any other mounting attitude, cable mounting is recommended

for easiest serviceability.

The sensed media can be any type compatible with the lower assembly and cable materials (316 stainless steel, Teflon, PVC, Nitrile and urethane), but it must be of a constant specific gravity.

**CABLE SUSPENSION MOUNTING KIT**

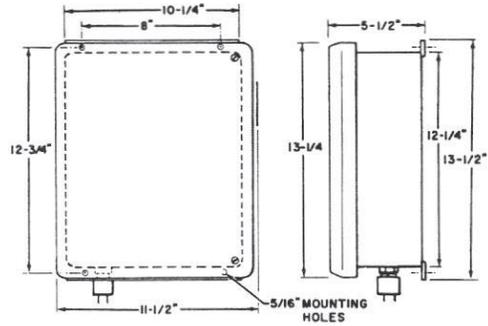


Kit includes 2' long 1-inch NPT Type 316 SS pipe with coupling, bolt, cable clamps and other hardware shown  
P/N 601418-01

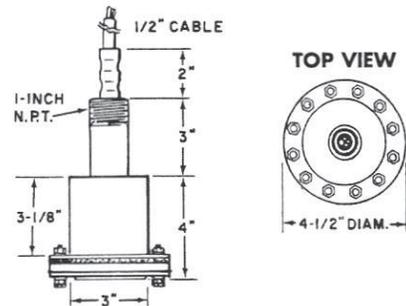
1/8-inch diameter, 7x19 SS cable; order the desired number of feet. Clamps are in Kit  
P/N 601440-XX

*Cable mounting is the preferred method for ease of serviceability.*

**UPPER ASSEMBLY DIMENSIONS**



**LOWER ASSEMBLY DIMENSIONS**

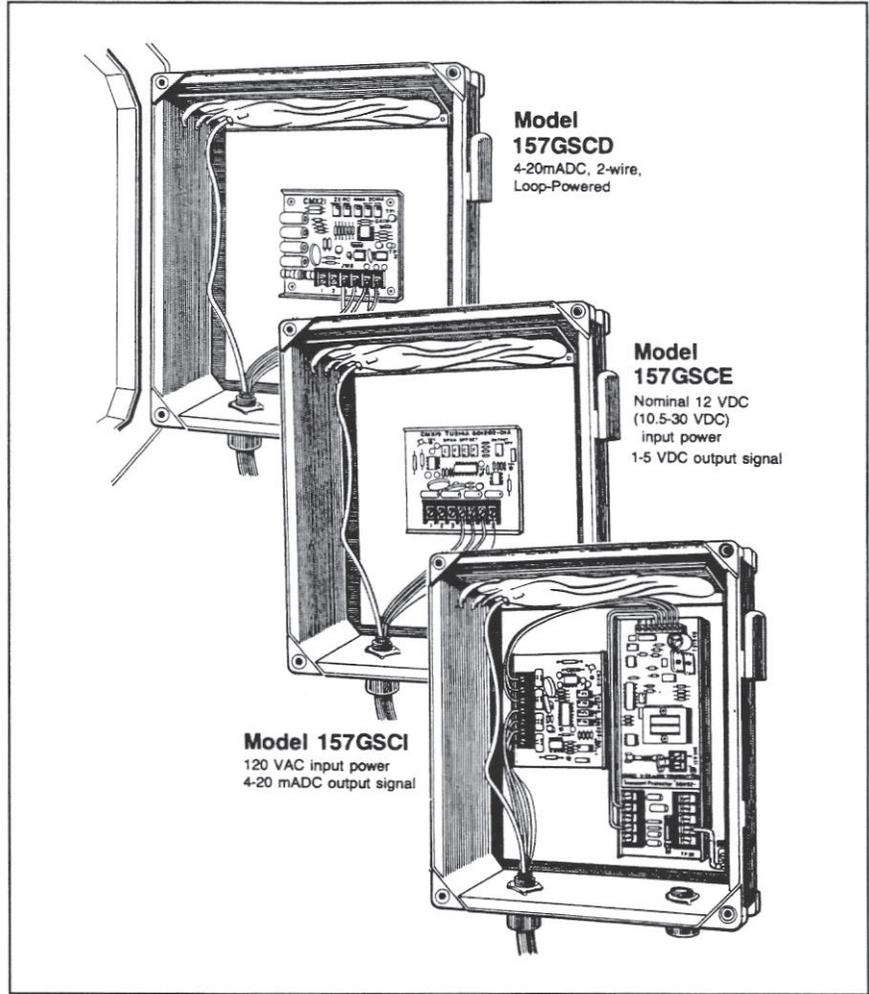


**PRESSURE RANGE TABLE**

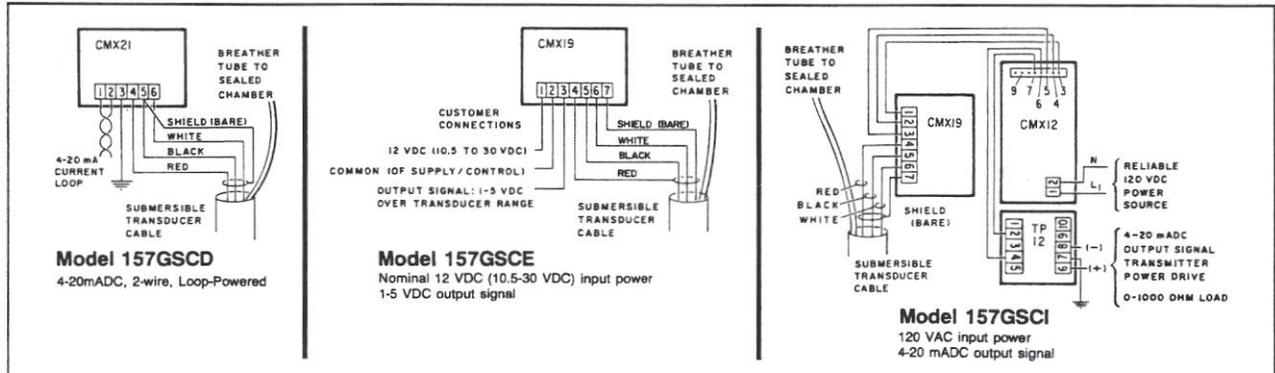
PRESSURE RANGE	RANGES PSIG	PRESSURE/LEVELS		MAX. PRESS. PSIG
		FT./WATER	IN./WATER	
1.0	0 to 1	2.31	27.72	20
5.0	0 to 5	11.55	138.6	50
15.0	0 to 15	34.65	416.0	150
30.0	0 to 30	69.3	832.0	150
75.0	0 to 75	173.25	2079.0	150
150.0	0 to 150	346.5	4158.0	225

*The Pressure Range Table shows maximum full-scale ratings of the six standard elements. Note the high proof pressures shown. Each range can be furnished with a "Feet-of-Water" calibration to any desired value from the maximum shown to as little as 15% of that figure.*

THREE MODELS TO MATCH YOUR  
ELECTRICAL SPECIFICATIONS



**ELECTRICAL CONNECTIONS**



### Model 157GSCD

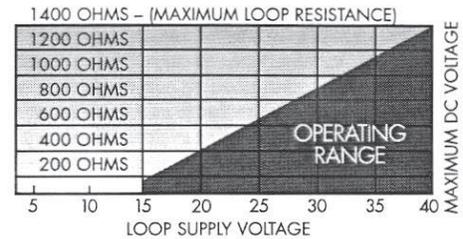
Loop-powered, 4-20 mA DC, 2-wire. Requires from 16 to 40 VDC loop power to drive up to a 0-1400 ohm resistive load (meter, controller, circuit resistance, etc.). See the Table for loop power/load driving relationships. Transient protection is provided, including a 3-element gas tube arrestor.

### Model 157GSCE

12 VDC-powered unit provides a precise 1-5 VDC output signal capable of driving a 100 ohm or higher resistance load. Supply voltage variations are accommodated over a 10.5 to 30 VDC

### Model 157GSCI

120 VAC-powered with a 10 VA current draw. Provides a 4-20 mA DC output signal to drive a 0 to 1000 ohm resistive load. Signal output loop is powered by this unit at approximately 33 VDC. This model includes a Manual Mode Switch



range; with a 30 mA DC maximum current draw. This model is well-suited to battery operation. Varistor/resistor/diode transient protection is provided.

and Pot as well as a 0-1 mA or 0-1.999 VDC attenuable drive circuit for an optional digital panel meter or related control. Transient protection is provided on both the 120 VAC power and the 4-20 mA DC output signal circuits.

#### STANDARD OPTIONS

USFilter Control Systems products can be customized to meet your requirements. Many options are available. Please talk to your USF Control Systems representative for recommendations and price quotes.

#### Choose A Stainless Steel Upper Assembly.

The housing of the upper assembly is furnished in Type 304 welded stainless steel under this option. The front door is hinged and gasketed. Nominal dimensions are generally similar to the basic molded polyester housing.

#### Directly Connect The A1000 To A Pipe Or Vessel By Converting It To An A3000.

Convert the A1000 submersible level transducer into a submersible pressure transducer that can be mounted on a pipe or vessel, giving the application the convenience of a standard gauge-type pressure transducer with the survivability of a submersible. Used extensively in valve vaults that may occasionally be flooded due to environmental conditions. Standard

connections include 3/4" and 2" female NPT.

#### Increase Safety To Your System By Adding An Intrinsic Safety Barrier.

The A1000 submersible level transducer system is rendered intrinsically safe through the use of an IS1 barrier. See page 9 of this brochure for further information regarding the use of IS1 barriers.

#### Add Convenience And Serviceability With A Digital Panel Meter.

The A1000 submersible level transducer upper electronics assembly is provided with a 3.5 digit LCD level readout.

#### Improve Reliability In Damp Environments With Thermostatically Controlled Condensation Protection.

The A1000 submersible level transducer upper electronics assembly is provided with an integral heater and high temperature cut-out thermostat to protect internal electronics from damage due to condensation.

SUGGESTED SPECIFICATIONS

**For Model 157GSCD**

The liquid level of the \_\_\_\_\_ shall be sensed by a USFilter Control Systems Bulletin A1000, Model 157GSCD Submersible Level Transducer. The transducer shall be a 4-20 mADC, 2-wire, 16 to 40 VDC loop-powered type with its output signal directly proportional to the measured level excursion over a factory-calibrated range of zero to \_\_\_ feet of water.

**For Model 157GSCE**

The liquid level of the \_\_\_\_\_ shall be sensed by a USFilter Control Systems Bulletin A1000, Model 157GSCE Submersible Level Transducer. The transducer shall be a 3-wire type to operate from a supply voltage of

10.5 to 30 VDC and produce a 1-5 VDC instrumentation signal in direct proportion to the measured level excursion over a factory-calibrated range of zero to \_\_\_ feet of water.

**For Model 157GSCI**

The liquid level of the \_\_\_\_\_ shall be sensed by a USFilter Control Systems Bulletin A1000, Model 157GSCI Submersible Level Transducer. The transducer shall be a 4-wire type to operate on 120 VAC incoming power and produce a 4-20 mADC instrumentation signal into a 0-1,000 ohm load in direct proportion to the measured level excursion over a factory-calibrated range of zero to \_\_\_ feet of water.

**For All Models**

The Transducer shall be of the solid-state head-pressure sensing type, suitable for continuous submergence and operation and shall be installed in accordance with manufacturer's instructions. The bottom diaphragm face of the sensor shall be installed (recommend 6") \_\_\_\_\_ inches above the floor at elevation \_\_\_\_\_. The sensor shall be mounted in a location and as shown on the job plans.

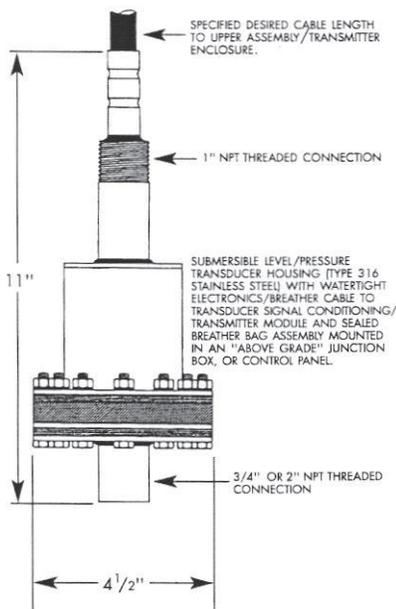
The transducer housing shall be fabricated of type 316 stainless steel with a bottom diaphragm 2-5/8" diameter of heavy-duty, limp, foul-free, molded Teflon bonded to a synthetic rubber back/seal.

A hydraulic fill liquid behind the diaphragm shall transmit the sensed pressure to a solid-state variable-capacitance transducer element to convert the sensed pressure to a corresponding electrical value. The sensed media shall exert its pressure against the diaphragm which flexes minutely so as to vary the proximity between an internal ceramic diaphragm and a ceramic substrate to vary the capacitance of an electrical field

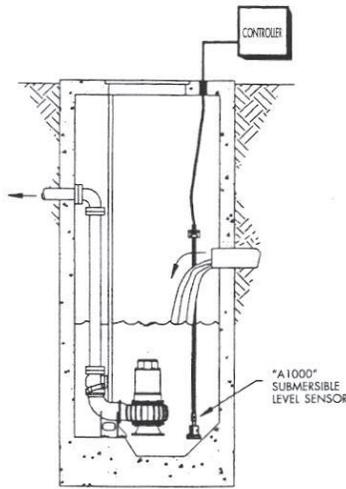
created between the two surfaces. A stable, hybrid, operational amplifier assembly shall be incorporated in the transducer to excite and demodulate the sensing mechanism. The transducer shall incorporate laser-trimmed temperature compensation and high-quality components and construction to provide a precise, reliable, stable output signal directly proportional to the sensed pressure over a factory-calibrated range.

The transducer element shall incorporate high over-pressure protection and be designed to withstand intermittent over-pressures five times the full scale range being sensed. Metallic diaphragms shall not be acceptable in that they are subject to damage or distortion. Sensing principles employing LVDTs, resistive or pneumatic elements shall not be acceptable.

The transducer/transmitter shall include easily accessible offset and span adjustments in the upper assembly. Span shall be adjustable from 100% down to 15% of the sensor range. Fine and coarse adjustments for both span and offset shall be



A3000



*Sewage or Stormwater Wet Well*

SUGGESTED SPECIFICATIONS (CONTINUED)

- MOUNTING METHODS (SELECT ONE)

**A. 1" Pipe Mounting Clamps**

The sensor shall be mounted using a vertical 1" pipe (supplied by the contractor) and secured in place by USFilter Control Systems Model 9GCL3 Type 304 stainless steel mounting clamps or equivalent.

**B. Cable Suspension Mounting Kit**

The sensor shall be suspension-mounted using a USFilter Control Systems cable suspension mounting kit or equivalent, consisting of a 2' long 1-inch NPT Type 316 stainless steel pipe with coupling, bolt, cable clamps and hardware along with the required length of 1/8 inch diameter 7 x 19 stainless steel cable.

SUGGESTED SPECIFICATIONS (CONTINUED)

- OPTIONS

**Safe Wiring Barrier**

Provide an intrinsically safe barrier between the upper and lower assemblies (or ahead of the entire transducer in the case of the 157GSCD). The barrier shall render the level sensing system suitable for use in Class 1, Division 1, Groups A, B, C and D, Class 2, Division 1, Groups E, F and G, and Class 3, Division 1 hazardous locations.

**Digital Indicating Meter (LCD)**

Furnish a 3.5 digit digital panel meter with a .5" high numeric LCD display calibrated in "feet and tenths of a foot," "inches of water" or other engineering

temperature changes and altitude as well as prevent fouling from moisture and other corrosive elements.

The transducer assembly shall be installed where directed by the Engineer and connected with other system elements and placed in successful operation. It shall be provided with input power and output signal transient protection, associated control elements as specified herein and in accordance with manufacturer's instructions.

units as desired. The meter shall provide a 0-1999 count range produced by a 4-20 mADC signal. Lesser values shall be produced by an attenuated signal. Mount on the front hinged door of the upper assembly with a weatherproof clear polycarbonate cover over the meter.

**Condensation-Protective Heater/Thermostat**

Furnish a 120 VAC powered resistor heater element and a sealed thermostat to keep the internal temperature of the upper assembly above the dew point to prevent problems associated with condensation.

**Type of Transducer**

Hydrostatic head-pressure-sensing type mounted at a fixed elevation in an open (vented to atmosphere) sump or tank.

The height of water above the bottom diaphragm imposes a pressure on the bottom limp interface diaphragm. This pressure is transmitted by an internal oil fill to a gauge pressure type variable-capacitance transducer which converts the pressure to a directly proportional electrical signal. The power supply to the transducer is supplied and regulated by an electronics assembly in the upper housing which also accepts the output signal of the lower assembly transducer and provides spanning and offsetting as well as transient protection and job connections.

**Basic Function**

Converts water level excursions over a calibrated range to corresponding proportional electronic process control signal.

**Pressure Ranges**

See Pressure Range Table, page 3.

**Pressure Overload**

See Pressure Range Table, page 3.

**Span Adjustments**

Coarse and fine. From 100% to 15% of range. Non-interactive with offset adjustments. NOTE: Span is the algebraic difference between zero level and the full-scale calibrated range of the transducer.

**Offset Adjustments**

Coarse and fine. From 0 to 75% of range. Non-interactive with span adjustments.

**Accuracy**

±0.3% best straight line of full span. This typical value includes combined effects of linearity, hysteresis and repeatability.

**Temperature Range**

Storage: -20 to +80 degrees C (-4 to +176 degrees F). Operation: 0 to +70 degrees C (+32 to +158 degrees F).

**Temperature Error**

Less than 1/2 of 1% span over a 0 to 50 degrees C (+32 to +122 degrees F) range.

**Relative Humidity**

0-95%, non-condensing.

**Stability over 1 year (typical)**

±1/2 of 1% of full span.

**Job Connections**

Clamp type barriers terminals for AWG #14-22.

**Media Compatibility**

Any media compatible with #316 SS, PVC, Teflon, synthetic rubber and urethane and with a specific gravity of 1.0 or other constant. Refer special requirements to the factory.

**Mounting Attitude**

The A1000 is factory-calibrated as a standard for use in the vertical position. It can be furnished calibrated for operation in any other desired attitude.

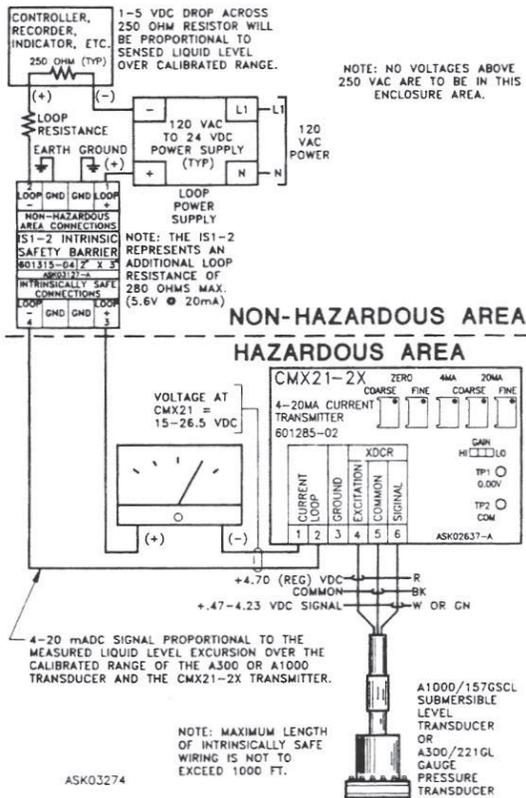
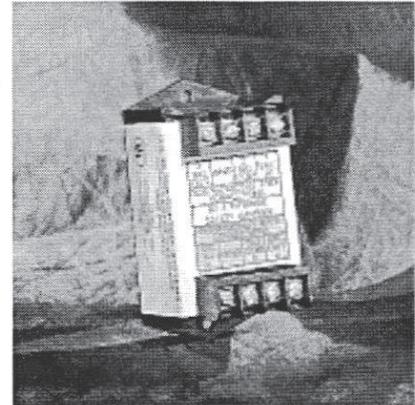
**Repairable**

All key parts of this transducer/transmitter can be repaired or replaced at the Factory. Easily field repaired.

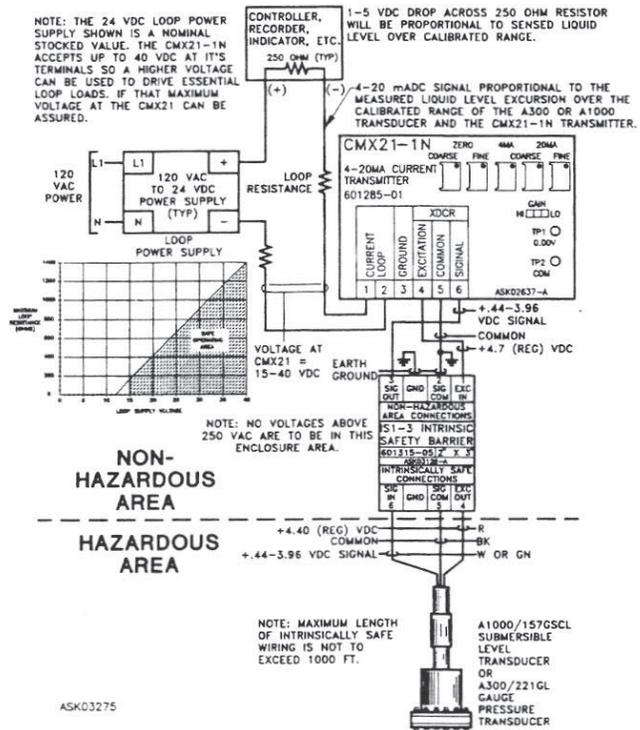
**IS1 Features In Brief**

- Analog signal Zener shunt-diode barrier.
- UL-recognized, Class 1, Division 1, Group D barrier.

The IS1-2 (2-wire) and IS1-3 (3-wire) Intrinsic Safety Barriers are used to provide isolation between a single analog transmitter located in a hazardous environment and the control panel, which is mounted in a non-hazardous area. The safety barrier provides "intrinsically safe" characteristics for the remotely mounted transducer equipment and associated circuitry installed in the defined hazardous location. The IS1 barriers are ideally suited for use in UL #913 applications. Part numbers for the safety barriers are listed with the mounting hardware options.



*Drawing A – The IS1-2 Barrier is used to provide intrinsically-safe characteristics for an A1000 (Model 157GSCD), CMX21-2X Current Transmitter, and Analog Meter. In this case, the entire system is U.L.-listed for operation within hazardous locations.*



*Drawing B – The IS1-3 is used to provide intrinsically-safe characteristics for the lower portion of the A1000 (Models 157GSCD and 157GSCI) when they use the CMX21-1N Current Transmitter in the non-hazardous area.*



PART NUMBERS

DESCRIPTION	PART NUMBER
<b>Sensors</b>	
A1000 1# sensor, up to 2.31'/2.72" (20# proof pressure)	601295-01
A1000 5# sensor, up to 11.55'/138.6" (50# proof pressure)	601295-02
A1000 15# sensor, up to 34.65'/416.0" (75" proof pressure)	601295-03
A1000 30# sensor, up to 69.3'/832.0" (150# proof pressure)	601295-04
A1000 75# sensor, up to 173.25' (375# proof pressure)	601295-05
A1000 150# sensor, up to 346.5'	601295-06
A1000 300# sensor, up to 693'	601295-07
<b>Cables</b>	
A1000 20' cable	601264-02
A1000 30' cable	601264-03
A1000 40' cable	601264-04
A1000 60' cable ( <i>For cable lengths greater than 60 feet consult factory</i> )	601264-06
<b>Upper Assemblies</b>	
A1000 GSCE (1-5V output), weatherproof fiberglass enclosure	601265-11
A1000 GSCE (4-20 mA output), weatherproof fiberglass enclosure	601294-01
A1000 GSCE (4-20mA), enclosure, 3-1/2 digit LCD digital meter w/viewing window	601294-03
A1000 GSCE (4-20mA), enclosure, heater and thermoswitch	601294-04
A1000 GSCE (4-20mA), enclosure, heater and thermoswitch, 24 VDC loop power	601317-01
A1000 GSCE (120 VAC pwr, 4-20 mA output), weatherproof fiberglass enclosure)	601265-12
A1000 GSCI (120 VAC pwr, 4-20 mA), encl, heater & thermoswitch	601265-14
A1000 GSCI (120 VAC pwr, 4-20 mA), encl, digital meter w/window, htr, thermo	601265-16
A1000 GSCI (120 VAC pwr, 4-20 mA), encl, digital meter w/viewing window	601265-17
A1000 GSCL (no upper assembly; for use with D15x controllers) breather kit	601288-01
<i>For upper assembly options not shown (intrinsically safe, UL), consult the factory.</i>	
<b>Mounting Hardware and Accessories</b>	
B100 9G CL3 stainless steel pipe mount clamps (transducer or float mount)	601134-01
A1000 Cable suspension mount fixture (without SS cable; see next item)	601418-01
A1000 Cable suspension mount stainless steel cable; each additional 10' (XX=length)	601440-XX
A1000 Model TCB terminal connection (junction) box w/breather	601291-02
A1000 Model CMX12 120 VAC powered power supply/4-20 mA transmitter	601119-01
A1000 Model CMX19 signal conditioner/1-5 VDC transmitter	601202-02
A1000 Model CMX21 signal conditioner/4-20 mA transmitter	601285-01
A1000 Model CMX21 signal conditioner/4-20 mA transmitter; intrinsically safe (potted)	601285-02
A1000 Model IS1-2 intrinsic safety barrier; 4-20 mA output (use w/potted CMX21)	601315-04
A1000 Model IS1-3 intrinsic safety barrier; 1-5 V output (standard)	601315-05

## COMPLETE CONTROL CAPABILITIES

USFilter Control Systems offers a single, high-quality source for everything from simple level sensors to telemetry systems to complex system control engineering and software. Based in St. Paul, MN, USFilter Control Systems is part of United States Filter Corporation, the leading global provider of industrial, municipal and residential water and wastewater treatment systems, products and services.

As a major manufacturer/integrator with an extensive selection of specialized product lines in the areas of SCADA and telemetry, power equipment integration, automation and measurement, USFilter Control Systems is uniquely positioned to provide cost-effective, comprehensive solutions for water, wastewater, and process control and telemetry applications. Our products and services encompass the following:

- Complete design and engineering services
- Field services, including training and troubleshooting
- Autocon SCADA systems
- Consolidated Electric SCADA systems
- Microcat control and telemetry products
- Remote terminal units and central control units
- Control and monitoring software
- Process control and communications computers
- I/O boards, modems and power supplies
- Power equipment integration
- Programmable logic controller systems
- Programmable process controllers
- Controllers and controller/alternators
- Tank pump control systems
- Pressure/level controllers
- Pump flow and performance monitoring
- Flow switches and float switches
- Intrinsic safety barriers
- Level transducers and level sensors
- Pressure transducers

To find out more about how to put  
USFilter to work for you,  
contact us at

# SIEMENS

Control Systems  
1239 Willow Lake Boulevard  
Vadnais Heights, MN 55110  
800.224.9474 *phone*  
651.766.2700 *phone*  
651.766.2701 *fax*

For more information,  
visit our web site at

[www.controlsystems.usfilter.com](http://www.controlsystems.usfilter.com)  
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#### Water Technologies

**CONTROL SYSTEMS PRODUCTS**  
 1239 WILLOW LAKE BOULEVARD  
 VADNAIS HEIGHTS, MINNESOTA 55110  
 651 - 766 - 2700 Fax: 651 - 766 - 2701  
 www.siemens.com/water

The A1000i is a 9-30VDC, two wire loop powered submersible level transducer with a 4-20mA signal output. It is mounted at a low point in a liquid media. The transducer uses a gauge pressure piezoresistive sensor element to measure the hydrostatic head-pressure. The sensor element is isolated from the media by a Teflon coated Buna-N diaphragm. This pressure is proportional to the height of the liquid above the sensing diaphragm and is converted to a proportional 4-20mA signal. This 4-20mA signal spans the full pressure range of the transducer.

The transducer is barometrically compensated via a rigid breather tube connected to a panel mounted sealed breather assembly. All A1000i transducers require a Breather Assembly Kit.

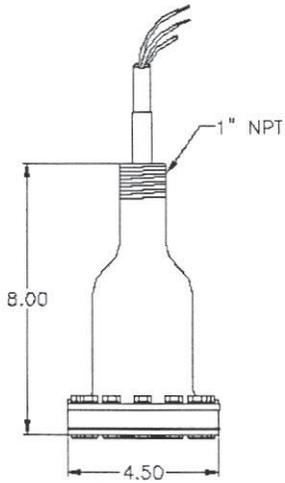
Part Number	Description
	<b>Sensors</b>
6012950011	A1000i sensor 1.5 PSI 4-20mA output (0-3.5 ft of water)
6012950012	A1000i sensor 5 PSI 4-20mA output (0-11.5 ft of water)
6012950013	A1000i sensor 15 PSI 4-20mA output (0-34.7 ft of water)
6012950014	A1000i sensor 30 PSI 4-20mA output (0-69.3 ft of water)
	<b>Housing/Cable Assembly</b>
6012640002	A1000 Housing/Cable Sub-Assembly 20ft
6012640003	A1000 Housing/Cable Sub-Assembly 30ft
6012640004	A1000 Housing/Cable Sub-Assembly 40ft
6012640006	A1000 Housing/Cable Sub-Assembly 60ft
6012640008	A1000 Housing/Cable Sub-Assembly 80ft
6012640010	A1000 Housing/Cable Sub-Assembly 100ft
60126400XX	A1000 Housing/Cable Sub-Assembly custom lengths (XX equals number of feet)
	<b>Mounting Hardware and Accessories</b>
6011340001	B100 9G CLS Stainless Steel Pipe Mounting Clamps
6014180001	Cable Suspension Mounting Pipe (without SS cable)
60144000XX	Stainless steel cable; each additional 10' ft (XX)
6012880001	Breather Assembly Kit (required for all A1000i sensors)
6012910002	Terminal Connection (Junction) Box w/Built In Breather Assembly

**Agency Approval** FM and CSA Intrinsically Safe Class I, Div. 1, Groups A,B,C,D with an approved barrier.

# Product Specification

A1000i Loop Powered/4-20mA Submersible Level Transmitter/Transducer

## Specifications



### Environmental

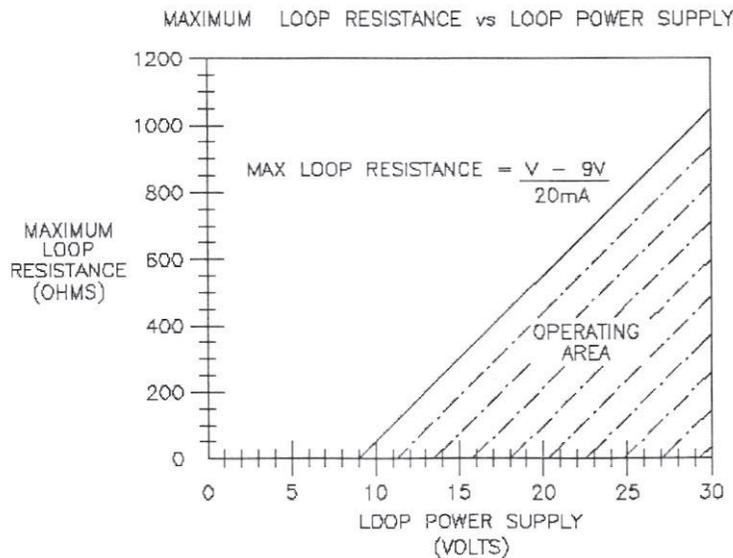
Atmosphere Ventilation sealed breather system equalizes atmospheric pressure  
 Operating Temperature range 32°F to +158°F Liquid must remain fluid.

### Physical

Housing 316 cast stainless steel, Teflon™ coated  
 Cable heavy-duty polyethylene with vent tube, shield and 18 AWG conductors  
 Mounting suspension cable mount or 1" pipe mount  
 Pressure Ranges 1.5 PSI to 30 PSI  
 Max Over Pressure Range 1.5 PSI 8X full scale  
 5.0 PSI 4X full scale  
 15 PSI & 30 PSI 2X full scale  
 Exposed Materials 316 cast stainless steel Teflon™ coated, synthetic rubber and urethane  
 Sensing Head two-layer diaphragm with Teflon™ and Buna-N material

### Electrical

Power Required 9 – 30 VDC  
 Typical Loop Resistance 250 ohm @ 15VDC  
 Maximum Loop Resistance 750 ohm @ 24VDC  
 Signal Output 4 - 20mA  
 Accuracy ±0.25 % full scale with long term stability of 0.2 % full scale per year.



**Intrinsically Safe Barrier Applications**

When selecting an intrinsically safe barrier consider the following: cable length, classification of hazardous area, cable inductance and capacitance, and the intrinsic safe ground system.

Barriers whose entity parameters meet the following requirements can be used.

- $V_{oc} \leq V_{max}$
- $I_{sc} \leq I_{max}$
- $C_a > C_i + C_{cable}$
- $L_a > L_i + L_{cable}$

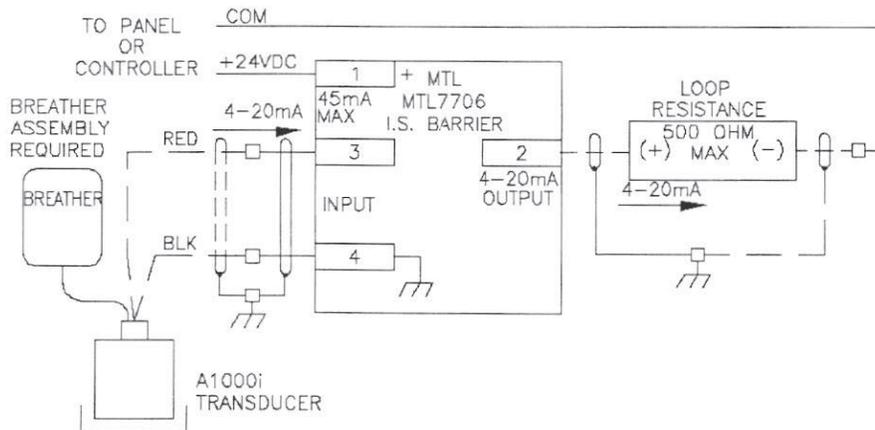
A1000i Transmitter Entity Parameters			
V <sub>max</sub>	I <sub>max</sub>	C <sub>i</sub>	L <sub>i</sub>
28V	93mA	0.11 uF	0.22mH

**Note:** IS1-2 Part number 6013150004 does not meet these entity parameters.  
 An intrinsically safe system should be designed and tested by a qualified engineering professional.

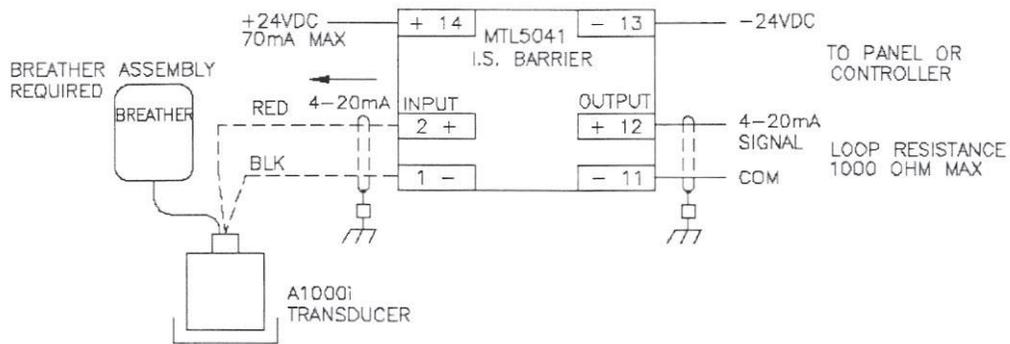
Compatible Barriers			
Manufacturer	Part No.	Type	MAX Loop Resistance
MTL	7706	Amplified Zener, Common Neg.	500 ohms
MTL	5041	Galvanically Isolated	1000 ohms
Phoenix Contact	Model PI/Ex-ME-RPS(s)-I/I 2835422	Galvanically Isolated	800 ohms

**Note:** Each of the barriers requires 24VDC to operate. When any of these barriers are used, with a CMR25-04, an external power source is required to power the IS barrier.

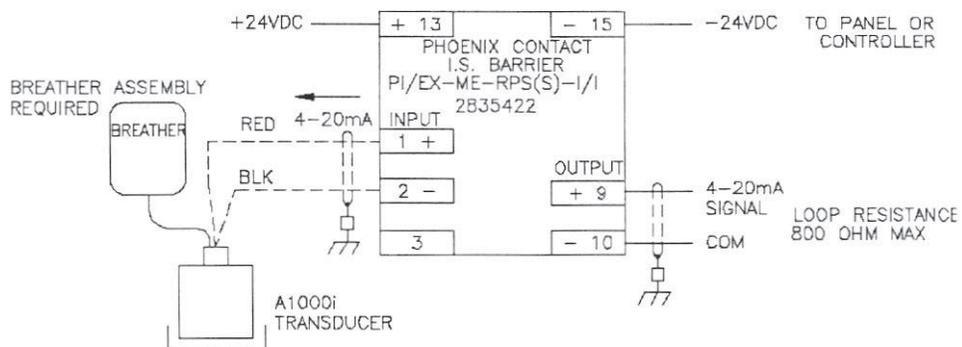
**MTL7706+ Active Zener Barrier (UL Pending)**



**MTL5041 Galvanically Isolated Barrier**

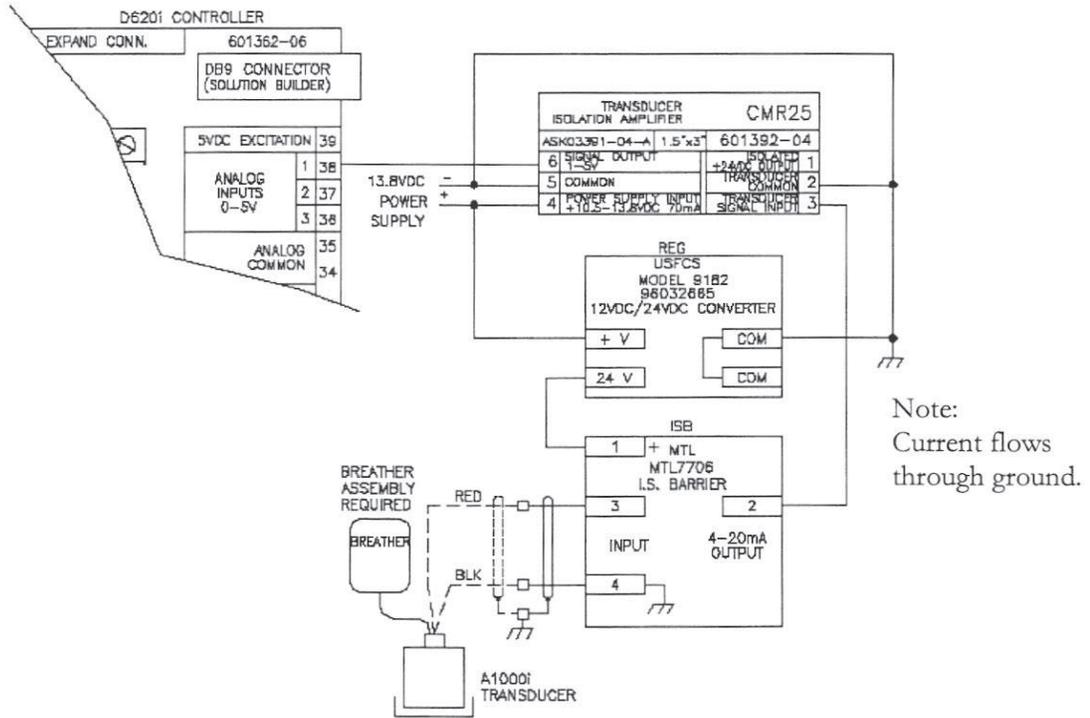


**Phoenix Contact Model PI/Ex-ME-RPS(s)-I/I Galvanically Isolated Barrier**



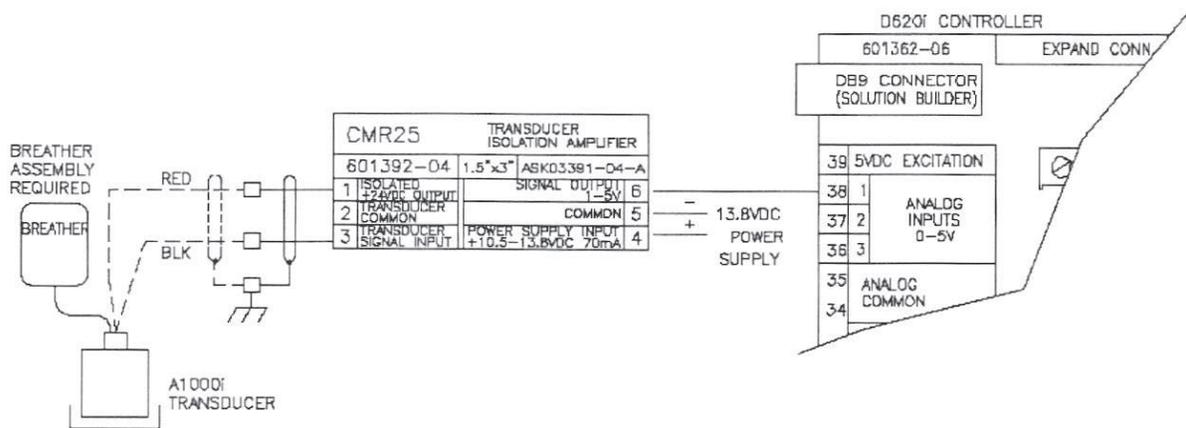
D620i CMR25 and IS Barrier Application

Note: This application connects the D620I common to ground.

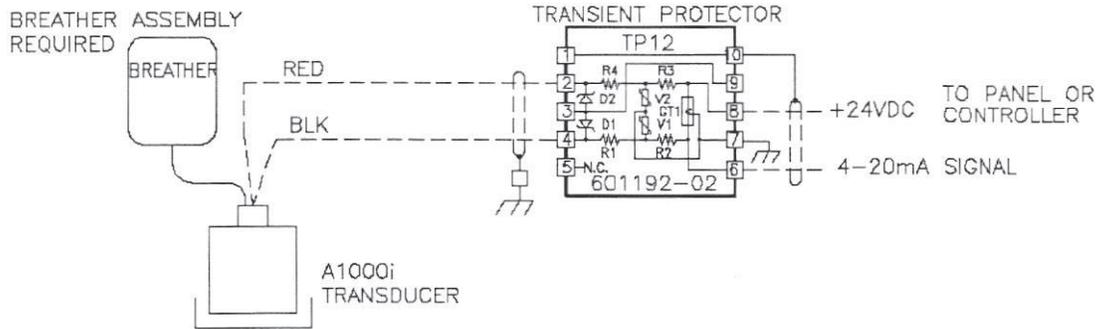


D620i Application

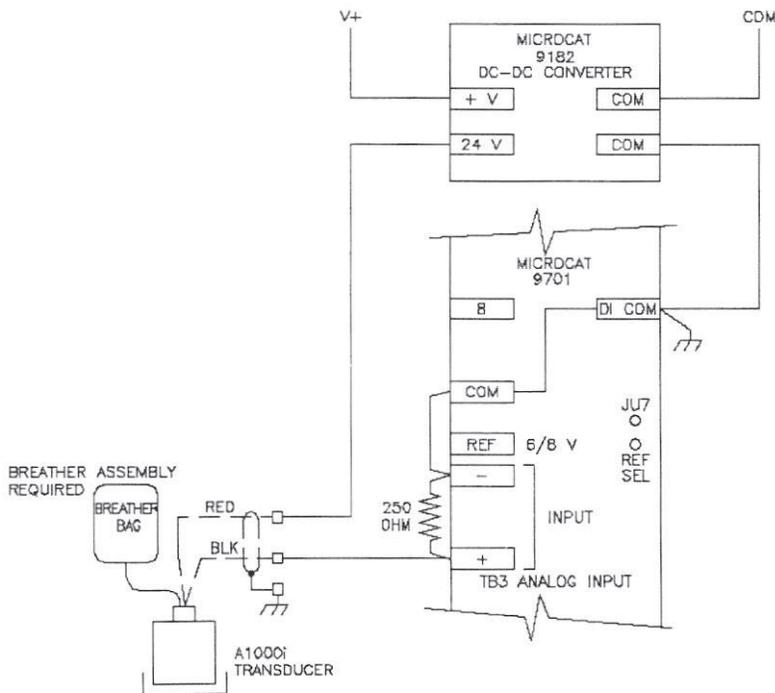
Note: This application is not intrinsically safe.



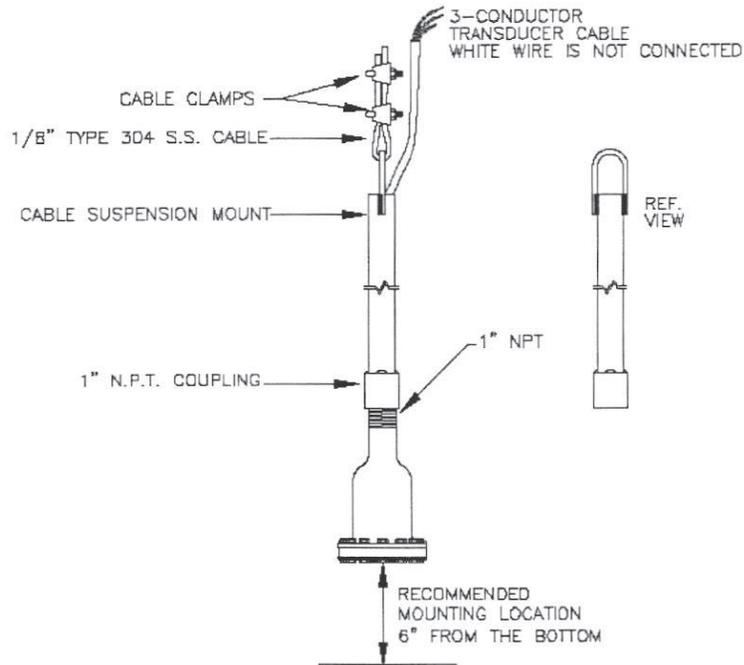
**TP12 Transient Protector Application**  
 Note: This application is not intrinsically safe



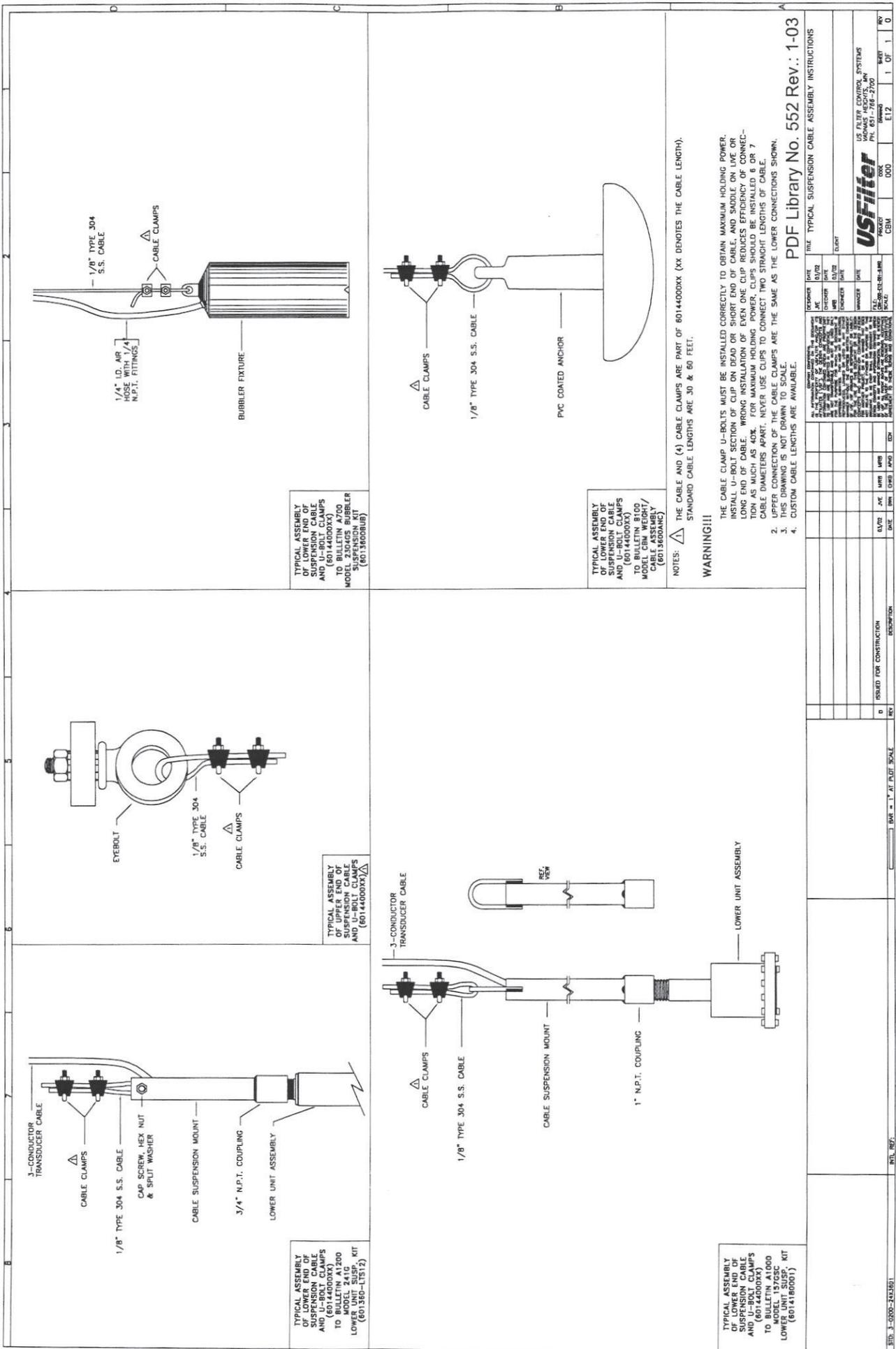
**Microcat Application**  
 Note: This application is not intrinsically safe.



Suspension Cable Mounting







TYPICAL ASSEMBLY OF LOWER END OF SUSPENSION CABLE AND U-BOLT CLAMPS TO BULLETIN A270 MODEL 2304GCS BUBBLER SUSPENSION KIT (8013908UB)

TYPICAL ASSEMBLY OF UPPER END OF SUSPENSION CABLE AND U-BOLT CLAMPS (8014400UP)

TYPICAL ASSEMBLY OF LOWER END OF SUSPENSION CABLE AND U-BOLT CLAMPS TO BULLETIN A1200 MODEL 241G LOWER UNIT SUSP. KIT (801390-L1012)

TYPICAL ASSEMBLY OF LOWER END OF SUSPENSION CABLE AND U-BOLT CLAMPS TO BULLETIN A1000 MODEL 241GCS LOWER UNIT SUSP. KIT (8014180001)

TYPICAL ASSEMBLY OF LOWER END OF SUSPENSION CABLE AND U-BOLT CLAMPS TO BULLETIN B100 MODEL CRM WEIGHT/CLAMP KIT (8013000AK)

NOTES:  $\Delta$  THE CABLE AND (4) CABLE CLAMPS ARE PART OF 80144000XX (XX DENOTES THE CABLE LENGTH). STANDARD CABLE LENGTHS ARE 30 & 60 FEET.

**WARNING!!!**

- THE CABLE CLAMP U-BOLTS MUST BE INSTALLED CORRECTLY TO OBTAIN MAXIMUM HOLDING POWER. INSTALL U-BOLT SECTION OF CLIP ON DEAD OR SHORT END OF CABLE, AND SADDLE ON LIVE OR LONG END OF CABLE. WRONG INSTALLATION OF EVEN ONE CLIP REDUCES EFFICIENCY OF CONNECTIONS AS MUCH AS 50%. ALWAYS USE U-BOLTS WITH SADDLES. NEVER USE CLIPS TO CONNECT TWO STRAIGHT LENGTHS OF CABLE. ALWAYS USE CLIPS TO CONNECT TWO STRAIGHT LENGTHS OF CABLE. ALWAYS USE CLIPS TO CONNECT TWO STRAIGHT LENGTHS OF CABLE.
1. UPPER CONNECTIONS OF THE CABLE CLAMPS ARE THE SAME AS THE LOWER CONNECTIONS SHOWN.
  2. THIS DRAWING IS NOT DRAWN TO SCALE.
  3. CUSTOM CABLE LENGTHS ARE AVAILABLE.

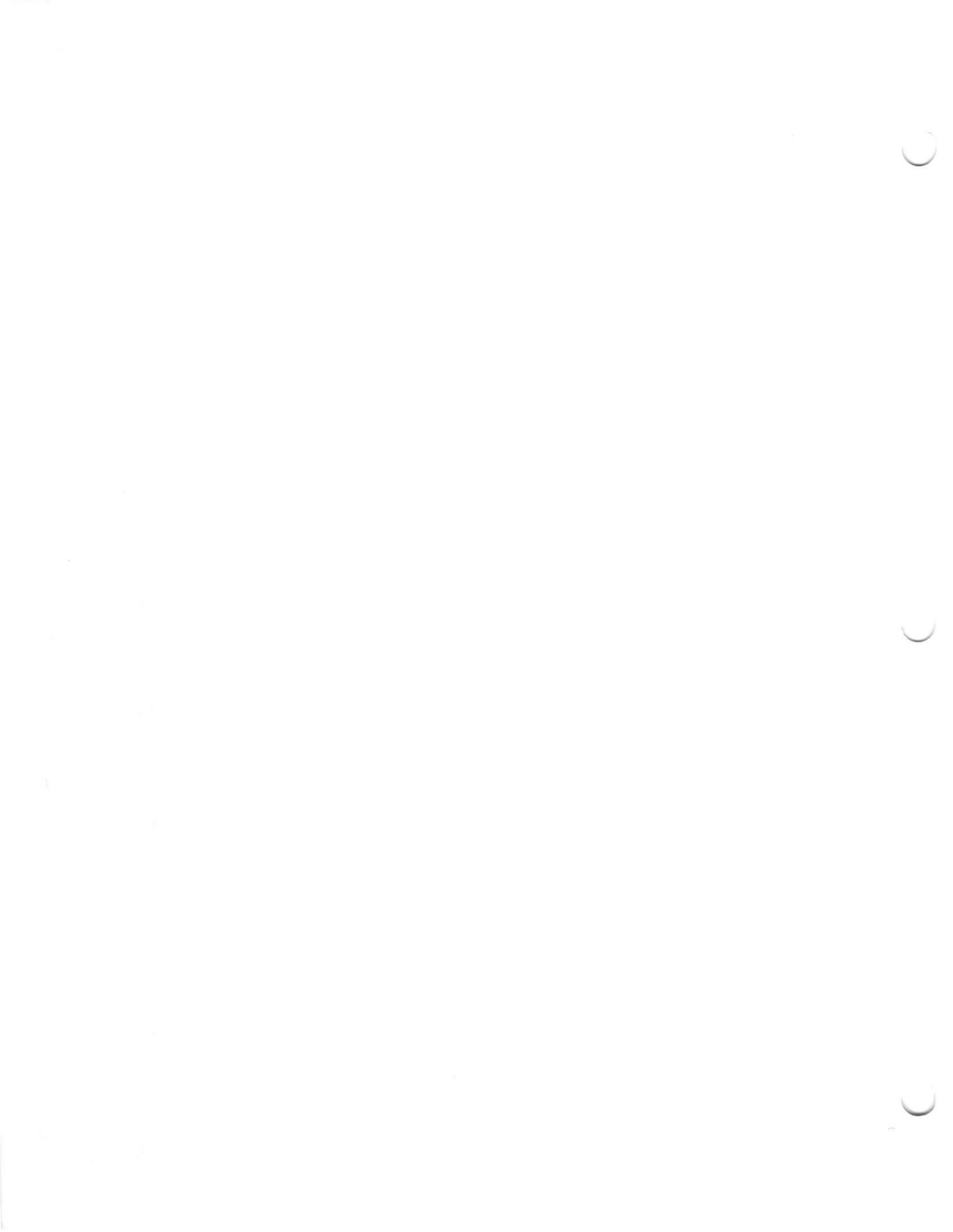
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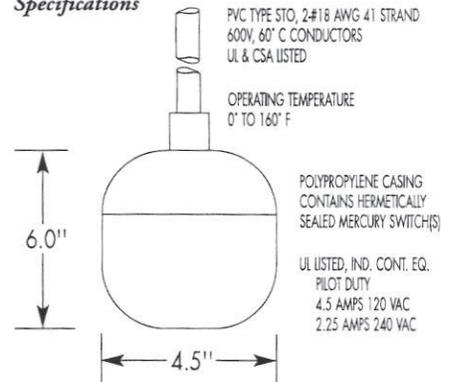


# LS DIRECT ACTING FLOAT SWITCH (B100)



The Model LS Float Switch is a simple, dependable, level-sensing automatic pump or alarm control device that operates reliably in sewage wet wells, sumps, ditches or process vats. The float body is of high-density polypropylene and the cable jacket is flexible PVC for outstanding performance in a wide range of corrosive environments. Each float senses the movement of the liquid level past its mounting point on a rising or falling level. Single floats are used for alarm actuation. Two floats are used for differential control of pumps. Floats contain a Form C-type contact mercury switch, which provides normally-open or normally-closed operation. Model LS

### Specifications



floats are furnished with clamp-mounting hardware for installation on a vertical 1" pipe. Accessory hardware is available for Suspended or Cable/Weight mounting.

### LS Features In Brief

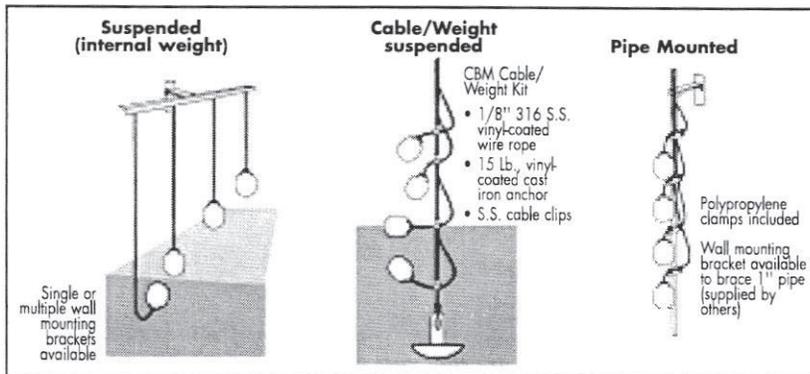
Model LS floats deliver reliable service under extreme conditions.

- Fixed or suspended installation
- Heavy-duty, Type STO #18/2 cable
- Tough, molded polypropylene body
- Dependable mercury to electrode tilt switch
- Completely potted switch and cable connections
- NO/NC switch configurations
- Standard cable lengths

**SIEMENS**

# DATA SHEET

DESCRIPTION	PART NUMBER
<b>LSC Float Switch</b>	
P30NONC LSC Float switch (1-N.O., 1-N.C.) w/30' cable, 3-wire	803138-30
S30NONC LSC Float switch (1-N.O., 1-N.C.) w/30' cable, 3-wire	803138-31
P60NONC LSC Float switch (1-N.O., 1-N.C.) w/60' cable, 3-wire	803138-60
S60NONC LSC Float switch (1-N.O., 1-N.C.) w/60' cable, 3-wire	803138-61
<b>Mounting Hardware &amp; Accessories</b>	
TCB junction box (with terminal blocks for 4 switches and ground lug)	601102-01
IS6 intrinsic safety barrier (requires 12-24 VDC@50mA power source)	601312-02
LS float switch pipe mount clamp (ordered as replacement)	601176-01
LS float switch cable mount clamp (ordered as replacement)	601211-01
CBM 15# anchor mounting kit (does not include SS cable; see next item)	803360-ANC
CBM stainless steel cable; 20'	601440-20
CBM stainless steel cable; each additional 10' (XX=length)	601440-XX
Wall mounting bracket	803134-01
Type W bracket	803213-01



**COMPLETE CONTROL CAPABILITIES**

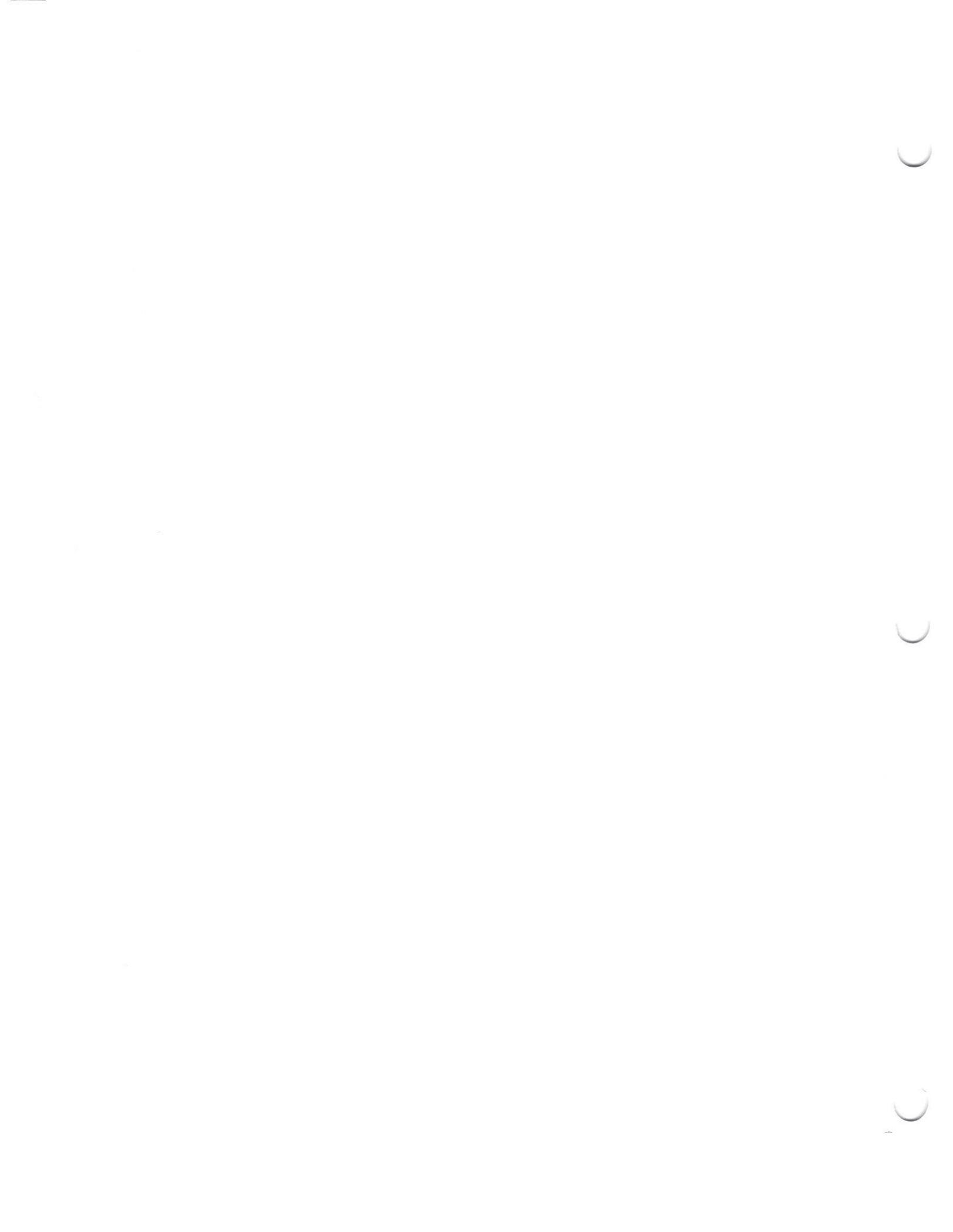
USFilter Control Systems offers a single, high-quality source for everything from simple level sensors to telemetry systems to complex system control engineering and software. Based in St. Paul, Minnesota, USFilter Control Systems is part of United States Filter Corporation, the leading global provider of industrial, municipal and residential water and wastewater treatment systems, products and services. As a major manufacturer/integrator with an extensive selection of specialized product lines in the areas of SCADA and telemetry, power equipment integration, automation and measurement, USFilter Control Systems is uniquely positioned to provide cost-effective, comprehensive solutions for water, wastewater, and process control and telemetry applications.

## SIEMENS

Control Systems  
 1239 Willow Lake Boulevard  
 Vadnais Heights, MN 55110  
 800.224.9474 *phone*  
 651.766.2700 *phone*  
 651.766.2701 *fax*

[www.controlsystems.usfilter.com](http://www.controlsystems.usfilter.com)  
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**Cutler-Hammer**

**Christmas Pump Station**

*Submittals For Approval*

**Low Voltage Motor Control (MCC)**

**Siemens Water Technologies**

**Eaton | Cutler - Hammer**



---

## Cutler-Hammer

### Christmas Pump Station

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Fax: 800-647-9112

**Siemens Water Technologies**

**Eaton | Cutler - Hammer**



**Cutler-Hammer**

**Christmas Pump Station**

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**Tab 1**

**Low Voltage Motor Control (MCC)**

**Siemens Water Technologies**

**Eaton | Cutler - Hammer**



## Cutler-Hammer

### *SUBMITTAL COMMENTS*

**Approved**

Release all for manufacture.  
No re-submittal required.

**Approved as Noted**

Release all for manufacture.  
Make necessary changes, show  
changes on construction drawings.

**Partial Approval  
Revise and Re-submit**

Release approved sections  
for manufacture. Re-submit  
rejected sections

**Rejected**

No release  
Re-submit all.

The following information is pertinent with the return of this submittal. Cutler Hammer requires all information to be initialed and a final signature of responsible party.

- Lug Sizes for all equipment have been verified
- Top or Bottom Entry for all equipment has been verified
- Shipping splits have been verified
- Nameplate information has been verified for all equipment
- Orientation of breakers has been verified for all equipment

Stamp or Signature

Date

\_\_\_\_\_

**Customer Comments:**

**Siemens Water Technologies**

**Eaton | Cutler - Hammer**

For an electronic version of this document contact your Cutler-Hammer Sales Representative

**EATON**

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**Cutler-Hammer**

MOTOR CONTROL CENTERS

## MCC General Information

### MCC General Information

Wiring Diagram Type	C-H Standard
MCC Quantity	1
Standards	UL845, NEMA, NEC
Special Codes	UL
Service Voltage (3 Phase)	480V
Frequency	60 Hz
System	3PH4W

### Incoming Line Termination

Device: HFD Main Bkr (200A trip), Lugs: 1-#4-4/0

Cable Entry	Top
Splice Kit / Transition	None
MCC Type Match Up	
MCC Type Match Up GO#	** None **

### Enclosure Specifications

Total Structures	4
Type	NEMA 12 Dust tight
Depth	21" Front Mt Only
Height	90"
Horizontal Wireways	9" High, Top & Bottom
Vertical Wireways	4"
Channel Sills	Yes
Bottom Plates	Yes
150 Watt Space Heaters	None
Space Heater Thermostat	No
Master Terminal Block Location	None
IBC/CBC Seismic Qualified	No

### MCC Starter Specifications

Wiring Class	2B
Control Voltage	120V
Control Voltage Src	Ind CPT
Nameplate Size	1" X 2.5"
Nameplate Color	Black / White Letters
Pilot Dev. Model	10250T
Ind. Light Type	6v Xfmr
PL Color (On)	Red
PL Color (Off)	Green
PL Color (Misc)	White

### Bus System Specifications

Main Bus Amps	600A
Main Bus Material	Copper
Main Bus Bar Plating	Tin
Insulated Horiz. Bus	No
1000A/sq in. Cu Bus	No
Vertical Bus Amps	See Structure Schedule
Vertical Bus Material	Tin Plated Copper
Vertical Bus Barrier	Isolated, Red
Bus Bracing	42,000
Ground Bus	300
Ground Bus Location	Top
Ground Bus Lug Size	1-#6-350Kcmil
Ground Bus Lug Type	Screw
Plug-in 300A Vert. Gnd. Bus	No
Neutral	300A
Neutral Bus Lug Location	Incoming Line
Neutral Bus Lug Size	1-#6-350Kcmil
Neutral Bus Lug Type	Screw
Horizontal Bus Temperature Rise	65 deg C
Bottom Vert. Bus Barrier	No

### Structure Schedule

There are 4 structure(s).  
 Structure(s) 2,3,4 have a 300 A Vertical Bus.  
 Structure(s) 1 have a 600 A Vertical Bus.  
 All Structures have a Communications Bus.

Total width of all sections is 84.0"  
 Height of all sections is 91"

### Unit Modifications

Solid State Overload Relay (Standard) (C396)  
 Wiremarkers at Each End  
 Terminal Block - Latching Pull-Apart, Std.  
 #16awg, MTW Control Wire

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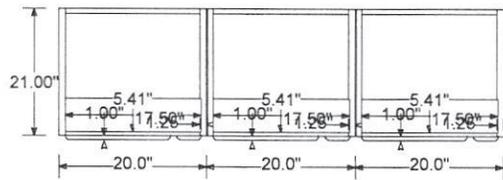
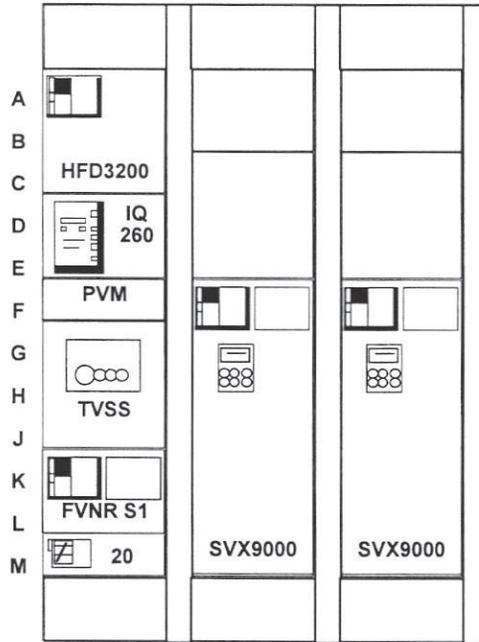
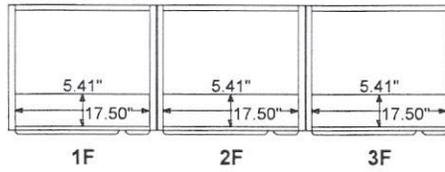
PREPARED BY <b>Krogh, Jay P</b>	DATE <b>08/17/09</b>	<b>Eaton Corporation</b> Fayetteville, NC	
APPROVED BY	DATE	JOB NAME <b>Christmas Pump</b>	DESIGNATION <b>MCC</b>
VERSION <b>6.8</b>		TYPE <b>MCC 2100</b>	DRAWING TYPE <b>Customer Appr.</b>
NEG-ALT NUMBER <b>MPY10611H906-0000</b>	REVISION	DWG SIZE <b>A</b>	G. O. ITEM SHEET <b>1 OF 6</b>

## Notes/Special Instructions

Provide Pump Protection Circuit for VFDs

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NEG-ALT NUMBER <b>MPY10611H906-0000</b>	REVISION	DWG SIZE <b>A</b>	G. O.	ITEM	SHEET <b>2 OF 6</b>	

**Top View**

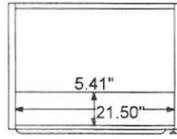


**Floor View**

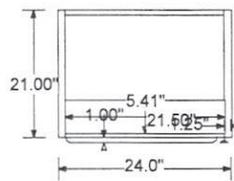
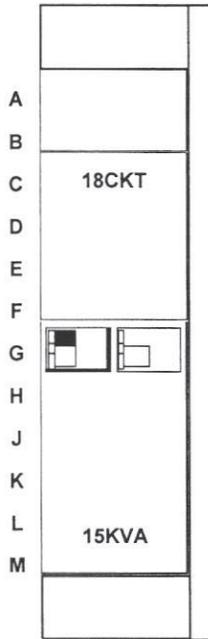
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PREPARED BY Krogh, Jay P	DATE 08/17/09	<b>Eaton Corporation</b>		Fayetteville, NC
APPROVED BY	DATE	JOB NAME Christmas Pump	DESIGNATION MCC	
VERSION 6.8		TYPE MCC 2100	DRAWING TYPE Customer Appr.	
NEG-ALT NUMBER MPY10611H906-0000	REVISION	DWG SIZE A	G.O.	ITEM
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Top View



4F



Floor View

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APPROVED BY	DATE	JOB NAME Christmas Pump	DESIGNATION MCC	
VERSION 6.8	TYPE MCC 2100	DRAWING TYPE Customer Appr.		
NEG-ALT NUMBER MPY10611H906-0000	REVISION	DWG SIZE A	G.O.	ITEM SHEET 4 OF 6

Unit	Nameplate	Description	Class	Starter Size HP/FLA Wire Diag.	Bkr/Sw Poles Trip/Clip	Unit Features
1C	MAIN BREAKER	HFD Main Bkr (200A trip), Lugs: 1-#4-4/ -#4-4/0		282832.DWF	HFD 3P 200	1 Service Entrance Assembly
1E	POWER METER	IQ 260 Power Quality Meter with Transducer				
1F		3 Phase Voltage Monitor				
1J		TVSS,CPS-160KA, Advisor Monitoring Display, with Circuit Breaker		281475.DWF		
1L	SUMP PUMP	FVNR Starter Size 1 [HMCP]	F206	1 1 265756.DWF	HMCP 3P 7	1 100VA Individual CPT, Fused 1 N.C. Starter Aux Contacts, Size 1-4 1 N.O. Starter Aux Contacts, Size 1-4 1 Mini Elapsed Time Meter 1 Pilot Light-10250T (Run) 1 3 Pos. Sel. Sw., 10250T (Hand-Off-Auto)
1M	UNIT HEATER	E125HCompact Bkr (20A trip)		5599A85.DWF	E125H 3P 20	
2B		12" Door				
2E		18" Door				

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	APPROVED BY	DATE	JOB NAME Christmas Pump	DESIGNATION MCC	
	VERSION 6.8		TYPE MCC 2100	DRAWING TYPE Customer Appr.	
NEG-ALT NUMBER MPY10611H906-0000	REVISION	DWG SIZE A	G.O.	ITEM	SHEET 5 OF 6

Unit	Nameplate	Description	Class	Starter Size HP/FLA Wire Diag.	Bkr/Sw Poles Trip/Clip	Unit Features
2M	PUMP #1	SVX9000 VFD-VT, 23 FLA, 480V, HMCP		15/23	HMCP 3P 30	1 Mini Elapsed Time Meter 1 Pilot Light-10250T (Stopped) 7 Interposing Relay 120V, 2 Pole, D7 Socket Type 1 C-H Model TRN Solid State On-Delay Timer 1 Pilot Light-10250T (Misc) 2 SVX9000 3-Contactor Bypass - FR5 1 Pilot Light-10250T (Run) 1 3 Pos. Sel. Sw., 10250T (Hand-Off-Auto)
3B		12" Door				
3E		18" Door				
3M	PUMP #2	SVX9000 VFD-VT, 23 FLA, 480V, HMCP		/23	HMCP 3P	1 Mini Elapsed Time Meter 1 Pilot Light-10250T (Stopped) 7 Interposing Relay 120V, 2 Pole, D7 Socket Type 1 C-H Model TRN Solid State On-Delay Timer 1 Pilot Light-10250T (Misc) 2 SVX9000 3-Contactor Bypass - FR5 1 Pilot Light-10250T (Run) 1 3 Pos. Sel. Sw., 10250T (Hand-Off-Auto)
4B		12" Door				
4F	PANEL A	PL1A Panelboard 100A 120/240V 1PH 3W 18 CKT		5A10397.DWF		18 Pnlbd Bkr, BAB 1 Pole 20A bkr
4M	XFMR A	15 Kva 1ph, 440-480V / 120-240V High Efficiency Xfmr, 70A Pri., 80A Sec		5A10397.DWF		

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	Krogh, Jay P	08/17/09	JOB NAME	Christmas Pump	
	APPROVED BY	DATE	DESIGNATION	MCC	
	VERSION		TYPE	DRAWING TYPE	
	6.8		MCC 2100	Customer Appr.	
NEG-ALT NUMBER	REVISION	DWG SIZE	G.O.	ITEM	SHEET
MPY10611H906-0000		A			6 OF 6

**Customer Bill of Material**

## 1 Freedom MCC

60 Hz, Class 2B wiring, 480V 3-Phase Service, 42,000 Bracing, Top Incoming,  
NEMA 12 Dust tight 21" Front Mt Only enclosure, 600A Copper Main Horizontal Bus,  
ANeutral, Main Breaker

1	HFD Main Bkr (200A trip), Lugs: 1-#4-4/0
1	IQ 260 Power Quality Meter with Transducer
3	600A Current transformer
1	3 Phase Voltage Monitor
1	FVNR Starter Size 1 [HMCP]
2	SVX9000 VFD-VT, 23 FLA, 480V, HMCP
1	E125HCompact Bkr (20A trip)
1	100VA Individual CPT, Fused
1	N.C. Starter Aux Contacts, Size 1-4
1	N.O. Starter Aux Contacts, Size 1-4
1	Solid State Overload Relay (Standard) (C396)
4	SVX9000 3-Contactor Bypass - FR5
2	Pilot Light-10250T (Misc)
2	C-H Model TRN Solid State On-Delay Timer
14	Interposing Relay 120V, 2 Pole, D7 Socket Type
2	Pilot Light-10250T (Stopped)
3	Pilot Light-10250T (Run)
3	Mini Elapsed Time Meter
3	3 Pos. Sel. Sw., 10250T (Hand-Off-Auto)
3	Wiremarkers at Each End
3	Terminal Block - Latching Pull-Apart, Std.
3	#16awg, MTW Control Wire
1	Service Entrance Assembly
1	15 Kva 1ph, 440-480V / 120-240V High Efficiency Xfmr, 70A Pri., 80A Sec. Bkr.
1	PL1A Panelboard 100A 120/240V 1PH 3W 18 CKT
18	Pnlbd Bkr, BAB 1 Pole 20A bkr
1	TVSS,CPS-160KA, AdVisor Monitoring Display, with Circuit Breaker
4	Structure Floor Leveling Channel Sills
3	300A Vertical Bus (Tin-plated cu)
4	Structure Bottom plates Included with NEMA 12
4	300A Horiz. Cu Gnd Bus, 1/4" x 1" Bar
4	300A Copper Full Length Neutral Bus
1	600A Vertical Bus (Tin-plated cu)
4	Isolated, Red glass polyester vertical bus barrier
4	42KA Bus Bracing
4	Tin Plated horizontal bus
4	600A Copper Frnt Mtd 21" N12 Dust Tight
3	12" Door
2	18" Door

## Special Configuration Notes:

- 1 Provide Pump Protection Circuit for VFDs

Designations: MCC

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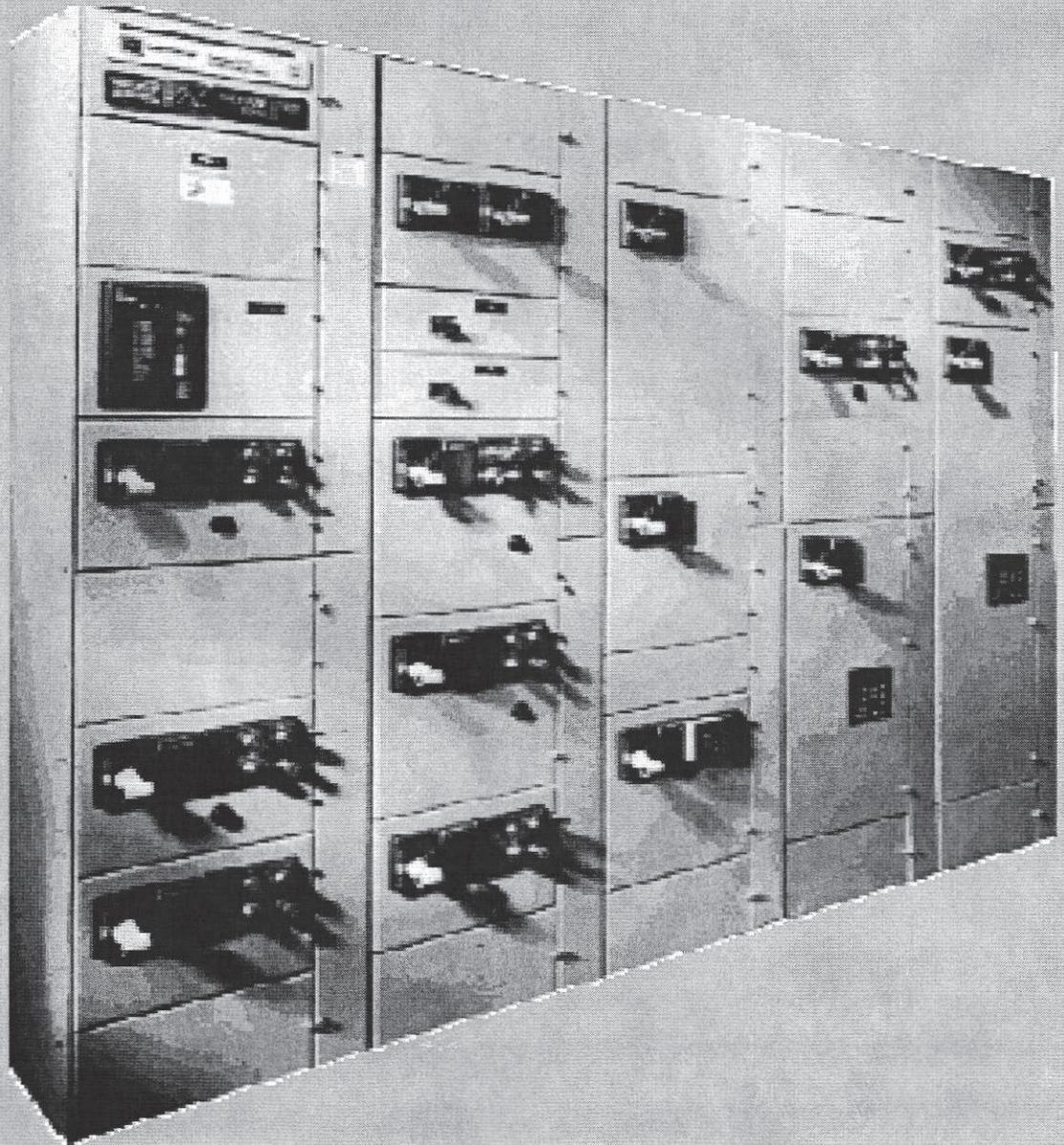
**Cutler-Hammer**

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## Cutler-Hammer

Motor Control Centers



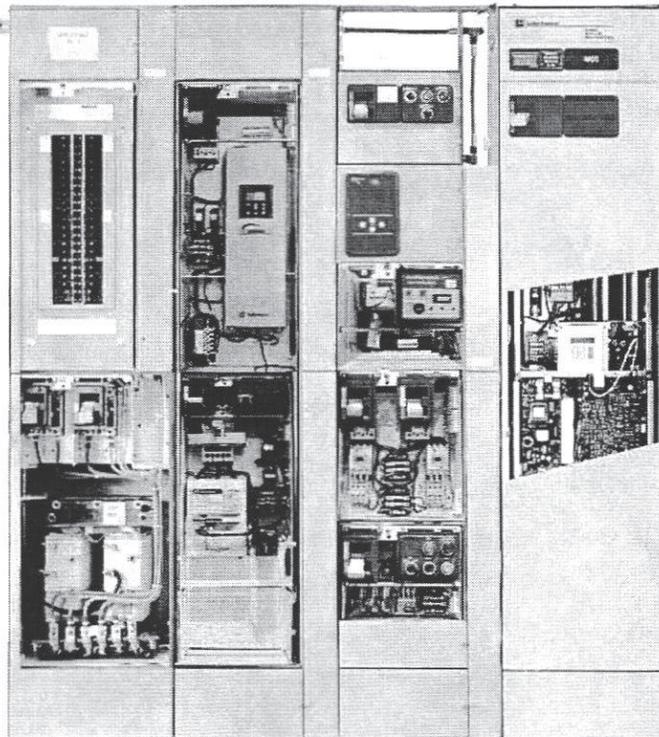


# Cutler-Hammer

## Low Voltage Motor Control Centers (ac/dc)

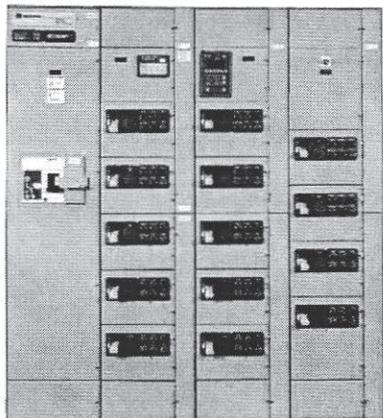
Technical Data

Supersedes TD.03A.01B.T.E  
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**2100 Series  
Motor Control Center**



2100 Series Motor Control Center

**General Description**

**Introduction**

Eaton Corporation currently produces two Cutler-Hammer motor control center designs; Freedom™ and Advantage™. Each MCC type provides quality group motor control for a wide variety of applications. Freedom MCCs offer the best motor control for traditional electromechanical starter applications. The Advantage motor starter brings enhanced solid-state technology to the electromechanical motor starter industry. Each MCC model utilizes the same rugged enclosure and plug-in cell design.

Refer to Table 80 for feature highlights of each MCC design.

**Features**

- UL® label.
- 42,000, 65,000, 100,000 AIC ratings.
- Molded Case, Insulated Case and Air Circuit Breakers.
- 3200 A maximum horizontal bus.
- Optional labyrinth barrier system for bus.
- Pull apart latching terminal blocks.
- Front only or front and rear unit mounting.
- Solid-state motor control.
- DeviceNet™ Communications for control and monitoring.
- PowerNet™ Communications for energy management and monitoring.

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## Description

Eaton's Cutler-Hammer Motor Control Centers (MCCs) provide the best method for grouping motor control as well as associated distribution equipment. The Freedom and Advantage 2100 Series Control Centers are specially designed to operate machinery, industrial processes and commercial building systems.

The MCC enclosure consists of a strong and rigid steel channel framework assembled into standardized vertical sections and bolted together to form a complete shipping section of up to 80-inch (2032.0 mm) maximum, four structures each. Structures include horizontal and vertical bus, insulation and isolation barriers, horizontal and vertical isolated wiring troughs, cable entrance areas and space for inserting starter and control equipment.

All control units, removable or fixed mounted, are assembled with Cutler-Hammer components of proven safety, quality and reliability. All components are wired in accordance with NEC® and UL standards. Specifically designed bus stabs, insertion guides, handle mechanisms and safety interlocks are added to form a standardized plug-in unit which meets the highest safety standards.

Both Freedom and Advantage 2100 Series MCCs may be applied on electrical systems up to 600 V, 50 or 60 Hz having available fault currents of up to 100,000 A rms. Freedom dc Motor Control Centers are available up to 250 Vdc, having available fault currents up to 22,000 A rms. Enclosure designs include NEMA® 1 Gasketed, 2, 12 and 3R. An ongoing temperature and short circuit design test program, as required by UL 845, ensures a quality product that meets the latest safety codes.

## Replacement MCC Units

In addition to fully assembled, free-standing MCC lineups, replacement MCC plug-in units are available for:

- Westinghouse 11-300, built from 1950.
- Westinghouse Type W, built from 1965.
- Westinghouse 5 Star, built from 1975.
- Westinghouse Series 2100, built since 1986.
- Westinghouse Advantage, built since 1991.
- Cutler-Hammer 9800, built from 1956.
- Cutler-Hammer F10, built from 1972.
- Cutler-Hammer Freedom, built since 1988.
- Cutler-Hammer Freedom Series 2100, built since 1995.

A complete plug-in unit for adding to an existing MCC includes the plug-in unit, hinged door, isolating divider pan, and all necessary installation hardware.

**Note:** Mounting hardware for an old Cutler-Hammer MCC is sold separately. Since MCC UL 845 standard was established in 1975, most standard replacement plug-in units will have UL labels.

## Ordering Information

Replacement plug-in units should be ordered by description indicating:

- Old General Order number/factory order number.
- MCC model.
- Type of plug-in unit.
- Required features.
- Circuit breaker or fuse rating.
- Schematic reference, if any.
- Motor data.

## NEMA Classifications (ICS 3, Part 1)

### Class I Control Centers

A mechanical grouping of combination motor control, feeder tap and/or other units arranged in a convenient assembly. Connections from the common horizontal power bus to the units are included. Interwiring or interlocking between units or to remotely mounted devices is not included. Only diagrams of the individual units are supplied.

When master terminal blocks are specified, a sketch showing general location of terminals is provided.

### Class II Control Centers

The same as Class I, but designed to form a complete control system. They include the necessary electrical interlocking and interwiring between units and interlocking provisions to remotely mounted devices. A suitable diagram illustrating operation of the control associated with the motor control center will be provided.

When master terminal blocks are specified, the terminal arrangement and required wiring connections are shown on the diagram.

### NEMA Types of Wiring

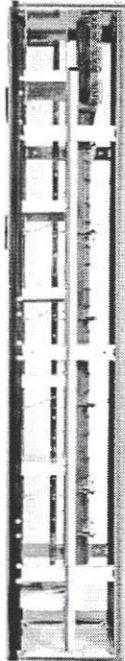
**Type A** includes no terminal blocks. Combination line starters are factory wired and assembled in the structure in the most efficient arrangement. Auxiliary devices can be supplied, but no wiring external to the unit will be furnished. All feeder circuit breaker or fusible disconnect units are in this classification.

**Type B** duplicates Type A except that all control wires terminate at blocks on the side or near the bottom of each unit. Load terminals are all conveniently located adjacent to the control terminal blocks on size 1 units only. Plug-in type terminal blocks are standard for all control wiring.

**Type C-S** all factory supplied control terminals and load terminals for size 1 and 2 starters are brought to a master terminal block located in the structure.

**Type C-M** all factory supplied control terminals and load terminals for size 1 and 2 starters are brought to a master terminal block located in a separate marshaling structure.

Structures



Standard Structure — Side View

Construction

The standard vertical structure is 90 inches (2286.0 mm) high and 20 inches (508.0 mm) wide. Front mounted only structures can be either 16 inches (406.4 mm) or 21 inches (533.4 mm) deep. Back-to-back unit mounting is 21 inches (533.4 mm) deep.

The structure framework is made of 12-gauge formed steel channels. The subframes for the front and rear of each structure are welded. These subframes are then bolted to longitudinal members to form the complete frame which is rigid and self-supporting. Side, back and roof covers of 14-gauge steel are mounted with screw fasteners for quick and easy removal. All doors are 14-gauge steel with a 1/2-inch (12.7 mm) flange to provide a rigid, secure closure for all openings. Doors mounted on removable pin hinges are provided on all unit compartments. Vertical wireways, top horizontal wireways and bottom horizontal wireways are standard.

The unit pan forms the top barrier of each unit space. In conjunction with the unit wrapper, this provides isolation between adjacent units and wireways. The guide rails are an integral part of this pan and provide precise alignment of the unit stabs on the vertical bus.

Standard Structure Arrangements

Standard structural height is 90 inches (2286.0 mm) with 9-inch (228.6 mm) horizontal wireways available at top and bottom for wiring. The balance of vertical compartments, 72 inches (1828.8 mm), is available for mounting of control units. This space can provide up to 12 6-inch (152.4 mm) high (X spaces) or any combination thereof.

Note: In the rear of back-to-back structures, the top horizontal wireway is 15 inches (381.0 mm) high and the bottom wireway is 9 inches (228.6 mm). This means that back-to-back structures have only 66 inches (1676.4 mm) 11X of usable space in the rear. 72-inch (1828.8 mm) 12X of mounting space is available with a 3-inch (76.2 mm) bottom wireway.

Special Structures

In addition to the standard 20-inch (508.0 mm) wide structure, extra wide structures are available in 4-inch (101.6 mm) increments up to 40 inches (1016.0) wide.

Reduced height structures, in increments of 6 inches (152.4 mm) 1X from 90 to 54 inches (2286.0 to 1371.6 mm), are available for applications with limited access.

Another special structure is a transition section between Type W and the Freedom 2100 Series. This structure is 10 inches (254.0 mm) wide to provide for horizontal bus splicing.

Paint

All enclosure parts are thoroughly cleaned and given a phosphatizing treatment to inhibit rust and to prime the metal for the finish coating. A 2 mil thick electrostatic powder paint coat is applied to all surfaces. The paint type and process meets UL 1332 for electrical equipment steel enclosures. All exterior enclosure covers and doors are painted ANSI 61 gray (Munsel No. 8.3G/6.10/0.54). For improved interior visibility, the interior of the enclosure and plug-in units are painted white (Munsel No. N9.43/0.21B, 0.23).

Enclosures

The standard enclosure type is NEMA Type 1 Gasketed General Purpose — Indoor. This enclosure is appropriate for installations with normal atmospheric conditions.

The NEMA Type 2 Dripproof — Indoor employs a special roof panel with a drip shield and water channels. This prevents liquid from dripping onto the front of the control center.

The NEMA Type 3R Rainproof and Sleet Resistant — Outdoor consists of a NEMA 1 gasketed enclosure mounted on a special base with an outdoor house erected around and over it. Non-walk-in, walk-in aisle and tunnel types are available.

The NEMA Type 12 Dust-tight and Driptight — Indoor has gasketed material around all doors, door cutouts, cover plates, side, top, and back sheets. A gasketed bottom plate is provided with this enclosure. This construction provides maximum protection against airborne matter and dripping liquids.

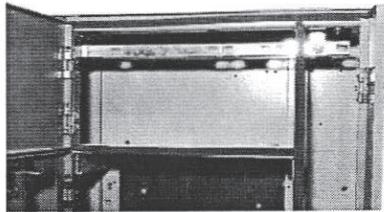
Indoor enclosures comply with NEC UL 845's "Two Meter Rule" when the bottom of the MCC is at the same level as the operator's platform. MCC elevated on a raised pad or installed on unembedded channel sills may require operator handle extensions for the uppermost operators. Handle extensions are optionally available and may be installed on-site.

Vertical Wireway

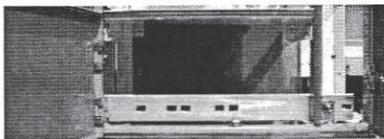
A vertical wireway is provided in each structure. Located on the right side, it extends the full 90-inch (2286.0 mm) height of the structure. The width of the wireway is 4-5/8 inches (117.5 mm) at the rear of the vertical frame members. Overall depth of the wireway is 8 inches (203.2 mm) providing a cross-sectional area of nearly 35 square inches (889 square mm) to easily accommodate control and load wiring. Supports are provided at suitable intervals to secure all wiring and cables.

The doors swing open 115° and opposite to the unit doors for maximum accessibility. The doors are mounted on concealed removable pin hinges for quick detachment and are secured in the closed position by spring-loaded quarter-turn indicating type fastener.

**Horizontal Wireways**



*Top Horizontal Wireway*



*Bottom Horizontal Wireway*

The top front horizontal wireway is 9 inches (228.6 mm) high and 8 inches (203.2 mm) deep in front mounted only structures and in the front of back-to-back mounted structures. It extends the full width of each structure and is totally isolated from the main horizontal bus. The bottom horizontal wireway is 9 inches (228.6 mm) high and extends the full depth of the structure. The entire floor area under the control center is open for unrestricted conduit entry. For top entry, the top wireway can be increased to 15 inches (381.0 mm) high, reducing the bottom wireway height to 3 inches (76.2 mm).

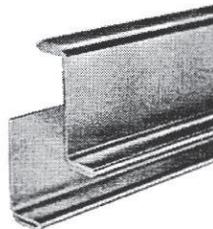
For back-to-back unit mounted, the rear top horizontal wireway is 15 inches (381.0 mm) high and 5 inches (127.0 mm) deep.

All horizontal wireway openings are covered by doors for increased accessibility. Each door is mounted with removable pin hinges to allow quick detachment.

**Bus System**

The bus system is designed to efficiently distribute power throughout the MCC and provides inherent mechanical strength in the event of faults.

**Vertical Bus**



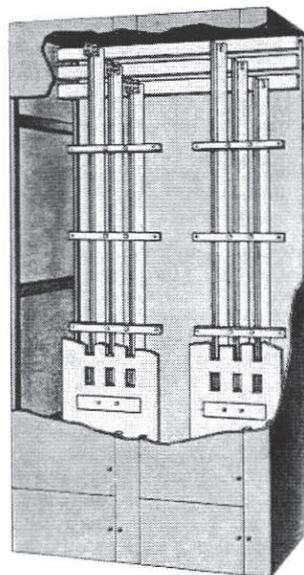
*Vertical Bus Configuration*

The vertical bus provides 3-phase power distribution from the main horizontal bus into the vertical compartments. The bus is a unique angular configuration with an "L" shape for front mounted only structures and a "Z" shape for back-to-back. These shapes have the inherent mechanical strength to withstand fault stresses. They also provide a smooth stabbing surface for unit connection.

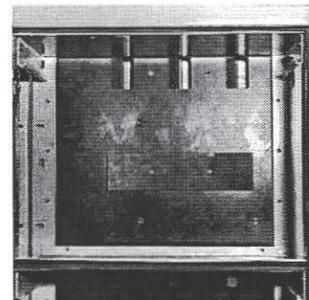
Due to the high strength capability of the bus bars, bus bracing at 65,000 rms symmetrical amperes is standard. Optional bracing is available at 42,000 A and 100,000 A rms. Bus braces are molded from a glass-reinforced polyester material which is non-tracking and impervious to moisture and other adverse atmospheric operating conditions.

The vertical bus is available in ratings of 300, 600, 800 and 1200 A for front mounted only, and 600, 800 and 1200 A for back-to-back mounted. **Vertical bus bars are tin-plated copper only.** Vertical bus of the incoming section will match the horizontal bus when applicable.

Isolation of the Freedom Series 2100 vertical bus compartment from the unit compartment is accomplished by a full height barrier. This is a single sheet of glass-reinforced polyester with cutouts to allow the unit stabs to engage the vertical bus. Snap-in covers are available for the cutout openings to provide total isolation during maintenance procedures.

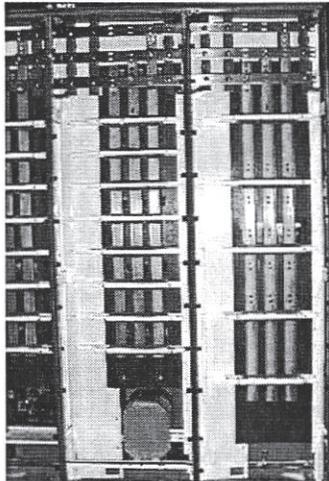


*MCC Bus Layout*



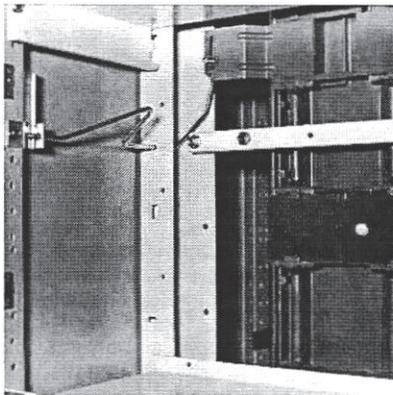
*Standard Isolation Barrier*

When insulation and isolation of the vertical bus is required, a **labyrinth design barrier**, as shown on the next page, is available. This barrier is molded glass-reinforced polyester and forms a labyrinth around the bus bars to prevent fault propagation. This design provides maximum protection against phase-to-phase insulation breakdown. Thermal efficiency is maintained by a close tolerance fit between the bus bars and the barrier which minimizes air pockets. The labyrinth barrier is standard for Advantage MCCs.



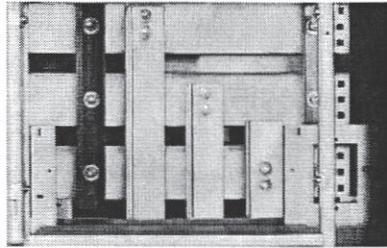
Standard Isolation Barrier Rear View

An automatic shutter mechanism is standard with the labyrinth barrier to provide complete isolation of the vertical bus. The shutter moves automatically to cover the stab openings when a unit is removed. This provides maintenance personnel with maximum protection since the vertical bus is never exposed. As the unit is reinserted in the compartment, the shutter moves sideways to uncover the stab openings in the barrier.



Labyrinth Barrier with Automatic Shutter Mechanism

Horizontal Bus



Horizontal Bus

The main horizontal bus provides 3-phase power distribution from the incoming line or primary disconnect device to each vertical structure in the motor control center. The bus bars are mounted in a vertical plane, edge to edge. This mounting produces an exceptionally strong assembly, able to withstand high fault current stresses.

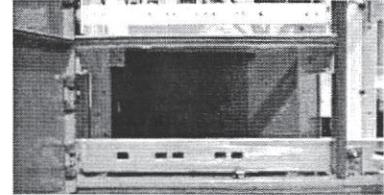
Standard horizontal bus bracing is 65,000 A rms symmetrical amperes. Optional bracing is available at 100,000 A rms. Bus braces are molded from high strength glass-reinforced polyester material which is non-tracking and impervious to moisture and other adverse atmospheric operating conditions.

The main horizontal bus is rated at 600 A as standard with ratings of 800, 1200, 1400, 1600, 2000, 2500 and 3200 A optionally available. Tin-plated copper bus bars are supplied as standard. Silver-plated copper is also available.

**Note:** 3200 A horizontal bus available in NEMA 1A enclosure only and 65°C rise above 40°C ambient only.

The horizontal main bus is isolated from the top horizontal wireway compartment by an isolation barrier. This two-piece steel barrier extends to the full width of each vertical structure. The two-piece design allows access to bus connections without the removal of the entire barrier, for added maintenance convenience. The bus bar layout permits front access to all bus connections. This allows maintenance personnel to make splices and check splice bolt torques from the front of the structure.

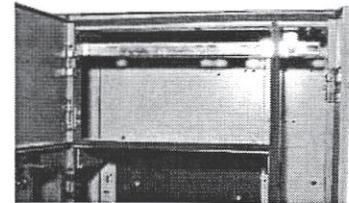
Neutral Assemblies



Neutral Bus (Bottom)

For 3-phase 4-wire applications, a neutral landing pad is provided as standard. This is a 100% rated neutral. As an option, half or fully rated neutral bus can be supplied in the bottom of the entire MCC.

Ground Bus



Ground Bus (Top)

Copper ground bus, rated 300 A 1/4-inch by 1-inch (6.4 mm by 25.4 mm) is supplied as standard. Mounting is across the top of each vertical structure in the horizontal wireway. The bus can also be mounted across the bottom when the bottom 9 inches (228.6 mm) are not occupied by units or master terminal blocks. A 1/4-inch by 2-inch (6.4 mm by 50.8 mm) copper ground bus rated 600 A is optional.

An optional 300 A vertical tin-plated only copper ground bus is available. Located in the vertical wireway, it provides direct starter unit grounding.

### Units

#### General

Motor starter units are combination type employing a linestarter and a disconnect device of proven capability. The disconnect device can be a motor circuit protector, circuit breaker or fusible switch. The Cutler-Hammer Type HMCP motor circuit protector is furnished as standard.

All starters through NEMA Size 5 are a drawout design except Size 5 electromechanical reduced voltage.

All dimensions and ratings in the following tables are based on NEMA B, 1800 RPM motors.

**The HMCP and starter combination has a 65,000 rms symmetrical ampere short circuit current rating as standard at 480 V.** Starter units are available with optional 100,000 A short circuit current rating. Series C thermal-magnetic circuit breakers (65 kAIC, or optional 100 kAIC) for starter units are also available.

Freedom and Advantage starters meet or exceed IEC 947-4 Type II testing with R and J fuses. Additionally, Advantage is Type II listed with Cutler-Hammer motor circuit protector disconnects.

The fusible switch disconnect device is the Type K. It is a quick-make, quick-break, visible blade switch with fuse clips for use with current-limiting or dual element, rejection type, NEMA Class J or R fuses. Rejection fuse clips for Class RK-5 fuses are standard. Fuses are not included as standard.

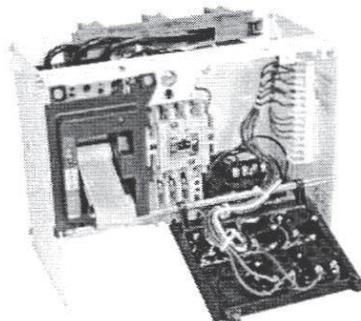
Both breaker and fuse selection must take into consideration the total short circuit capacity of the system to which the control center is connected.

Typical starter units available include the following:

- Full voltage, non-reversing.
- Full voltage, reversing.
- Two-speed, single winding and two winding.
- Reduced voltage, autotransformer, closed transition.
- Reduced voltage, wye delta.
- Reduced voltage, part winding.
- Reduced voltage, solid state.
- Adjustable frequency drives.

Each starter includes a stainless steel corrosion-resistant safety ground clip that makes connection before the power stabs engage the vertical bus.

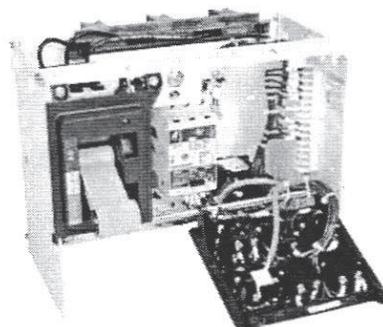
### Units — Freedom Starter



*Freedom — FVNR Starter*

Freedom Series 2100 starter units are equipped with Cutler-Hammer Freedom starters and contactors NEMA sizes 1 through 5. Size 6 and 7 starters are A200 type. These contactors have been successfully applied in thousands of the most demanding industrial applications. Overload protection is provided by a 3-pole adjustable ambient compensated, bi-metallic thermal overload relay. The overload relay also provides single-phase sensitivity and isolated alarm contact. An insulated hand reset button extends through the compartment door.

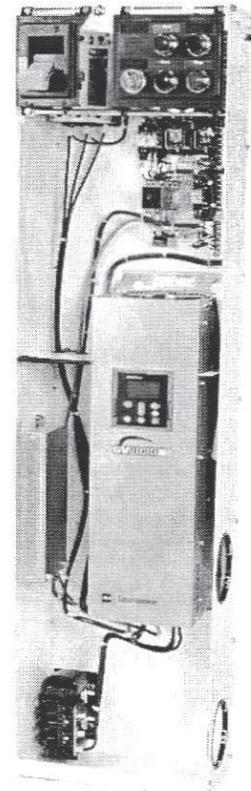
### Units — Advantage Starter



*Advantage — FVNR Starter*

Advantage starter units are equipped with Cutler-Hammer Advantage starters NEMA sizes 1 through 6. Introduced in 1991, the Advantage starter has been successfully applied in the most demanding industrial applications. Utilizing microprocessor control, the Advantage starter affords phase unbalance protection, ground fault protection, more accurate motor overload protection, discrete pickup and dropout voltages and inherent coil surge protection. Additionally, motor running data and starter status are available through PowerNet and DeviceNet communications systems.

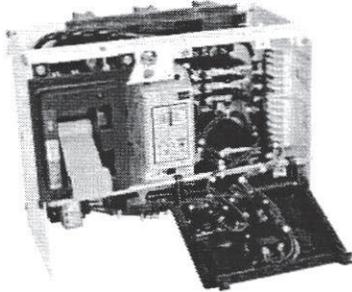
### Units — ac Drives



*Adjustable Frequency Drive*

**Adjustable Frequency Drives** are available from .5 hp to 1100 hp for control of standard ac motors in processes that benefit from the ability to change motor speed. Use of Inverter Duty motors is recommended. Controllers are available to handle constant torque applications, such as conveyors and crushers, and variable torque applications, such as fans and pumps. Control schemes are available for volts/Hz, open loop vector and closed loop vector models. SV9000 drive units include as standard: line reactors and a door mounted keypad. Units up to 150 hp VT have a standard output reactor for V/dT filtering. AF91 drive units include as standard: a line reactor, viewing window for drive display, and an output filter. All drive structures are bus connected which allows for expansion of the MCC on both sides of the structure. A wide range of AFD features and options are available to meet the requirements of most applications. AFDs are available in NEMA 1A.

**Units — Solid-State  
Reduced Voltage Starters**



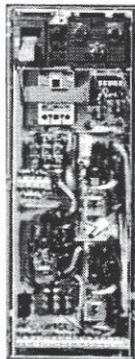
*IT. SSRV Starter Unit*

IT. SSRV Starters are designed to reduce the inrush current to a motor during starting and limit the amount of available starting torque, thus reducing mechanical wear and utility demand requirements. The amount of starting current is field adjustable to match the specific requirements of all applications.

Cutler-Hammer IT. SSRV Controllers are available with a wide variety of standard features: Kick start, soft stop, phase loss and stall protection. IT. Solid-State Reduced Voltage Starters are 30 – 70% smaller than competitive designs.

Typical applications include conveyors, compressors, machine tools, pumps and fans.

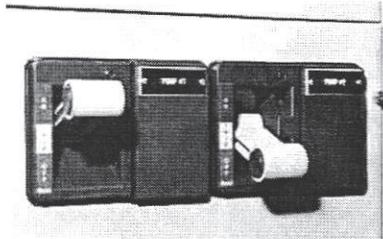
**Units — dc Starters**



*dc Starter Unit*

UL listed dc MCCs use combination circuit breaker dc starters suitable for motor starting duty only. Using Cutler-Hammer Type ME dc definite purpose contactors, all dc starters are suitable for up to 250 Vdc and have a 22 kA withstand rating. Class 135 starting resistors for reduced voltage starters are sized for 200% starting current. Typical applications include emergency lube oil pumps, emergency seal oil pumps and emergency turning gear motors.

**Feeder Tap Units**



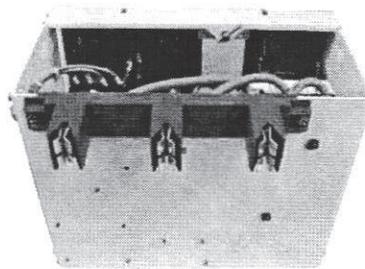
*Dual Feeder Tap Unit*

Feeder tap units may contain either circuit breakers or fusible switches. Drawout breaker units include the fixed trip Type HFD, single or dual mounted in ratings through 150 A and the interchangeable trip Types HJD and HKD single mounted through 250 A and 400 A respectively. Larger Series C® circuit breakers with ratings to 2500 A are fixed mounted.

Fusible feeder tap units utilize the Cutler-Hammer Type K visible blade disconnect switch. Fused switches are mounted in drawout units through 400 A with 30 and 60 A ratings available in dual mountings. Fixed mounted switch ratings of 600 A and 800 A are also available.

All switches are supplied with fuse clips for use with current-limiting or dual-element rejection type. Types of fuses include Class J, R or L.

**Stab Assembly**



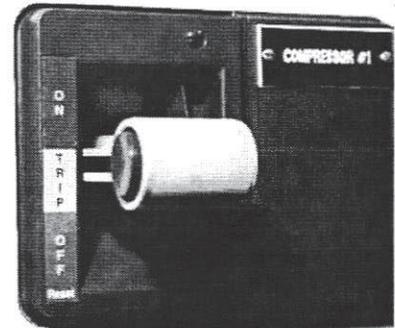
*Plug-in Unit Bus Stabs*

A tin-plated copper alloy stab incorporates the ultimate in mechanical simplicity to provide precise control of contact pressure on the bus. This ensures a positive connection yet permits easy unit insertion and withdrawal. Self-aligning stabs are mounted in a glass-reinforced plastic insulation block which totally shrouds each stab and absolutely ensures positive alignment of the stabs with the vertical bus. The insulation block is also an integral part of the phase-to-phase isolation system. Power wiring

is welded to the stabs and is totally contained within the unit enclosure. This means the vertical bus compartment is completely free of wiring for maximum safety and reliability.

Stab assemblies are accurately matched to the electrical requirements of each individual unit and are provided in 60, 150, 300 or 400 A ratings.

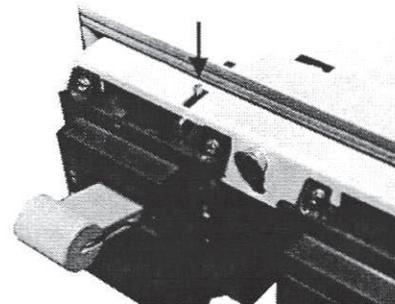
**Handle Mechanism**



*Circuit Breaker Handle Mechanism*

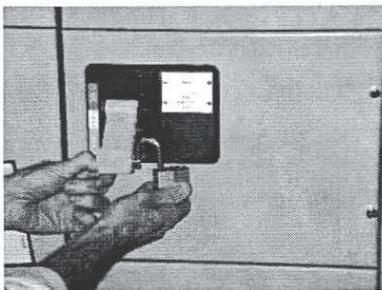
The handle mechanism is designed to provide a high mechanical leverage so that little effort is required to operate any device.

The standard handle mechanism is a vertical motion type device with four positions; ON, OFF, TRIPPED and RESET. Only circuit breaker types have tripped and reset positions. It is securely mounted to the front of the unit and mechanically connected to the breaker or fusible switch, eliminating alignment problems. It provides a positive indication of the breaker or switch position, even with the door open.



*Unit Insertion Interlock*

The handle and exterior front panel are molded from the same plastic material as the device panel. A textured surface preserves the appearance. The ON position indicator is at the top and is a bright red. The OFF/RESET position is at the bottom and is bright green. The TRIP position, a bright yellow, is in the middle, between the ON and OFF position. All position indicator colors contrast with the black background and are highly visible even at considerable distances. The operating handle is designed for rugged duty and solid operator feel.

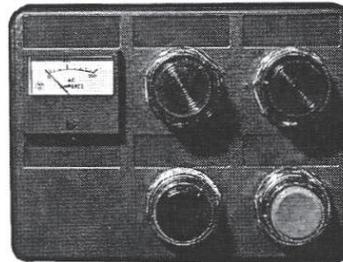


*Padlocking Bar*

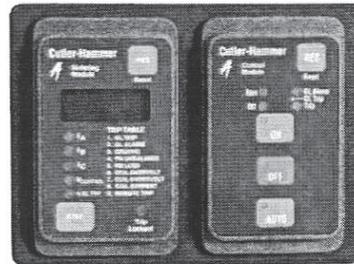
The handle mechanism provides several safety features:

- In the ON position, an interlock prevents the unit door from being opened. A door interlock defeater screw located above the handle is provided to enable authorized maintenance personnel access to the units when required.
- With the unit door open and the operating handle in the ON position, an interlock slides into a slot in the divider pan above and prevents removal of the unit. This same interlock prevents insertion of the unit unless the handle mechanism is in the OFF position. The interlock also prevents the operating handle from being turned on with the unit door open.
- To ensure that units are not energized accidentally or by unauthorized personnel, the handle mechanism can be padlocked in the OFF position. Sufficient space is available for a maximum of three padlocks. Where critical processes are involved and to prevent unauthorized shutdown, the handle mechanism can be modified to enable padlocking in the ON position.

## Device Panel



*Standard Device Panel*



*Advantage Device Panel with  
ACM and Metering Module*

The device panel can accommodate up to six 1-3/16-inch (30.2 mm) Cutler-Hammer 10250T type pilot devices such as oiltight pushbuttons, indicating lights, selector switches and miniature meters.

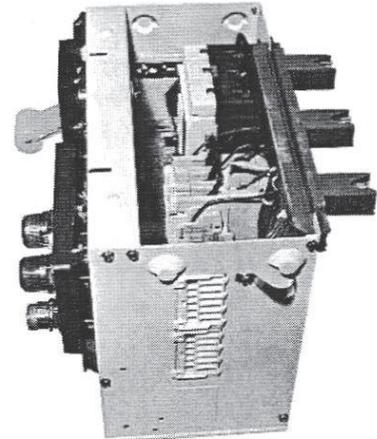
Molded into the panel is a knockout for each device location. This facilitates the future addition of devices to the panel.

The device panel is hinged on a horizontal pivot tube extending across the front of the unit. With the unit door open, loosening two captive retaining screws at the top of the panel and sliding it 1/2-inch (12.7 mm) left, permits it to swing down. This provides ready access to the rear of the panel and increased accessibility to the unit interior.

## Nameplates

Unit nameplates are engraved with 3/16-inch (4.8 mm) high white lettering on a black background. They are heat and crack resistant to eliminate the need for replacement. Nameplates are mounted with stainless steel self-tapping screws.

## Unit Wrapper



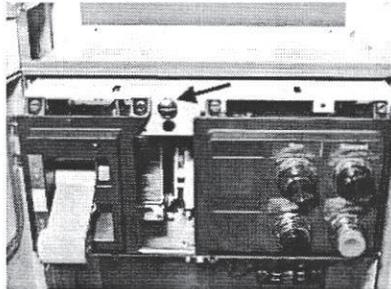
*Plug-in Unit Wrapper*

The unit wrapper is fabricated of 14-gauge steel. After fabrication, it is cleaned and given a rust inhibiting phosphatizing treatment. The finish on a unit wrapper is a baked Munsel No. N9.43/0.21B, 0.23 white. This is highly durable finish, gloss-white in color to increase visibility within the unit and facilitate wiring and maintenance procedures.

The unit wrapper consists of a three-sided rugged steel shell including the mounting base for the unit components. The smallest unit measures 13-3/4 inches (349.3 mm) wide, 8 inches (203.2 mm) deep and 6 inches (152.4 mm) high. Units increase in 6-inch (152.4 mm) increments to a maximum height of 72 inches (1828.8 mm).

The unit wrapper is designed to provide ample space for cable entry from the wireway to the unit.

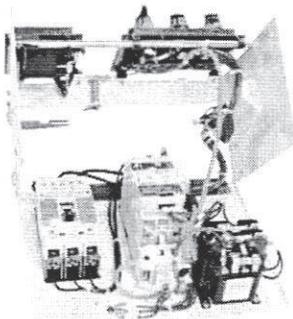
The unit wrapper has four mounting points, two on each side, which support the unit in the structure. They engage guide rails located near the top of each unit space. This mounting point guide rail system produces minimum friction and allows units to be inserted and withdrawn easily. The guide rails also give precise alignment to the unit for accurate stabbing on the vertical bus.



Unit Wrapper Latch

At the top center of the unit wrapper is a quarter-turn latch which securely holds the unit in the compartment. The latch can only be engaged when the stabs are fully mated with the vertical bus. Upon release of the latch, the unit can be partially withdrawn such that the stabs disengage from the vertical bus. In this position, the latch can be re-engaged to prevent the unit from being returned to the fully stabbed position or from being removed from the structure. The latch can be padlocked in this position to ensure that the stabs remain disengaged during maintenance.

**Unit Maintenance**



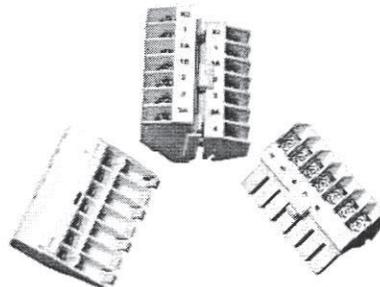
Plug-in Unit Maintenance

The three-piece unit wrapper design facilitates easy work bench maintenance. When removed from the MCC, the unit top/side barrier assembly can easily be swiveled up and back for complete access to components and wiring.

**Terminal Blocks**

A side mounted, seven-circuit, latching pull-apart terminal block is standard on units with NEMA Type B or C wiring. This industrial grade Cutler-Hammer MCC terminal block provides solid electrical connections while conserving space and making installation and maintenance easier.

Terminal blocks are mounted in knock-outs on the vertical wireway side of the unit housing affording greater access to the unit compartment and interior components. The two-piece terminal block snap-locks together to ensure permanent circuit continuity. To aid installation and wiring checks, the terminal marking strips for both sides of the terminal block are fully visible from the front of the starter compartment.



Side Mounted — Latched Pull-Apart Terminal Block

Heavy-duty saddle wire terminals are of the resilient collar design which eliminates loose connections caused by expansion and contracting of the conductor as the current is switched on and off. This unique design maintains constant pressure as the wire expands and contracts. This 600 V, 30 A rated terminal block will accept 12 AWG stripped wires as well as ring or spade wire lugs. All terminal block conductors are fully shielded for added safety and cleanliness.

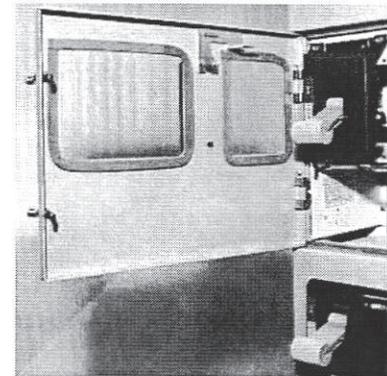
A 12-inch (304.8 mm) high (2X-space) starter unit accommodates up to three side-mounted terminal blocks providing a maximum of 21 points. Larger units accommodate two additional 7-point terminal blocks for every additional 6 inches (152.4 mm) 1X-space of unit height. The 6-inch (152.4 mm) compact starter unit uses a 9-point pull-apart terminal block which is installed along the top front of the starter unit.

Control wiring within each starter compartment consists of 16 AWG control wire for Freedom 2100 Series MCCs and 14 AWG wire for Advantage 2100 Series MCCs. Rated 105°C, the flame-retardant, thermoplastic insulated wire is red. Power wiring is black and sized to carry the maximum full load current of the starter unit.

**Front Rail Mounted Terminal Blocks**

For special applications, other types of rail mounted terminal blocks are also available. They are installed horizontally at the bottom front of the starter unit. Refer to the Cutler-Hammer business for terminal block types available and space restrictions.

**Unit Doors**

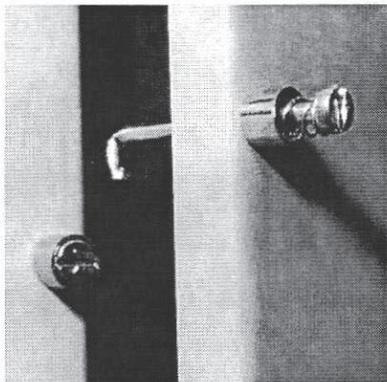


12-inch (304.8 mm) Unit Door

Unit doors are formed of 14-gauge steel with a 1/2-inch (12.7 mm) flange on all four sides. The flange adds rigidity to the door and provides a surface to contain door gasketing. Cutouts are made in the door as required to accommodate the operating handle and device panel. The doors are cleaned, phosphatized and given a finish of gray, baked on enamel ANSI 61.

The doors will open 115° opposite to the wireway doors permitting optimum access to the unit compartment. The doors are mounted on removable concealed pin hinges. This permits quick removal of any door in a vertical structure without disturbing adjacent doors.

Doors 2X and larger are held closed with a minimum of two quarter-turn indicating type fasteners. They securely hold the door in the closed position, yet allow quick and easy access to the unit when required. The fasteners provide a visual indication of the latched position. The head slot of the fastener is designed to prevent screwdriver slippage.



Spring-Loaded Unit Door 1/4 Turn Latch

### Options

Starter and feeder tap units can be modified to meet a variety of specification requirements. Some typical components which can be added include: control power transformers with two primary and one secondary control fuses, control relays, CEP7 or IQ 500 (solid-state overload) relays, ground fault relays, current transformers, extra electrical interlocks, push-buttons, selector switches, indicating lights, circuit breaker shunt trip or undervoltage release and auxiliary switches. In most cases, one of these modifications does not increase starter unit size.

### Additional Equipment

In addition to motor starter and feeder units, additional equipment can be supplied including the following:

- Single-phase dry-type distribution transformers in ratings of .5, .75, 1, 1.5, 2, 3, 5, 7.5, 10, 15, 20, 25, 30 and 45 kVA.
- 3-phase dry-type distribution transformers in ratings of 9, 15, 25, 30 and 45 kVA.
- Lighting panelboards with up to 42 circuits with either plug-in branch breakers or bolt-on branch breakers, 120/240 V, 120/208 V or 480 V, single- or 3-phase.
- Current limiting reactors with ohmic values of .01, .015, .02 and .025, and ampere ratings of 600, 800, 1000 and 1200.

- Metering equipment including the IQ family of solid-state power monitors, voltmeters and ammeters.
- PLC and DCS I/O racks.
- IT family of solid-state reduced voltage starters.
- AF91 and SV9000 adjustable frequency controllers.
- Active Harmonic Correction Units.
- Transient Voltage Surge Suppression (TVSS) units.
- Size 4, 5 and 6 vacuum starters and contactors.
- Power factor correction capacitors.
- Automatic transfer switches.
- DeviceNet Communications.
- PowerNet Communications.
- PanelMate industrial Operator Interface.
- Industrial PCs.

### Control and Load Terminations

For NEMA Type A wiring each unit is assembled and devices interwired. Terminal blocks are not supplied and control and load wiring is internal to the unit.

For NEMA Type B wiring, control wires are terminated at blocks within the unit. Refer to the discussion of units for types of terminal blocks available.

For NEMA Type C-S wiring, control, and size 1 and 2 starter load wires are extended from the unit terminal blocks to master terminal blocks located at the top or bottom of each vertical structure.

The mounting location of the master terminal block in front mounted only structures is in the existing horizontal wireway space at the top or at the bottom as shown above. When mounting is made in an incoming line section, 12 inches (304.8 mm) of unit space must be used. When mounting is made in the rear of back-to-back mounted structures, 6 inches (152.4 mm) of unit space must be used at the bottom and 12 inches (304.8 mm) at the top.

Master terminal blocks are rack mounted to permit removal of entire assembly for ease of wiring during installation and maintenance.

For NEMA Type C-M wiring control and size 1 and 2 starter load wires are extended from the unit terminal blocks to master terminal blocks located in a separate marshaling structure.

### Incoming Line

Incoming line cables entering the MCC from either the top or bottom can be easily terminated onto main lugs or connected to a main disconnect. All incoming line sections comply with NEC wiring bending requirements as adopted by UL.

### Main Lugs Only (MLO)

Up to 1200 A rated horizontal bus, cables, up to four per phase, are terminated on crimp or screw lugs mounted on adapters solidly bolted to fully rated vertical bus. Top entry cables are terminated at the top of the MCC and bottom entry cables are conveniently terminated near the bottom. **Table 77** shows spacing requirements for various cable configurations. MLO termination for 1600, 2000, 2500 and 3200 A requires a full vertical section.

Note: 3200 A main lugs only available in NEMA 1A enclosure only and 65°C rise above 40°C ambient only.

### Main Disconnects

Incoming cables may also be easily terminated on a main circuit breaker or fused switch. A variety of molded case or encased circuit breakers are available. **Tables 55** through **60** show spacing requirements for various main devices.

**Metering**



***IQ Analyzer***

The Cutler-Hammer IQ family of metering and power monitors includes:

**IQ 100** cost-effective electronic power meter provides 3-phase display for L-L, L-N voltage, current.

**IQ 320** microprocessor-based 3-phase power monitor displays phase currents, voltage, L-L, L-N, power-real and apparent, power factor, frequency, energy: wathours, VAR hours, VA hours.

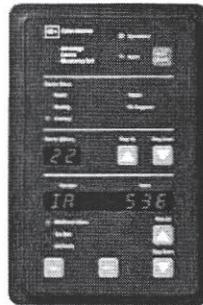
**IQ 200** includes all of the functions of the IQ 320 Meter. The door mounted display is smaller, making the IQ 200 ideal for use on individual starter and drive units.

**IQ DP-4000** includes all of the functions of the IQ 320 plus THD readings for voltage and current. Additionally, the IQ 4130 includes contact inputs and outputs. This device is ideal for incoming line monitoring.

**IQ Analyzer** provides extensive metering, power quality analysis, remote input monitoring, control relaying, analog input/outputs, and is communications capable. A display provides the flexibility of exhibiting large characters with high visibility and small characters for detailed descriptions.

These IQ power monitors each contain their own voltage power pack for systems up to 600 V. Therefore, separate potential transformers are not required. Either two or three separate current transformers must be used. All IQ power monitors are communications capable. Refer to **Section 3** of the *Cutler-Hammer Consulting Application Guide, 13th Edition* for further details.

**Communications — PowerNet**



***Central Monitoring Unit***

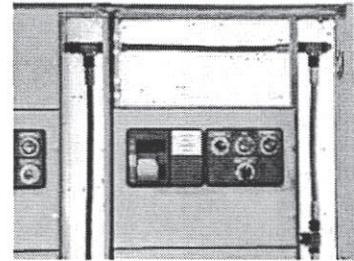
The Advantage MCC is available with the PowerNet communications network. PowerNet network capable devices, such as Advantage starters, the IQ family of metering devices, addressable relays, energy sentinels and many others, can be connected together with one twisted pair PowerNet communications network. Advantage starters may be controlled and monitored from remote locations. 3-phase motor running current, control voltage, elapsed time, start count and overload status information is available on the network.

**Central Monitoring Unit (CMU)** For Advantage MCCs, a Central Monitoring Unit can be installed to provide centralized motor monitoring for an entire MCC. Using a PowerNet communications network, all Advantage starters with WPONI network modules are serially connected to the CMU via one shielded twisted pair network. At the CMU, motor running data as well as start/stop and overload status can be conveniently monitored.

**Parameters Displayed**

- Monitored values:
  - Device description
  - I<sub>A</sub>, I<sub>B</sub>, I<sub>C</sub> currents
  - Control voltage
  - Present time, date
  - Resettable operation unit
  - Run time, hours
- Trip data — current values and cause of trip.
- Set points:
  - Device size
  - OL trip current setting (FLA setting)
  - OL trip class
  - Ground fault protection — ON/OFF
  - Phase loss/unbalance protection — ON/OFF
  - Reset mode — Auto/Manual
  - Frequency

**Communications — DeviceNet**



***DeviceNet Wiring***

Freedom and Advantage MCCs are available with DeviceNet MCCs. DeviceNet is a device level open communication network linking DeviceNet capable control products, such as Advantage Starters, Freedom Starters, Adjustable Frequency Drives, PanelMate® 1700 Series and operator interfaces, DN50 I/O blocks, *IT* soft starters and iPCs. These products are prewired in the MCC with DeviceNet cable. Available control and monitoring features of Advantage Starters and SV9000 drives include:

- ON/OFF control.
- Control voltage.
- Trip reset.
- Trip indication.
- Cause of trip.
- Thermal capacity.
- 3-phase or average motor current.
- Various drive parameters.
- Overload warning.

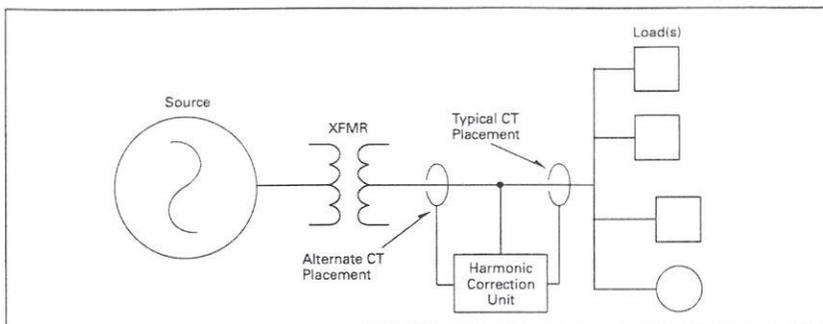
Available control and monitoring features of Freedom Starters and *IT*. Solid State Reduced Voltage include:

- ON/OFF control.
- Overload trip indication.
- RUN status.
- Disconnect status.

The DeviceNet specification is controlled by the Open Device Vendors Association (ODVA). The DeviceNet system can be controlled from:

- iPC (industrial personal computer) PC-based control software.
- DeviceNet scanner cards designed for leading PLC and DCS systems.

**Harmonic Correction**



**Figure 1. Clean Control Center Installation Diagram**

The Clean Control Center utilizes a harmonic correction unit to provide harmonic cancellation directly on the Motor Control Center Horizontal Bus. The harmonic correction unit senses the load current and injects into the ac lines a synthesized waveform that is inverted compared to the remaining signal. The result is a clean waveform as seen by the upstream electrical system. Single or multiple harmonic correction units may be applied within a Clean Control Center providing an economical solution to excessive harmonics due to ac drives or other non-linear loads. Use of the Clean Control Center will provide compliance to the most stringent 5% Total Demand Distortion (TDD) requirements of IEEE 519. Clean Control Center assemblies include a 24-inch (609.6 mm) wide MCC structure, Active Harmonic Correction Unit, Current Transformers and a doormounted digital interface panel.

**PLCs**

**Programmable Controllers** can be mounted in Freedom Series 2100 and Advantage MCCs in a wide variety of configurations. Popular mounting configurations include small PLCs unit mounted to replace relays, medium sized PLCs with I/O for control of an MCC lineup, and remote I/O drops mounted in an MCC and connected to the main CPU via coaxial cable. Due to the flexibility of PLCs and the wide variety of applications and configurations, the Freedom Series 2100 and Advantage MCCs are designed to meet the mounting requirements of most applications.

**Motor Protection**

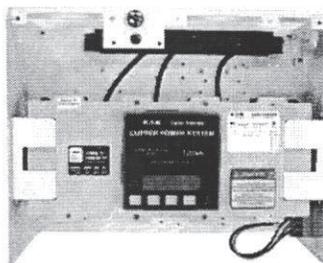
The CEP7 Solid-State Overload Relay offers improved motor protection due to high repeat accuracy and fast reaction times to phase failures. The state-of-the-art microelectronics design permits the choice of relays with different trip classes (Class 10, 20) to accommodate motors with a variety of application needs.

The CEP7 Solid-State overload is available on all starter sizes. (Size 5 and up utilize CTs with the overload relay.) Key features include:

- Phase loss
- Phase imbalance
- Wide adjustment range
- Low energy usage
- Reduced heat

The MP-3000 Motor Overload Relay is a microprocessor-based relay which provides superior motor protection for critical process motors. Standard protective features provided in the MP-3000 include: I<sup>2</sup>t with programmable locked rotor protection, instantaneous overcurrent, ground fault, underload, jam, phase loss/unbalance/reversal, limit starts/hr, alarm and trip modes and capability to utilize RTDs for motor protection. Functions are user programmed via a data entry and display panel mounted in the door of the Freedom Series 2100. Alarm and Trip contacts are provided for remote indication. In addition, the MP-3000 will have the capability for remote monitoring via a communications port. The ultimate in motor protection is available in the MP-3000 and the Series 2100 MCC.

**TVSS (Clipper Surge Protection)**



**TVSS (Clipper Power System) with Circuit Breaker Disconnect**

Visor Series TVSS Units feature advanced Thermodynamic Fusing Technology and Intelligent Monitor Options in 12, 18-inch space factors. All TVSS units (100 – 500 kA) meet UL 449, 2nd edition and UL 1283. Internal fuse protection is up to 200 kAIC.

Standard MCC offering includes SuperVisor Monitoring Display with power quality meter for volts, sag, swell, outage, transient counter, Form C contact, alarm enable and disable.

**Additional Services**

**Startup Assistance**

To ensure complete customer satisfaction and to expedite equipment startup for Motor Control Centers, this service provides a factory-trained representative at the job-site during equipment energization. This service is provided on a fixed price basis. In addition to factory directed startup, the standard equipment warranty is extended for a period of 24 months. This service is especially beneficial when solid-state equipment is incorporated within the MCC due to the flexibility in adjusting solid-state equipment for each application.

**Maintenance and Operational Training**

A full range of Training and Operational Training programs are available for all types of MCC mounted equipment. In addition, Preventative Maintenance programs are available to ensure years of trouble-free operation.

**Seismic Qualification**

Seismic testing has been completed for Freedom and Advantage MCCs. Freedom and Advantage MCCs are qualified for UBC® Seismic Zones 1 and 2, IBC and CBC without modification. For Seismic Zones 3 and 4, additional end plates are required.

**Note:** Contact the Cutler-Hammer business for availability of seismically qualified MCC.

**Retrofits**

Existing installations can many times benefit from some of the "new" technology equipment available in today's MCCs. The Cutler-Hammer business offers a full range of retrofit capabilities to upgrade existing MCC lineups. Examples include: vacuum contactors, reduced voltage solid-state starters, solid-state metering and solid-state overload protection. Starter retrofit kits for selective competitor MCCs are also available. Consult factory for availability.

Technical Data

Table 1. Short Circuit Ratings for Motor Control (480 Volt)

Short Circuit Protective Device	Combination Starter FV and RV (kA)	Solid-State Reduced Voltage	Adjustable Frequency Drives
HMCP Motor Circuit Protector (Standard Rating)	65	65	65
HMCP Motor Circuit Protector (Optional Rating)	100	100	100
MCCB Molded Case Circuit Breaker (Standard Rating)	65	65	65
MCCB Molded Case Circuit Breaker (Optional Rating)	100	—	100
Fusible Switch	100	100	100

Table 2. Combination Starters with Series C Motor Circuit Protectors or Molded Case Circuit Breakers — Dimensions in Inches (mm)

Motor Circuit Protector Ratings are suitable for both NEMA Design B and NEMA Design E (high efficiency) motors. Per NEC, the motor circuit protectors may be adjusted to 17X motor FLA.

NEMA Size	Maximum Horsepower					HMCP Frame ①	MCCB Frame ②	Freedom		Advantage	
	208 V	240 V	380 V	480 V	600 V			Unit Size	X Space	Unit Size	X Space
<b>Full Voltage Non-Reversing</b>								<b>Type F206</b>		<b>Type W206</b>	
1	7.5	7.5	10	10	10	150	HFD/FDC HFD/FDC	6 (152.4) ③ 12 (304.8) ④ 18 (457.2)	1X ③ 2X ④ 3X	6 (152.4) ③ 12 (304.8) ④ 18 (457.2)	1X ③ 2X ④ 3X
2	10	15	25	25	25	150	HFD/FDC HFD/FDC	12 (304.8) ④ 18 (457.2)	2X ④ 3X	6 (152.4) ③ 12 (304.8) ④ 18 (457.2)	1X ③ 2X ④ 3X
3	25	30	50	50	50	150	HFD/FDC HFD/FDC HFD/FDC	18 (457.2) ⑤ 24 (609.6)	3X ⑤ 4X	12 (304.8) ③ 18 (457.2) ⑤ 24 (609.6)	2X ③ 3X ⑤ 4X
4	40	50	75	100	100	150	HFD/FDC HFD/FDC HJD/JDC	18 (457.2) ⑤⑥ 24 (609.6) ⑥	3X ⑤ 4X	12 (304.8) ③ 18 (457.2) ⑤⑥ 24 (609.6) ⑥	2X 3X ⑤ 4X
5	50 75	60 100	100 150	125 200	150 200	250 600	HJD/JDC HKD/KDC	36 (914.4)	6X	36 (914.4)	6X
6	25 150	100 200	250 300	300 350 400	400 —	600	HLD/LDC ⑩	48 (1219.2)	8X	42 (1066.8)	7X ⑩
7	—	300	—	600	600	1200	HND	72 (1828.8) ⑦	12X	60 (1524.0)	10X
7	—	300	—	600	600	1200	HND	72 (1828.8) ⑦	12X	72 (1828.8) ⑦	12X
<b>Full Voltage Non-Reversing — Dual Unit ⑧</b>								<b>Type F246</b>		<b>Type W246</b>	
1	7.5	7.5	10	10	10	150	HFD/FDC	18 (457.2)	3X	18 (457.2)	3X
2	10	15	25	25	25	150	HFD/FDC	18 (457.2)	3X	18 (457.2)	3X
<b>Full Voltage Reversing</b>								<b>Type F216</b>		<b>Type W216</b>	
1	7.5	7.5	10	10	10	150	HFD/FDC	18 (457.2) ⑤ 24 (609.6)	3X ⑤ 4X	18 (457.2) ⑤ 24 (609.6)	3X ⑤ 4X
2	10	15	25	25	25	150	HFD/FDC	18 (457.2) ⑤ 24 (609.6)	3X ⑤ 4X	18 (457.2) ⑤ 24 (609.6)	3X ⑤ 4X
3	25	30	50	50	50	150	HFD/FDC	24 (609.6) ⑥	4X	24 (609.6) ⑥	6X
4	40	50	75	100	100	150	HJD/JDC	30 (762.0) ⑤	5X	30 (762.0) ⑤	5X
5	50 75	60 100	100 150	125 200	150 200	250 600	HJD/JDC HKD/KDC	60 (1524.0)	10X	60 (1524.0)	10X
6	125 150	100 200	250 300	300 350 400	400 —	600 1200	HLD/LDC HND ⑫	72 (1828.8) ⑦ 72 (1828.8) ⑫	12X 12X ⑫	72 (1828.8) 72 (1828.8) ⑬	12X 12X ⑬

① Standard Combination Starter Units with HMCP Magnetic Only disconnect have short circuit ratings of 65,000 amperes at 480 volts. Optional HMCP combination starter units are available with 100,000 amperes at 480 volts.

② Optional Combination Starter Units with Thermal-Magnetic breaker disconnects are available with either 65,000 amperes or 100,000 amperes at 480 volts.

③ Maximum of (3) pilot devices, (2) auxiliary contacts; 100 VA CPT maximum. Standard lugs only.

④ 12-inch (304.8 mm)/2X unit is standard.

⑤ 18-inch (457.2 mm)/3X unit is standard.

⑥ Minimum 30-inch (762.0 mm) space needed with Thermal-Magnetic Circuit Breaker.

⑦ Requires 28-inch (711.2 mm) wide structure.

⑧ Limited options. Two starter units share common door.

⑨ 30-inch (762.0 mm) space needed for Thermal-Magnetic Circuit Breaker.

⑩ For top entry, 8X space required.

⑪ 1200A HMCP frame available in 11X 66-inch (1676.4 mm).

⑫ Requires 36-inch (914.4 mm) wide structure.

⑬ Requires 28-inch (711.2 mm) wide structure.

**Note:** For HMCP continuous ampere ratings by Motor hp, see Table 81 on Page 39.

Table 2. Combination Starters with Series C Motor Circuit Protectors or Molded Case Circuit Breakers (Continued)

NEMA Size	Maximum Horsepower					HMCP Frame ①	MCCB Frame ②	Freedom		Advantage	
	208 V	240 V	380 V	480 V	600 V			Unit Size		Unit Size	
								Inches (mm)	X Space	Inches (mm)	X Space
<b>Two-Speed One Winding, Constant/Variable Torque</b>							<b>Type F946</b>		<b>Type W946</b>		
1	7.5	7.5	10	10	10	150	HFD/FDC	24 (609.6) ③	4X	24 (609.6) ③	4X
2	10	15	25	25	25	150	HFD/FDC	24 (609.6) ③	4X	24 (609.6) ③	4X
3	25	30	50	50	50	150	HJD/JDC	36 (914.4) ③④	6X	36 (914.4) ③④	6X
4	40	50	75	100	100	150	HJD/JDC	36 (914.4) ③④	6X	36 (914.4) ③④	6X
5	50	60	100	125	150	250	HJD/JDC	72 (1828.8) ⑤	12X	72 (1828.8) ⑤	12X
	75	100	150	200	200	400	HKD/KDC				
<b>Two-Speed Two Winding, Constant/Variable Torque</b>							<b>Type F956</b>		<b>Type W956</b>		
1	7.5	7.5	10	10	10	150	HFD/FDC	24 (609.6)	4X	24 (609.6) ③	4X
2	10	15	25	25	25	150	HFD/FDC	24 (609.6)	4X	24 (609.6) ③	4X
3	25	30	50	50	50	150	HFD/FDC	30 (762.0)	5X	30 (762.0) ③	5X
4	30	40	60	75	100	150	HFD/FDC	30 (762.0)	5X	30 (762.0) ③	5X
	40	50	75	100	—	250	HJD/JDC	30 (762.0) ⑥	5X	30 (762.0) ③	5X
5	50	60	100	125	150	250	HJD/JDC	72 (1828.8) ⑤	12X	72 (1828.8) ⑤	12X
	75	100	150	200	200	400	HKD/KDC				
<b>Reduced Voltage Autotransformer</b>							<b>Type F606</b>		<b>Type W606</b>		
2	10	15	25	25	25	150	HFD/FDC	36 (914.4)	6X	36 (914.4)	6X
3	25	30	50	50	50	150	HFD/FDC	48 (1219.2)	8X	54 (1371.6)	9X
4	30	50	75	100	100	150	HJD/JDC	54 (1371.6)	9X	54 (1371.6)	9X
5	50	60	100	125	150	250	HJD/JDC	72 (1828.8)	12X	72 (1828.8)	12X
	75	100	150	200	200	400	HKD/KDC				
6	150	200	300	400	400	600	HLD/LDC	72 (1828.8) ⑦	12X	72 (1828.8) ⑦	12X
7	—	300	—	600	600	1200	HND	72 (1828.8) ⑦	12X	72 (1828.8) ⑦	12X
<b>Reduced Voltage Part Winding</b>							<b>Type F706</b>		<b>Type W706</b>		
1PW	10	10	15	15	15	150	HFD/FDC	24 (609.6)	4X	24 (609.6) ⑧	4X
2PW	20	25	40	40	40	150	HFD/FDC	24 (609.6)	4X	24 (609.6) ⑧	4X
3PW	40	50	75	75	75	150	HFD/FDC	30 (762.0)	5X	30 (762.0) ⑧	5X
4PW	—	—	—	100	125	150	HFD/FDC	36 (914.4) ⑧	6X	36 (914.4) ⑧	6X
	60	60	125	150	150	250	HJD/JDC				
	75	75	150	—	—	400	HKD/KDC				
5PW	100	125	—	250	300	400	HKD/KDC	72 (1828.8) ⑦	12X	72 (1828.8) ⑦	12X
	150	150	250	350	350	600	HLD/LDC				
<b>Reduced Voltage Wye Delta Open Transition</b>							<b>Type F806</b>		<b>Type W806</b>		
2YD	20	25	40	40	40	150	HFD/FDC	30 (762.0)	5X	30 (762.0)	5X
3YD	30	40	75	75	75	150	HFD/FDC	42 (1066.8)	7X	42 (1066.8)	7X
	40	50	—	—	—	250	HJD/JDC				
4YD	60	75	125	150	150	250	HJD/JDC	48 (1219.2)	8X	42 (1066.8)	7X
	—	—	150	—	—	400	HKD/KDC				
5YD	100	125	200	250	300	400	HKD/KDC	72 (1828.8) ⑦	12X	72 (1828.8) ⑦	12X
	150	150	250	300	—	600	HLD/LDC				
<b>Reduced Voltage Wye Delta Closed Transition</b>							<b>Type F896</b>		<b>Type W896</b>		
2YD	20	25	40	40	40	150	HFD/FDC	42 (1066.8)	7X	42 (1066.8)	7X
3YD	40	50	—	—	—	250	HFD/FDC	54 (1371.6)	9X	54 (1371.6)	9X
4YD	60	75	125	150	150	250	HJD/JDC	60 (1524.0)	10X	60 (1524.0)	10X
	—	—	150	—	—	400	HKD/KDC				
5YD	100	125	200	250	300	400	HKD/KDC	72 (1828.8) ⑦	12X	72 (1828.8) ⑦	12X
	150	150	250	300	—	600	HLD/LDC				

① Standard Combination Starter Units with HMCP Magnetic Only disconnect have short circuit ratings of 65,000 amperes at 480 volts. Optional HMCP combination starter units are available with 100,000 amperes at 480 volts.

② Optional Combination Starter Units with Thermal-Magnetic breaker disconnects are available with either 65,000 amperes or 100,000 amperes at 480 volts.

③ Add 6-inch (152.4 mm) space for low speed disconnect.

④ 42-inch (1066.8 mm) space needed with Thermal-Magnetic Circuit Breaker. 48-inch (1219.2 mm) space needed with Thermal-Magnetic Circuit Breaker.

⑤ Requires 28-inch (711.2 mm) wide structure.

⑥ 36-inch (914.4 mm) space needed for Thermal-Magnetic Circuit Breaker.

⑦ Requires 21-inch (533.4 mm) deep, 28-inch (711.2 mm) wide structure.

⑧ For starting speed disconnect, add 6-inch (152.4 mm) space.

**Intelligent Technologies IT. Solid-State Reduced Voltage Starter — HMCP**

The IT. solid-state reduced voltage starter uses SCRs when starting and a low impedance run circuit during operation. The IT. solid-state starter has five 24 Vdc inputs and two relay outputs. IT. soft start units include a disconnect, starter, 24 Vdc power supply and 100 VA CPT.

**Motor Service Factor (SF) Effect on IT. Starter Selection**

- A 1.0 service factor motor may draw up to 1.00 x full load amperes.
- A 1.15 service factor motor may draw up to 1.15 x full load amperes. (15% more current.)
- IT. starters are current rated devices. In some cases, a larger IT. SSRV starter must be supplied for 1.15 SF motors. See the maximum horsepower chart below.

**Table 3. Standard Duty Ratings — Motor Circuit Protector Disconnect**

Ampere Rating	IT. Width (mm)	Maximum Horsepower or (kW)										HMCP/MCCB Frame	Unit Size Inches (mm)
		208 V		240 V		380 V		480 V		600 V			
		1.15 SF	1.0 SF	1.15 SF	1.0 SF	1.15 SF	1.0 SF	1.15 SF	1.0 SF	1.15 SF	1.0 SF		
<b>HMCP</b> ①													
37	65	10	10	10	10	15	18.5	20	25	30	30	100	12
66		15	20	20	20	30	30	40	50	50	60	100	(304.8)
105	110	30	30	30	40	45	55	60	75	75	100	150	18
135		40	40	40	50	—	—	75	100	100	125	150	(457.2)
135		—	—	—	—	55	75	—	—	—	—	250	
180	200	—	—	60	60	—	—	—	—	150	150	250	36
180		50	60	—	—	75	90	125	150	—	—	400	(914.4)
240		60	75	75	75	110	132	150	200	200	200	400	
304		75	100	100	100	—	—	200	250	250	300	400	
304		—	—	—	—	132	160	—	—	—	—	600	
360	290	125	125	125	150	160	200	—	—	300	350	600	54
420		150	150	—	—	200	220	300	350	350	450	600	(1371.6)
500		—	—	150	200	250	250	350	400	450	500	600	
650	290	200	200	200	250	315	375	450	500	600	600	1200	72
720		200	250	250	300	—	—	500	600	600	700	1200	(1828.8)
850		—	—	300	350	375	500	600	700	700	900	1200	
1000	290	—	—	350	400	500	560	700	800	900	1000	2000	72 ③③ (1828.8)

**Thermal-Magnetic Circuit Breaker Disconnect** ①

37	65	10	10	10	10	15	18.5	20	25	30	30	150	12
66		15	20	20	20	30	30	40	50	50	60	150	(304.8)
105	110	30	30	30	40	45	55	60	75	75	100	150	18
135		40	40	40	50	55	75	75	100	100	125	225	(457.2)
180	200	—	—	—	—	—	—	—	—	150	150	250	36
180		50	60	60	60	75	90	125	150	—	—	250	(914.4)
240		60	75	75	75	110	132	150	200	200	200	400	
304		75	100	100	100	—	—	—	—	—	—	400	
304		—	—	—	—	—	—	200	250	250	300	600	
360	290	125	125	125	150	160	200	—	—	300	350	600	72
420		150	150	—	—	200	220	300	350	350	450	600	(1828.8)
500		—	—	150	200	250	250	350	400	450	500	600	
650	290	200	200	—	—	—	—	450	500	600	600	800	72
650		—	—	200	250	315	375	—	—	—	—	1200	(1828.8)
720		200	250	250	300	—	—	500	600	600	700	1200	
850		—	—	300	350	375	500	600	700	700	900	1200	
1000	290	—	—	350	400	500	560	700	800	900	1000	2000	72 ③③ (1828.8)

① Standard duty ampere rating. See rating chart below.

② 28-inch (711.2 mm) wide structure.

③ Bottom exit only. Top exit unit is 24 inches (609.6 mm) wide (rear is unusable).

**Note:** Most motors used in industrial applications are 1.15 Service Factor (SF).

**Table 4. Option Sizing — Dimensions in Inches (mm)**

IT. Width (mm)	Disconnect Type	Starter Size	Option Unit Size ⑤	Structure Width
<b>Isolating Contactor</b>				
65	HMCP, MCCB	1,2,3	24 (609.6)	20 (508.0)
110	HMCP, MCCB	3,4	36 (914.4)	20 (508.0)
110	HMCP, MCCB	5	54 (1371.6)	20 (508.0)
200	HMCP, MCCB	5,6	72 (1828.8)	20 (508.0)
290	HMCP, MCCB	6	72 (1828.8)	32 (812.8)
290	HMCP, MCCB	7	72 (1828.8)	48 (1219.2)
<b>Bypass Starter</b>				
65	HMCP, MCCB	1,2,3	24 (609.6)	20 (508.0)
110	HMCP, MCCB	3,4	36 (914.4)	20 (508.0)
110	HMCP, MCCB	5	54 (1371.6)	20 (508.0)
200	HMCP, MCCB	5,6	72 (1828.8)	24 (609.6)
290	HMCP, MCCB	6	72 (1828.8)	32 (812.8)
290	HMCP, MCCB	7	72 (1828.8)	48 (1219.2)

**Note:** Unit size includes space for IT. starter and option.

**Table 5. Control Options**

Extra 50 VA Control Power Transformer ④⑤
24 Vdc Control ④
Line or Load MOV Protection ④
Pump Control Option ④
DeviceNet Communications Module ④⑤

④ Option fits in standard unit space.

⑤ Option adds 6 inches (1X) to 37 and 66 ampere units.

**Table 6. Standard Duty Ratings**

Ramp Current % of FLA	Ramp Time	Starts Per Hour	Similar to Starting Method
300%	30 Seconds	3	Soft Start Full Voltage Wye Delta
500%	10 Seconds	3	
350%	20 Seconds	3	
480%	20 Seconds	2	80% RVAT
390%	20 Seconds	3	65% RVAT
300%	20 Seconds	4	50% RVAT

**IT06 — Intelligent Technologies IT Solid-State Reduced Voltage Starter — HMCP**

The IT solid-state reduced voltage starter uses SCRs when starting and a low impedance run circuit during operation. The IT solid-state starter has five 24 Vdc inputs and two relay outputs. IT soft start units include a disconnect, starter, 24 Vdc power supply and 100 VA CPT.

**Motor Service Factor (SF) Effect on IT Starter Selection**

- A 1.0 service factor motor may draw up to 1.00 x full load amperes.
- A 1.15 service factor motor may draw up to 1.15 x full load amperes. (15% more current.)
- IT starters are current rated devices. In some cases, a larger IT SSRV starter must be supplied for 1.15 SF motors. See the maximum horsepower chart below.

**Table 7. Severe Duty Ratings — Motor Circuit Protector Disconnect**

Ampere Rating	IT Width (mm)	Maximum Horsepower or (kW)										HMCP/MCCB Frame	Unit Size Inches (mm)
		208 V		240 V		380 V		480 V		600 V			
		1.15 SF	1.0 SF	1.15 SF	1.0 SF	1.15 SF	1.0 SF	1.15 SF	1.0 SF	1.15 SF	1.0 SF		
<b>HMCP ①</b>													
22	65	5	5	5	7.5	7.5	11	10	15	15	20	100	12 (304.8)
42		10	10	10	15	18.5	22	25	30	30	40	100	
65	110	15	20	20	20	22	30	40	50	50	60	100	18 (457.2)
80		—	—	—	—	37	37	—	—	—	—	100	
80		20	25	25	30	—	—	50	60	60	75	150	
115	200	30	40	30	40	55	55	75	75	100	100	150	36 (914.4)
150		—	—	50	50	—	—	100	100	—	—	150	
150		40	50	—	—	55	75	—	—	125	150	250	
192		—	—	—	—	90	90	—	—	—	—	250	
192		50	60	60	75	—	—	125	125	150	200	400	
240	290	60	75	—	—	110	132	150	200	—	—	400	54 (1371.6)
305		75	100	100	100	132	160	200	250	250	300	400	
365		100	125	125	150	160	200	250	300	300	350	600	
420		125	150	—	—	200	220	300	350	350	450	600	
480		—	—	150	200	220	250	350	400	450	500	600	
525		—	—	—	—	—	—	350	450	—	—	600	
600	—	—	—	—	—	—	450	500	500	600	1200	72 ②③ (1828.8)	

**Thermal-Magnetic Circuit Breaker Disconnect ①**

22	65	5	5	5	7.5	7.5	11	10	15	15	20	150	12 (304.8)
42		10	10	10	15	18.5	22	25	30	30	40	150	
65	110	15	20	20	20	22	30	40	50	50	60	225	18 (457.2)
80		20	25	25	30	37	37	50	60	60	75	225	
115		30	40	30	40	55	55	75	75	100	100	400	
150	200	40	50	50	50	55	75	100	100	125	150	400	36 (914.4)
192		50	60	60	75	90	90	125	150	150	200	400	
240		60	75	—	—	110	132	150	200	—	—	600	
305	290	75	100	100	100	132	160	200	250	250	300	800	54 (1371.6)
365		100	125	125	150	160	200	250	300	300	350	1200	
420		125	150	—	—	200	220	300	350	350	450	1200	
480	290	—	—	150	200	220	250	350	400	450	500	1200	72 (1828.8)
525		—	—	—	—	—	—	350	450	—	—	1200	
600		—	—	—	—	—	—	450	500	500	600	1200	

① Severe duty ampere rating. See rating chart below.

② 28-inch (711.2 mm) wide structure.

③ Bottom exit only. Top exit unit is 24 inches (609.9 mm) wide (rear is unusable).

**Note:** Most motors used in industrial applications are 1.15 Service Factor (SF).

**Table 8. Option Sizing — Dimensions in Inches (mm)**

IT Width (mm)	Disconnect Type	Starter Size	Option Unit Size ②	Structure Width
<b>Isolating Contactor</b>				
65	HMCP, MCCB	1,2,3	24 (609.6)	20 (508.0)
110	HMCP, MCCB	3,4	36 (914.4)	20 (508.0)
110	HMCP, MCCB	5	54 (1371.6)	20 (508.0)
200	HMCP, MCCB	5,6	72 (1828.8)	20 (508.0)
290	HMCP, MCCB	6	72 (1828.8)	32 (812.8)
290	HMCP, MCCB	7	72 (1828.8)	48 (1219.2)
<b>Bypass Starter</b>				
65	HMCP, MCCB	1,2,3	24 (609.6)	20 (508.0)
110	HMCP, MCCB	3,4	36 (914.4)	20 (508.0)
110	HMCP, MCCB	5	54 (1371.6)	20 (508.0)
200	HMCP, MCCB	5,6	72 (1828.8)	24 (609.6)
290	HMCP, MCCB	6	72 (1828.8)	32 (812.8)
290	HMCP, MCCB	7	72 (1828.8)	48 (1219.2)

**Note:** Unit size includes space for IT starter and option.

**Table 9. Control Options**

Extra 50 VA Control Power Transformer ②③
24 Vdc Control ②
Line or Load MOV Protection ②
Pump Control Option ②
DeviceNet Communications Module ②③

② Option fits in standard unit space.

③ Option adds 6 inches (1X) to 37 and 66 ampere units.

**Table 10. Severe Duty Ratings**

Ramp Current % of FLA	Ramp Time	Starts Per Hour	Similar to Starting Method
450%	30 Seconds	4	Soft Start
500%	10 Seconds	10	Full Voltage
350%	65 Seconds	3	Wye Delta
480%	25 Seconds	4	80% RVAT
390%	40 Seconds	4	65% RVAT
300%	60 Seconds	4	50% RVAT

Table 11. Combination Starters with Fusible Switches — Dimensions in Inches (mm)

NEMA Size	Maximum Horsepower					Switch Rating ①	Freedom		Advantage	
	208 V	240 V	380 V	480 V	600 V		Unit Size		Unit Size	
							Inches (mm)	X Space	Inches (mm)	X Space
<b>Full Voltage Non-Reversing — Fusible</b>							<b>Type F204</b>		<b>Type W204</b>	
1	7.5	7.5	10	10	10	30	6 (152.4) ⑩ 12 (304.8) ② 18 (457.2)	1X 2X ② 3X	6 (152.4) ⑩ 12 (304.8) ② 18 (457.2)	1X 2X ② 3X
2	10	15	25	25	25	60	12 (304.8) ② 18 (457.2)	2X ② 3X	12 (304.8) ② 18 (457.2)	2X ② 3X
3	25	30	50	50	50	100	24 (609.6)	4X	24 (609.6)	4X
4	40	50	75	100	100	200	36 (914.4)	6X	36 (914.4)	6X
5	75	100	150	200	200	400 ③	60 (1524.0)	10X	54 (1371.6)	9X
6	150	200	300	400	400	600	66 (1676.4) ④ 72 (1828.0) ⑤	11X 12X	60 (1524.0)	10X
<b>Full Voltage Reversing — Fusible</b>							<b>Type F214</b>		<b>Type W214</b>	
1	7.5	7.5	10	10	10	30	24 (609.6)	4X	24 (609.6)	4X
2	10	15	25	25	25	60	24 (609.6)	4X	24 (609.6)	4X
3	25	30	50	50	50	100	30 (762.0)	5X	30 (762.0)	5X
4	40	50	75	100	100	200	54 (1371.6)	9X	48 (1219.2)	8X
5	75	100	150	200	200	400	72 (1828.0) ⑤	12X	72 (1828.0) ⑤	12X
6	150	200	300	400	400	600	72 (1828.0) ⑤	12X	72 (1828.0) ⑤	12X
<b>Two-Speed One Winding — Fusible</b>							<b>Type F944</b>		<b>Type W944</b>	
1	7.5	7.5	10	10	10	30	24 (609.6)	4X	24 (609.6)	4X
2	10	15	25	25	25	60	24 (609.6)	4X	24 (609.6)	4X
3	25	30	—	30	50	60	36 (914.4)	6X	36 (914.4)	6X
	25	30	50	50	50	100				
4	—	—	—	—	60	100	60 (1524.0)	10X	54 (1371.6)	9X
	40	50	75	100	100	200				
5	75	100	150	200	200	400	72 (1828.0) ⑥	12X	72 (1828.0) ⑥	12X
<b>Two-Speed Two Winding — Fusible</b>							<b>Type F954</b>		<b>Type W954</b>	
1	7.5	7.5	10	10	10	30	24 (609.6)	4X	24 (609.6)	4X
2	10	15	25	25	25	60	30 (762.0)	5X	24 (609.6)	4X
3	—	—	—	—	30	60	30 (762.0)	5X	30 (762.0)	5X
	25	30	50	50	50	100				
4	—	—	—	—	30	60	36 (914.4) ⑦	6X	36 (914.4)	6X
	25	30	50	50	50	100				
5	40	50	75	100	100	200	54 (1371.6) ⑧	9X	48 (1219.2)	8X
6	75	100	150	200	200	400	72 (1828.0) ⑥	12X	72 (1828.0) ⑥	12X
<b>Reduced Voltage Autotransformer — Fusible</b>							<b>Type F604</b>		<b>Type W604</b>	
2	10	15	25	25	25	60	36 (914.4)	6X	36 (914.4)	6X
3	25	30	50	50	50	100	60 (1524.0)	10X	54 (1371.6)	8X
4	40	50	75	100	100	200	72 (1828.0) ⑧	12X	72 (1828.0) ⑧	12X
5	75	100	150	200	200	400	72 (1828.0) ⑧	12X	72 (1828.0) ⑧	12X
6	150	200	300	400	400	600	72 (1828.0) ⑨	12X	72 (1828.0) ⑨	12X

① Combination fused starter units rated 100 kAIC short circuit current.  
 ② 12-inch (304.8 mm)/2X unit is standard.  
 ③ Certain items in unit option Groups B and C may require additional space. See Page 27.  
 ④ For bottom entry of motor cables.  
 ⑤ For top entry of motor cables.  
 ⑥ Requires 28-inch (711.2 mm) wide structure.  
 ⑦ Add 6-inch (152.4 mm) space for low speed fuses.  
 ⑧ Add 12-inch (304.8 mm) space for low speed fuses.  
 ⑨ Bottom 24-inch (609.6 mm) space in rear is unusable.  
 ⑩ Requires 28-inch (711.2 mm) wide and 21-inch (533.4 mm) deep structure.  
 ⑪ Maximum of (3) pilot devices, (2) auxiliary contacts; 100 VA CPT, standard lugs only.

**Table 11. Combination Starters with Fusible Switches (Continued)**

NEMA Size	Maximum Horsepower					Switch Rating ①	Freedom		Advantage	
	208 V	240 V	380 V	480 V	600 V		Unit Size		Unit Size	
							Inches (mm)	X Space	Inches (mm)	X Space
<b>Reduced Voltage Part Winding — Fusible</b>						<b>Type F704</b>		<b>Type W704</b>		
1PW	10	10	15	15	15	60	24 (609.6)	4X	24 (609.6)	4X
2PW	—	15	25	30	40	60	24 (609.6)	4X	24 (609.6)	4X
3PW	—	—	—	50	60	100	48 (1219.2)	8X	48 (1219.2)	8X
4PW	50	—	100	100	150	200	54 (1371.6)	9X	48 (1219.2)	8X
5PW	100	100	200	250	300	400	72 (1828.8) ②	12X ②	72 (1828.8) ②	12X ②
<b>Reduced Voltage Wye Delta Open Transition — Fusible</b>						<b>Type F804</b>		<b>Type W804</b>		
2YD	15	15	30	40	40	60	36 (914.4)	6X	36 (914.4)	6X
3YD	25	30	50	60	75	100	54 (1371.6)	9X	54 (1371.6)	9X
4YD	50	60	100	125	150	200	72 (1828.8) ②	12X ②	60 (1524.0)	10X
5YD	100	125	200	250	300	400	72 (1828.8) ②	12X ②	72 (1828.8) ②	12X ②
6YD	—	—	—	—	350	400	72 (1828.8) ③	12X ③	72 (1828.8) ③	12X ③
	250	200	350	400	500	600				
	300	350	400	500	700	800				
			500	700	700	1200				
<b>Reduced Voltage Wye Delta Closed Transition — Fusible</b>						<b>Type F894</b>		<b>Type W894</b>		
2YD	15	15	30	40	40	60	48 (1219.2)	8X	48 (1219.2)	8X
3YD	25	30	50	60	75	100	66 (1676.4)	11X	66 (1676.4)	11X
4YD	50	60	100	125	150	200	72 (1828.8) ②	12X ②	72 (1828.8) ②	12X ②
5YD	100	125	200	250	300	400	72 (1828.8) ②	12X ②	72 (1828.8) ②	12X ②
6YD	—	—	—	—	350	400	72 (1828.8) ③	12X ③	72 (1828.8) ③	12X ③
	250	200	350	400	500	600				
	300	350	400	500	700	800				
			500	700	700	1200				

① Combination fused starter units rated 100 kAIC short circuit current.  
 ② Requires 28-inch (711.2 mm) wide structure.  
 ③ Requires 28-inch (711.2 mm) wide and 21-inch (533.4 mm) deep section.

**Intelligent Technologies /I/. Solid-State  
Reduced Voltage Starter — Fusible Switch**

The /I/. solid-state reduced voltage starter uses SCRs when starting and a low impedance run circuit during operation. The /I/. solid-state starter has five 24 Vdc inputs and two relay outputs. /I/. soft start units include a disconnect, starter, 24 Vdc power supply and 100 VA CPT.

**Motor Service Factor (SF) Effect on /I/. Starter Selection**

- A 1.0 service factor motor may draw up to 1.00 x full load amperes.
- A 1.15 service factor motor may draw up to 1.15 x full load amperes. (15% more current.)
- /I/. starters are current rated devices. In some cases, a larger /I/. SSRV starter must be supplied for 1.15 SF motors. See the maximum horsepower chart below.

**Table 12. Standard Duty Ratings — Fusible Disconnect ①**

Ampere Rating	/I/. Width (mm)	Maximum Horsepower (kW)										Switch Rating	Unit Size Inches (mm)
		208 V		240 V		380 V		480 V		600 V			
		1.15 SF	1.0 SF	1.15 SF	1.0 SF	1.15 SF	1.0 SF	1.15 SF	1.0 SF	1.15 SF	1.0 SF		
37 66	65	10 15	10 20	10 20	10 20	15 30	18.5 30	20 40	25 50	30 50	30 60	30/60 100	18 (457.2)
105 135	110	30 40	30 40	30 40	40 50	45 55	55 75	60 75	75 100	75 100	100 125	200 200	30 (762.0)
180 240 304 304	200	50 60 — 75	60 75 — 100	60 75 100 —	60 75 100 —	75 110 — 132	90 132 — 160	125 150 — 200	150 200 — 250	150 200 — 250	150 200 — 300	400 400 400 600	60 (1524.0)
360 420 420 500	290	125 — 150 —	100 — 125 —	125 — — 150	150 — — 200	160 200 — 250	200 220 — 250	— — 300 350	— — 350 400	— — 350 450	350 — 450 500	600 600 800 800	72 (1828.8)
650 720 850	290	200 200 —	200 250 —	200 250 300	250 300 350	315 — 375	375 — 500	450 500 600	500 600 700	600 600 700	600 700 900	1200 1200 1200	72 (1828.8)
1000	290	—	—	350	400	500	560	700	800	900	1000	1200	72 ②③ (1828.8)

① Standard duty ampere rating. See rating chart below.  
 ② 28-inch (711.2 mm) wide structure.  
 ③ Bottom exit only. Top exit unit is 24 inches (609.6 mm) wide (rear is unusable).  
**Note:** Most motors used in industrial applications are 1.15 Service Factor (SF).

**Table 13. Control Options**

Extra 50 VA Control Power Transformer ④
24 Vdc Control ④
Line or Load MOV Protection ④
Pump Control Option ④
DeviceNet Communications Module ④

④ Option fits in standard unit space.

**Table 14. Standard Duty Ratings**

Ramp Current % of FLA	Ramp Time	Starts Per Hour	Similar to Starting Method
300%	30 Seconds	3	Soft Start
500%	10 Seconds	3	Full Voltage
350%	20 Seconds	3	Wye Delta
480%	20 Seconds	2	80% RVAT
390%	20 Seconds	3	65% RVAT
300%	20 Seconds	4	50% RVAT

**Table 15. Option Sizing for Isolating Contactor and Bypass Starter**

/I/. Width (mm)	Fused Switch Type	Starter Size	Option Unit Size (Inches) ⑤	Structure Width Inches (mm)
65	30/60/100 A	1,2,3	36 (914.4)	20 (508.0)
110	100 A	3	36 (914.4)	20 (508.0)
110	200 A	4	54 (1371.6)	20 (508.0)
200	400/800 A	5,6	72 (1828.8)	32 (812.8)
290	600/800 A	6	72 (1828.8)	36 (914.4)
290	800/1200 A	7	72 (1828.8)	64 (1625.6)

⑤ Unit size includes space for /I/. starter and option.

**Intelligent Technologies *IT*. Solid-State  
Reduced Voltage Starter — Fusible**

The *IT*. solid-state reduced voltage starter uses SCRs when starting and a low impedance run circuit during operation. The *IT*. solid-state starter has five 24 Vdc inputs and two relay outputs. *IT*. soft start units include a disconnect, starter, 24 Vdc power supply and 100 VA CPT.

**Motor Service Factor (SF) Effect on *IT*. Starter Selection**

- A 1.0 service factor motor may draw up to 1.00 x full load amperes.
- A 1.15 service factor motor may draw up to 1.15 x full load amperes. (15% more current.)
- *IT*. starters are current rated devices. In some cases, a larger *IT*. SSRV starter must be supplied for 1.15 SF motors. See the maximum horsepower chart below.

**Table 16. Severe Duty Ratings — Fusible ①**

Ampere Rating	<i>IT</i> . Width (mm)	Maximum Horsepower (kW)										Switch Rating	Unit Size (Inches)
		208 V		240 V		380 V		480 V		575 V			
		1.15 SF	1.0 SF	1.15 SF	1.0 SF	1.15 SF	1.0 SF	1.15 SF	1.0 SF	1.15 SF	1.0 SF		
22	65	5	5	5	7.5	7.5	11	10	15	15	20	30/60 30/60 100	18 (457.2)
42		10	10	—	—	—	—	—	—	—	—		
42		—	—	10	15	18.5	22	25	30	30	40		
65	110	15	20	20	20	22	30	40	50	50	60	200 200	30 (762.0)
80		20	25	25	30	37	37	50	60	60	75		
115	200	—	—	—	—	—	—	75	75	100	100	200 400 400 400	60 (1524.0)
115		30	40	30	40	55	55	100	100	—	—		
150		40	50	50	50	55	75	—	—	125	150		
192		50	60	60	75	90	90	125	150	150	200		
240	290	60	75	—	—	110	132	150	200	—	—	600 600 800 800 800 1200 1200	72 (1828.8)
305		75	100	100	100	132	160	200	250	250	300		
365		100	125	125	150	160	200	250	300	300	350		
420		125	150	—	—	200	220	300	350	350	450		
480		—	—	—	—	220	250	—	—	—	—		
480		—	—	150	200	—	—	350	400	450	500		
525		—	—	—	—	—	—	350	450	—	—		
600	290	—	—	—	—	—	—	450	500	500	600	1200	72 ②③

- ① Severe duty ampere rating. See rating chart below.
  - ② 28-inch (711.2 mm) wide structure.
  - ③ Bottom exit only. Top exit unit is 24 inches (609.6 mm) wide (rear is unusable).
- Note:** Most motors used in industrial applications are 1.15 Service factor (SF).

**Table 17. Control Options**

Extra 50 VA Control Power Transformer ④
24 Vdc Control ④
Line or Load MOV Protection ④
Pump Control Option ④
DeviceNet Communications Module ④

④ Option fits in standard unit space.

**Table 18. Severe Duty Ratings**

Ramp Current % of FLA	Ramp Time	Starts Per Hour	Similar to Starting Method
450%	30 Seconds	4	Soft Start
500%	10 Seconds	10	Full Voltage
350%	65 Seconds	3	Wye Delta
480%	25 Seconds	4	80% RVAT
390%	40 Seconds	4	65% RVAT
300%	60 Seconds	4	50% RVAT

**Table 19. Option Sizing for Isolating Contactor and Bypass Starter**

<i>IT</i> . Width (mm)	Fused Switch Type	Starter Size	Option Unit Size (Inches) ⑤	Structure Width (Inches)
65	30/60/100 A	1,2,3	36 (914.4)	20 (508.0)
110	100 A	3	36 (914.4)	20 (508.0)
110	200 A	4	54 (1371.6)	20 (508.0)
200	400/800 A	5,6	72 (1828.8)	32 (812.8)
290	600/800 A	6	72 (1828.8)	36 (914.4)
290	800/1200 A	7	72 (1828.8)	64 (1625.6)

⑤ Unit size includes space for *IT*. starter and option.

**AF91 Adjustable Frequency Drives**

Maximum motor lead length is 500 feet (152 m). Drives are dual rated CT and VT with 150% Overload for 1 minute. Standard unit includes disconnect, 1% line reactor, 50 VA CPT, a 1.5% output reactor, and provisions for a control relay. Output reactor is not required if using an inverter duty motor.

- All AF91 units are Plug-in for 20-inch (508 mm) wide structures.
- Maximum motor lead length is 500 feet (152 m).
- Firmly connect each drive chassis to an earthed ground. Grounding conduit does not provide adequate grounding.
- Use separate conduit for output power conductors and digital and analog control signals. Within the MCC, care should be taken in routing power and control wiring.

**Table 20. AF91 Adjustable Frequency Drives — Dimensions in Inches (mm)**

Maximum Hp	Maximum Amperes	CB Type	Standard Unit Space		Typical Option Space		Maximum Option Space	
			Inches (mm)	X Space	Inches (mm)	X Space	Inches (mm)	X Space
<b>460 V Application (+/- 10%)</b>								
.5	1.5	HMCP or MCCB	18 (457.2)	3 (76.2)	30 (762.0)	5 (127.0)	42 (1066.8)	7 (177.8)
1	2.5		18 (457.2)	3 (76.2)	30 (762.0)	5 (127.0)	42 (1066.8)	7 (177.8)
2	3.8		18 (457.2)	3 (76.2)	30 (762.0)	5 (127.0)	42 (1066.8)	7 (177.8)
3	5.5		18 (457.2)	3 (76.2)	30 (762.0)	5 (127.0)	42 (1066.8)	7 (177.8)
5	8.6		18 (457.2)	3 (76.2)	30 (762.0)	5 (127.0)	42 (1066.8)	7 (177.8)
<b>208/240 V Application</b>								
.25	1.4	HMCP or MCCB	18 (457.2)	3 (76.2)	30 (762.0)	5 (127.0)	42 (1066.8)	7 (177.8)
.5	2.6		18 (457.2)	3 (76.2)	30 (762.0)	5 (127.0)	42 (1066.8)	7 (177.8)
1	4		18 (457.2)	3 (76.2)	30 (762.0)	5 (127.0)	42 (1066.8)	7 (177.8)
2	7.1		18 (457.2)	3 (76.2)	30 (762.0)	5 (127.0)	42 (1066.8)	7 (177.8)
3	10		18 (457.2)	3 (76.2)	30 (762.0)	5 (127.0)	42 (1066.8)	7 (177.8)
5	15.9		18 (457.2)	3 (76.2)	30 (762.0)	5 (127.0)	42 (1066.8)	7 (177.8)

**Note:** 3% line reactors should be used where Power Factor Correction Capacitors are an integral part of the MCC Line Power.

**Table 21. AF91 Options**

Description	Units with Space
Viewing Window	①②
Output Contactor	②③
Manual 3 Contactor Bypass	③④
3 or 5% Line Reactors ⑤	②③
Door Mounted Keypad	①②③
Door Mounted Display	③
Oversized CPT	②③
Fusible Disconnect	②③
Line Fuses	③④
Dual Overloads	②③
EMI Filter	③
1 Control Relay	①②③
2 Control Relays	②③
3 Control Relays	③

- ① Standard unit.
- ② Typical option unit.
- ③ Maximum option unit.
- ④ Only one of these options can fit in the typical option unit.
- ⑤ Three or 5% line reactors should be used where power factor correction capacitors are an integral part of the MCC lineup.

**SV9000 1 – 30 Hp at 480 V Plug-in Adjustable Frequency Drive Units**

All standard units include a disconnect, an ac choke, output reactor and a door-mounted keypad. All plug-in units have a built-in Dynamic Braking Circuit, M3 frame Standard unit drives do not include a CPT.

**Note:** Output reactor not included on 240 V units. Standard on 380 – 500 V drives up to 125 hp (CT rating).

**CT:** Constant Torque drives are capable of producing 200% starting torque for 10 seconds and are rated 150% overload for one minute.

**VT:** Variable Torque drives are capable of producing 200% starting torque for 10 seconds and are rated 110% overload for one minute.

**Table 22. SV9000 Adjustable Frequency Drives — Dimensions in Inches (mm)**

CT/VT Amperes	Nominal Hp CT/VT or (kW)	CB Type ①	Standard Unit Space	Standard Unit Space (X)	Typical Options Space ①	Typical Option Unit Space (X)	Maximum Option Unit Space	Maximum Option Unit Space (X)	
<b>200V – 230 V</b>									
3.6	.75	HMCP or MCCB	18 (457.2)	3X	30 (762.0)	5X	36 (914.4)	6X	
4.7	1		18 (457.2)	3X	30 (762.0)	5X	36 (914.4)	6X	
5.6	1.5		18 (457.2)	3X	30 (762.0)	5X	36 (914.4)	6X	
7	2		18 (457.2)	3X	30 (762.0)	5X	36 (914.4)	6X	
10	3		24 (609.6)	4X	36 (914.4)	6X	42 (1066.8)	7X	
16	5		24 (609.6)	4X	36 (914.4)	6X	42 (1066.8)	7X	
22	7.5		24 (609.6)	4X	36 (914.4)	6X	42 (1066.8)	7X	
30	10		36 (914.4)	6X	48 (1219.2)	8X	54 (1371.6)	9X	
43	15		36 (914.4)	6X	48 (1219.2)	8X	54 (1371.6)	9X	
57	20		36 (914.4)	6X	48 (1219.2)	8X	54 (1371.6)	9X	
<b>380V – 415 V</b>									
2.5	.75		HMCP or MCCB	18 (457.2)	3X	30 (762.0)	5X	36 (914.4)	6X
3.5	1.1	18 (457.2)		3X	30 (762.0)	5X	36 (914.4)	6X	
4.5	1.5	18 (457.2)		3X	30 (762.0)	5X	36 (914.4)	6X	
6.5	2.2	18 (457.2)		3X	30 (762.0)	5X	36 (914.4)	6X	
8	3	24 (609.6)		4X	36 (914.4)	6X	42 (1066.8)	7X	
10	4	24 (609.6)		4X	36 (914.4)	6X	42 (1066.8)	7X	
13	5.5	24 (609.6)		4X	36 (914.4)	6X	42 (1066.8)	7X	
18	7.5	24 (609.6)		4X	36 (914.4)	6X	42 (1066.8)	7X	
24	11	36 (914.4)		6X	48 (1219.2)	8X	54 (1371.6)	9X	
32	15	36 (914.4)		6X	48 (1219.2)	8X	54 (1371.6)	9X	
42	18.5	36 (914.4)		6X	48 (1219.2)	8X	54 (1371.6)	9X	
48	22	36 (914.4)		6X	48 (1219.2)	8X	54 (1371.6)	9X	
<b>440V – 500 V</b>									
2.5	1	HMCP or MCCB	18 (457.2)	3X	30 (762.0)	5X	36 (914.4)	6X	
3	1.5		18 (457.2)	3X	30 (762.0)	5X	36 (914.4)	6X	
3.5	2		18 (457.2)	3X	30 (762.0)	5X	36 (914.4)	6X	
5	3		18 (457.2)	3X	30 (762.0)	5X	36 (914.4)	6X	
8	5		24 (609.6)	4X	36 (914.4)	6X	42 (1066.8)	7X	
11	7.5		24 (609.6)	4X	36 (914.4)	6X	42 (1066.8)	7X	
15	10		24 (609.6)	4X	36 (914.4)	6X	42 (1066.8)	7X	
21	15		24 (609.6)	4X	36 (914.4)	6X	42 (1066.8)	7X	
27	20		36 (914.4)	6X	48 (1219.2)	8X	54 (1371.6)	9X	
34	25		36 (914.4)	6X	48 (1219.2)	8X	54 (1371.6)	9X	
40	30		36 (914.4)	6X	48 (1219.2)	8X	54 (1371.6)	9X	

① For fusible disconnect use typical option unit.

**Note:** Drive units fit into a standard 20-inch (508.0 mm) wide MCC structure.

**Table 23. Plug-in Options**

Plug-in Options	
<b>Option Boards ②</b>	
I/O Expander	③
Encoder Expander	③
Interbus S Communications	③
Modbus <sup>®</sup> -RTU Communications	③
PROFIBUS <sup>®</sup> Communications	③
Lonbus Communications	③
SDS <sup>™</sup> Communications	③
DeviceNet Communications	④
Metasys <sup>®</sup> N2 Communications	③
Siemens <sup>®</sup> Apogee FLN Communications	③
<b>Plug-in Control Relays</b>	
1 Relay	⑤
2 Relays	⑤
3 Relays	⑥
Speed Pot	④
Speed Pot and HOA Selector Switch	④
<b>Other Options</b>	
Automatic Bypass Circuit	⑦
Bypass Drive Test Switch	⑦
7 Relay 120V Control W/CPT	⑧
Isolated Signal Processor	③
3-15 PSIG Interface	③
Dynamic Breaking Resistors	⑧
Graphics Keypad	④
Line Fuses	③⑤
RFI Filter	④
Deduct to Remove Output Filter	⑥
KLC 2000 ft. dV/dT Filter	⑥
Output Contactor	③
Dual Overloads	③⑥
3 Contactor Bypass	③⑥
Solid-State Starter Bypass	⑥
<b>RWT Filter</b>	
NEMA 1	⑩
NEMA 4X, Class 1, Division 2	⑩

② Only one option board per drive can be selected.

③ All options will fit in Typical and maximum option unit.

④ This option will fit in all units.

⑤ One of these options will fit in 5 – 30 hp CT at 480 V frame standard units, 1 – 30 hp CT at 480 V Typical and maximum option units.

⑥ All options will fit in maximum option unit.

⑦ Use with bypass option.

⑧ DB resistors are to be mounted by the customer external to the MCC.

⑨ Not available for 240 V units.

⑩ RWT is mounted at the motor. See **Section 35** of the *Cutler-Hammer Consulting Application Guide, 13th Edition* for Reflected Wave Trap (RWT).

**Note:** Output reactor or dV/dT filter not required for motor lead lengths shorter than 100 feet (30.4 m) — 30 feet (9.1 m) for 2 hp and below, or when a RWT filter is used at the motor.

**Note:** Maximum motor lead length is 160 feet (48.8 m) for 1.5 hp and below, 330 feet (100.6 m) for 2 hp and 400 feet (121.9 m) for 3 hp and larger when using a standard output reactor.

**Note:** Motor lead lengths up to 2000 feet (609.6 m) can be achieved by using the KLC dV/dT filter.

**SV9000 30 – 200 Hp at 480 V Non-Plug-in Adjustable Frequency Drive Units**

All standard units include a disconnect, a line reactor, output reactor and a door-mounted keypad. Standard units of 9X unit space must be located in the bottom of the MCC and there is no vertical bus in the lower 48 inches (1219.2 mm). There is no vertical bus for 12X units.

**Note:** Output reactor not included on 200 – 240 V units. Standard on 380 – 690 V drives up to 125 hp (CT rating).

**CT:** Constant Torque drives are capable of producing 200% starting torque for 10 seconds and are rated 150% overload for one minute.

**VT:** Variable Torque drives are capable of producing 200% starting torque for 10 seconds and are rated 110% overload for one minute.

**Table 24. SV9000 Adjustable Frequency Drives — Dimensions in Inches (mm)**

CT Amperes	Nominal Hp or CT (kW)	VT Amps	Nominal Hp or VT (kW)	CB Type ①	Standard Unit Space	Standard Unit Space (X)	Options Space	Drive Options Space (X)
<b>200V – 230 V</b>								
—	—	70	25	HMCP or MCCB	54 (1371.6)	9X	72 (1828.8)	12X
70	25	83	30		54 (1371.6)	9X	72 (1828.8)	12X
83	30	113	40		54 (1371.6)	9X	72 (1828.8)	12X
113	40	139	50		72 (1828.8)	12X	72 (1828.8) ③	12X
139	50	165	60		72 (1828.8)	12X	72 (1828.8) ③	12X
165	60	200	75		72 (1828.8)	12X	72 (1828.8) ③	12X
200	75	264	100		72 (1828.8) ②	12X	72 (1828.8) ④	12X
—	—	—	—		72 (1828.8) ②	12X	72 (1828.8) ④	12X
<b>380V – 415 V, 50/60Hz</b>								
—	—	60	30	HMCP or MCCB	54 (1371.6)	9X	72 (1828.8)	12X
60	30	75	37		54 (1371.6)	9X	72 (1828.8)	12X
75	37	90	45		54 (1371.6)	9X	72 (1828.8)	12X
90	45	—	—		54 (1371.6)	9X	72 (1828.8)	12X
—	—	110	55		72 (1828.8)	12X	72 (1828.8) ③	12X
110	55	150	75		72 (1828.8)	12X	72 (1828.8) ③	12X
150	75	180	90		72 (1828.8)	12X	72 (1828.8) ③	12X
180	90	—	—		72 (1828.8)	12X	72 (1828.8) ③	12X
—	—	210	110		72 (1828.8) ②	12X	72 (1828.8) ④	12X
210	110	270	132		72 (1828.8) ②	12X	72 (1828.8) ④	12X
270	132	325	160		72 (1828.8) ②	12X	72 (1828.8) ④	12X
325	160	410	200		72 (1828.8) ②	12X	72 (1828.8) ④	12X
<b>440V – 500 V, 50/60 Hz</b>								
—	—	52	40	HMCP or MCCB	54 (1371.6)	9X	72 (1828.8)	12X
52	40	65	50		54 (1371.6)	9X	72 (1828.8)	12X
65	50	77	60		54 (1371.6)	9X	72 (1828.8)	12X
77	60	96	75		54 (1371.6)	9X	72 (1828.8)	12X
96	75	125	100		72 (1828.8)	12X	72 (1828.8) ③	12X
125	100	160	125		72 (1828.8)	12X	72 (1828.8) ③	12X
160	125	180	150		72 (1828.8)	12X	72 (1828.8) ③	12X
180	150	—	—		72 (1828.8) ②	12X	72 (1828.8) ④	12X
—	—	250	200		72 (1828.8) ②	12X	72 (1828.8) ④	12X
260	200	320	250		72 (1828.8) ②	12X	72 (1828.8) ④	12X
<b>525V – 690 V, 50/60 Hz</b>								
4.5	3	—	—	HMCP or MCCB	36 (914.4)	6X	72 (1828.8)	12X
—	—	7.5	5		36 (914.4)	6X	72 (1828.8)	12X
7.5	5	10	7.5		36 (914.4)	6X	72 (1828.8)	12X
10	7.5	14	10		36 (914.4)	6X	72 (1828.8)	12X
14	10	19	15		36 (914.4)	6X	72 (1828.8)	12X
19	15	23	20		36 (914.4)	6X	72 (1828.8)	12X
23	20	26	25		36 (914.4)	6X	72 (1828.8)	12X
26	25	35	30		36 (914.4)	6X	72 (1828.8)	12X
35	30	42	40		54 (1371.6)	9X	72 (1828.8)	12X
42	40	52	50		54 (1371.6)	9X	72 (1828.8)	12X
52	50	62	60		54 (1371.6)	9X	72 (1828.8)	12X
62	60	—	—		54 (1371.6)	9X	72 (1828.8)	12X
—	—	85	75		72 (1828.8) ②	12X	72 (1828.8) ④	12X
85	75	100	100		72 (1828.8) ②	12X	72 (1828.8) ④	12X
100	100	122	125		72 (1828.8) ②	12X	72 (1828.8) ④	12X
122	125	145	150		72 (1828.8) ②	12X	72 (1828.8) ④	12X
145	150	—	—		72 (1828.8) ②	12X	72 (1828.8) ④	12X

① Drives with Fusible disconnects require drive with option space.  
 ② 28-inch (711.2 mm) wide, 21-inch (533.4 mm) deep enclosure with bolt-in panel.  
 ③ All options will fit in option unit.  
 ④ 40-inch wide (1016.0 mm), 21-inch (533.4 mm) deep enclosure with bolt-in panel.

**Table 25. Non Plug-in Options**

Non Plug-in Options	
<b>Option Boards ⑤</b>	
I/O Expander	⑥
Encoder Expander	⑥
Interbus S Communications	⑥
Modbus-RTU Communications	⑥
PROFIBUS Communications	⑥
Lonbus Communications	⑥
SDS Communications	⑥
DeviceNet Communications	⑥
Metasys N2 Communications	③
Siemens Apogee FLN Communications	③
<b>Plug-in Control Relays</b>	
1 Relay	⑥
2 Relays	⑥
3 Relays	⑥
Speed Pot	④
Speed Pot and HOA Selector Switch	④
<b>Other Options</b>	
Automatic Bypass Circuit	⑦
Bypass Drive Test Switch	⑦
7 Relay 120 V Control W/CPT	⑥
Isolated Signal Processor	⑥
3-15 PSIG Interface	⑥
Dynamic Breaking Resistors	⑥
Graphics Keypad	⑥
Line Fuses	⑥
RFI Filter	⑥
Deduct to Remove Output Filter	⑧
KLC 1000 ft. dV/dT Filter	⑥
Output Contactor	⑥
Dual Overloads	⑥
3 Contactor Bypass	⑥
Solid-State Starter Bypass	⑥
Dynamic Breaking Circuit	⑥
<b>RWT Filter</b>	
NEMA 1	⑩
NEMA 4X, Class 1, Division 2	⑩

⑤ Only one option board per drive can be selected.  
 ⑥ This option will fit in all units.  
 ⑦ Use with bypass option.  
 ⑧ All options will fit in option unit.  
 ⑨ DB resistors are to be mounted by the customer external to the MCC.  
 ⑩ Not available for 240 V units.  
 ⑪ RWT is mounted at the motor.  
**Note:** Output reactor or dV/dT filter not required for motor lead lengths shorter than 100 feet (30.4 m) — 30 feet (9.1 m) for 2 hp and below, or when a RWT filter is used at the motor.  
**Note:** Maximum motor lead length is 160 feet (48.8 m) for 1.5 hp and below, 330 feet (100.6 m) for 2 hp and 400 feet (121.9 m) for 3 hp and larger when using a standard output reactor.  
**Note:** Motor lead lengths up to 2000 feet (609.6 m) can be achieved by using the KLC dV/dT filter.  
**Note:** Fusible units take option unit space. Not all options will fit in fusible units.

**SV9000 200 – 1100 Hp at 480 V Multi-Structure Adjustable Frequency Drive Units**

All standard units include a disconnect, a line reactor, and a door-mounted keypad. Disconnect and drive unit are in separate structures, structures are mechanically interlocked. Structures have no vertical bus. These drives are bottom exit only.

**CT:** Constant Torque drives are capable of producing 200% starting torque for 10 seconds and are rated 150% overload for one minute.

**VT:** Variable Torque drives are capable of producing 200% starting torque for 10 seconds and are rated 110% overload for one minute.

**Table 26. SV9000 Adjustable Frequency Drives — Dimensions in Inches (mm)**

CT Amperes	Nominal Hp or CT (kW)	VT Amperes	Nominal Hp or VT (kW)	CB Type ①	Standard Unit Space	Standard Unit Space (X)	Options Space	Drive Options Space (X)	
<b>380V – 415 V</b>									
410	(200)	510	(250)	MCCB	72 (1828.8) ②	12X	72 (1828.8) ③	12X	
510	(250)	580	(315)		72 (1828.8) ②	12X	72 (1828.8) ③	12X	
600	(315)	750	(400)		72 (1828.8) ④	12X	⑤	12X	
750	(400)	840	(500)		72 (1828.8) ④	12X	⑤	12X	
840	(500)	1050	(630)		72 (1828.8) ⑤	12X	⑥	12X	
1050	(630)	1270	(710)		72 (1828.8) ⑤	12X	—	—	
1270	(710)	1330	(800)		72 (1828.8) ⑥	12X	—	—	
1330	(800)	1460	(900)		72 (1828.8) ⑥	12X	—	—	
1460	(900)	—	—		72 (1828.8) ⑥	12X	—	—	
1600	(1000)	—	—		72 (1828.8) ⑥	12X	—	—	
<b>440V – 480 V</b>									
320	250	400	300		MCCB	72 (1828.8) ②	12X	72 (1828.8) ③	12X
400	300	460	400			72 (1828.8) ②	12X	72 (1828.8) ③	12X
480	400	600	500			72 (1828.8) ④	12X	⑤	12X
600	500	672	600			72 (1828.8) ④	12X	⑤	12X
700	600	880	700			72 (1828.8) ⑦	12X	⑧	12X
880	700	1020	800	72 (1828.8) ⑧		12X	—	—	
1020	800	1070	900	72 (1828.8) ⑧		12X	—	—	
1070	900	1200	1000	72 (1828.8) ⑧		12X	—	—	
1200	1000	—	—	72 (1828.8) ⑧		12X	—	—	
1300	1100	—	—	72 (1828.8) ⑧		12X	—	—	
<b>500 – 575 V</b>									
—	—	222	200	MCCB		72 (1828.8) ②	12X	72 (1828.8) ③	12X
222	200	287	250			72 (1828.8) ②	12X	72 (1828.8) ③	12X
287	250	325	300			72 (1828.8) ④	12X	⑤	12X
325	300	400	400			72 (1828.8) ④	12X	⑤	12X
400	400	490	500			72 (1828.8) ⑦	12X	⑧	12X
490	500	620	600		72 (1828.8) ⑧	12X	—	—	
620	600	700	700		72 (1828.8) ⑧	12X	—	—	
700	700	—	—		72 (1828.8) ⑧	12X	—	—	
780	800	—	—		72 (1828.8) ⑧	12X	—	—	

- ① Drives with fusible disconnects require drive with option space.
- ② 60-inch (1524.0 mm) wide unit. Drive is in a 40-inch (1016.0 mm) wide structure and disconnect is in a 20-inch (508.0 mm) wide structure.
- ③ 80-inch (2032.0 mm) wide unit. Drive is in a 40-inch (1016.0 mm) wide structure and disconnect is in a 40-inch (1016.0 mm) wide structure.
- ④ 68-inch (1727.2 mm) wide unit. Drive is in a 48-inch (1219.2 mm) wide structure and disconnect is in a 20-inch (508.0 mm) wide structure.
- ⑤ Contact factory for sizing.
- ⑥ 116-inch (2946.4 mm) wide unit. 96-inch (2438.4 mm) drive is in (2) 48-inch (1219.2 mm) wide structures, disconnect is in a 20-inch (508.0 mm) wide structure.
- ⑦ 100-inch (2540.0 mm) wide unit. 80-inch (2032.0 mm) drive is in (2) 40-inch (1016.0 mm) wide structures, disconnect is in a 20-inch (508.0 mm) wide structure.

**Table 27. Multi-Structure Options**

Options	
<b>Option Boards ⑥</b>	
I/O Expander	⑥
Encoder Expander	⑥
Interbus S Communications	⑥
Modbus-RTU Communications	⑥
PROFIBUS Communications	⑥
Lonbus Communications	⑥
SDS Communications	⑥
DeviceNet Communications	⑥
Metasys N2 Communications	③
Siemens Apogee FLN Communications	③
<b>Plug-in Control Relays</b>	
1 Relay	⑥
2 Relays	⑥
3 Relays	⑥
<b>Other Options</b>	
Automatic Bypass Circuit	⑥
Bypass Drive Test Switch	⑥
7 Relay 120 V Interface Board w/CPT	⑥
Isolated Signal Processor	⑪
3-15 PSIG Interface	⑪
Dynamic Breaking Resistors	⑫
Graphics Keypad	⑨
Line Fuses	⑥⑩
RFI Filter	⑪
KLC 1000 ft. dV/dT Filter	⑩⑫
Output Contactor	⑬⑭
3 Contactor Bypass	⑬⑭
Dynamic Breaking Circuit	⑨
<b>RWT Filter</b>	
NEMA 1	⑮
NEMA 4X, Class 1, Division 2	⑮

- ⑥ Only one option board per drive can be selected.
- ⑦ This option will fit in all units.
- ⑧ Use with bypass option.
- ⑨ All options will fit in Option unit.
- ⑫ DB resistors are to be mounted by the customer external to the MCC.
- ⑬ Consult factory for sizing and availability.
- ⑭ dV/dT filter not available 700 hp and above.
- ⑮ RWT is mounted at the motor. See **Section 35** of the *Cutler-Hammer Consulting Application Guide, 13th Edition for Reflected Wave Trap (RWT)*.

**Note:** Output reactor or dV/dT filter not required for motor lead lengths shorter than 100 feet (30.4 m) — 30 feet (9.1 m) for 2 hp and below, or when a RWT filter is used at the motor.

**Note:** Maximum motor lead length is 160 feet (48.8 m) for 1.5 hp and below, 330 feet (100.6 m) for 2 hp and 400 feet (121.9 m) for 3 hp and larger when using a standard output reactor.

**Note:** Motor lead lengths up to 2000 feet (609.6 m) can be achieved by using the KLC dV/dT filter.

**Note:** Fusible units take option unit space. Not all options will fit in fusible units.

Unit Options for ac Combination Starters, ac Drives

Option Group A

Table 28. Wiring Class

Description
NEMA Class IA ① NEMA Class IC
NEMA Class IIB NEMA Class IIC NEMA Class IS (Includes 1B wiring and 2B schematics)

① Control Terminal Blocks and Device Panels not included with NEMA 1A wiring.

Table 29. 100 kA Circuit Breaker Starter Interrupting Capacity

Starter Type	Voltage
Starters with HMCPs Starters with Thermal Magnetic Circuit Breakers	480
Starters with HMCPs Starters with Thermal Magnetic Circuit Breakers	600 ②

② Current Limiter Attachments are used. Add 6 inches (152.4 mm) to all size 3 and 4 starters.

Table 30. Control Circuit Transformers — Typical Sizing ③

Starter Size
1, 2 (100 VA) — Includes extra 50 VA 3, 4 (150 VA) — Includes extra 50 VA 5, 6 (250 VA) — Includes extra 50 VA
Extra 50 VA, Size 1, 2 Extra 100 VA, Size 3, 4 Extra 150 VA, Size 5, 6

③ Refer to Table 79 for actual ratings.

Note: Price includes 1 secondary and 2 primary fuses.

Table 31. Control Circuit Fusing

Description
Control Fuse and Auxiliary Switch Control Fuse Blown Fuse Indicator

Note: Required in accordance with NEC for all starter units with control wiring external to the MCC. See NEC, General for exceptions.

Table 32. Motor Starter Auxiliary Contacts

Description
1NO or 1NC (Size 1-4)      Maximum of eight on each contactor ④ 1NO or 1NC (Size 5-6)      Maximum of four on each contactor

④ Maximum of 4 per contactor on multi-contactor starters and 6-inch (152.4 mm) units.

Table 33. Interlock for Switch or Breaker Operator

Description
1NO – 1NC 2NO – 2NC

Note: For use when control circuit is fed from an external source.

Table 34. Internal Circuit Breaker Options

Description
Alarm Contact Auxiliary 1NO – 1NC Auxiliary 2NO – 2NC 120 Volts Shunt Trip 50°C (Thermal Magnetic)

Table 35. Terminal Blocks

Description	
Side Mounted (Will accept stripped wire or ring/spade wire lug – 14 AWG wire maximum)	
Front Rail – Pressure Connector Front Rail – Pull Apart Front Rail – Utility/Accepts ring wire lug.	Additional 6-inch (152.4 mm) space required for Freedom Starters Size 1 – 4

Table 36. Control Wire Options

Description
#16 AWG (standard) #14 AWG Wire Markers
Spade Wire Terminals Ring Wire Terminals ⑤ Wiring to Common CPT
SIS Power Wire – Substitution SIS Control Wire – Substitution Starter Class 2 Interwiring/Per Wire

⑤ Freedom Starter control terminals only available with spade wire terminals.

Table 37. Miscellaneous Options

Description
Mini Ammeter and CT ⑥ Mini Voltmeter Mini Elapsed Time Meter
Panel Elapsed Time Meter ⑦ Operations Counter Wiring Diagram on Door Coil Surge Suppressor
CT for Remote Metering (Requires additional 6-inch (152.4 mm) space) Heater Packs Installed Device Labels Blank Device Panels

⑥ May add 6 inches (152.4 mm) to unit size. Consult factory.

⑦ May add 6 inches (152.4 mm). Consult factory.

Table 38. Vacuum Contactors in Lieu of Air Break

Starter Type
FVNR FVR, 2S2W, PW RVAT, 2S1W, YD-Open YD-Closed

Table 39. Ground Fault Protection — Instantaneous or Adjustable

Description	
Earth Leakage Breakers Size 1-4 Earth Leakage Breakers Size 5 GRT1 Size 1-4 GRT1 Size 5-6	All require additional 6-inch (152.4 mm) space

**Table 40. Power Fuses — R, J Type**

Ampere Rating
30
60
100
200
400
600

**Table 41. Power Factor Capacitor Options**

Description
Blown Power Fuse Indicator (Set of 3-1 Per Phase)

**Table 42. Current Limiter Attachment for HMCP**

Description	
Size 1-2	—
Size 3	Requires additional 6-inch (152.4 mm) space
Size 4	Requires additional 6-inch (152.4 mm) space

**Option Group B**

Devices may require extra unit space.

**Table 43. Timing Relays**

Type of Relay	Mounting
Solid-State Timer Pneumatic — AGASTAT	Panel Panel On or Off Delay
24 Hour Motor Timer 7 Day Timer Repeat Cycle Timer	Panel Panel Door or Panel

**Table 44. Control Relays**

Number of Poles	Type
2-Pole 4-Pole	General Purpose Type D7 Socket Relay N300 Fixed Contacts
2-Pole 4-Pole 6-Pole 8-Pole 10-Pole	Type AR Machine Tool Relays N600 Convertible Contacts
2-Pole 3-Pole 4-Pole 6-Pole ① 8-Pole ①	Type M — D26 Relays N600 Convertible Contacts

① The 6- and 8-pole units can be provided with 4 additional non-convertible NO contacts.

**Table 45. Alternators**

Description	
2-Circuit Alternator 3-Circuit Alternator	Panel (Additional 6-inch (152.4 mm) space required on size 1s and size 2s)

**Option Group C**

Devices may require extra unit space.

**Table 46. Monitoring Relays**

Type of Relay		
D60LA Current Sensing Voltage Transducer	— Price Includes 1 PT	Additional 6-inch (152.4 mm) space required
ac Current Sensors with CTs ②	0 – 5 A Thru 0 – 100 A 0 – 50 A Thru 0 – 300 A 0 – 300 A Thru 0 – 600 A	
ac Current Transducer, 4 – 20 mA, Self-powered with CTs ③	All Ratings	
Phase Monitoring Relay — 3-Phase Watt Transducer, 4 – 20 mA, Self-powered CTs ③		

② Loop powered devices — requires 24 Vdc power source which is typically provided in the PLC.

③ Does not require separate 24 Vdc power source. Suitable for powering analog meters.

**Table 47. Extra Bi-Metallic Overload Relay — Type C306**

Description
Size 1 — 32 Amperes Overload Relay Size 2 — 75 Amperes Overload Relay Size 3 — 100 Amperes Overload Relay Size 4 — 144 Amperes Overload Relay

**Option Group D**

Devices may require extra unit space.

**Table 48. Solid-State Overload Relays**

Description
CEP7 Solid-State Overload MP-3000 Motor Protector MP-3000 RTD Module IQ 500 Relay ④ IQ 500M Load Protection ④⑤⑥

④ Requires thermal-magnetic disconnect.

⑤ Includes LAM, JAM, ULM functions with 2 dry contacts.

⑥ Requires a 120 V source.

⑦ Size 4 starters require an additional 6-inch (152.4 mm) (1X) space. When used with CEP7 Solid-State Overload.

**Option Group E**

**Table 49. Oiltight Pushbuttons, Lights, Selector Switches**

Device	Device Type
Pushbuttons 1 Unit 2 Unit 3 Unit	10250T ①②
Selector Switches 2 Position 3 Position 4 Position Key Operated Adder	
Pilot Lights Standard XFMR 6 Volt Bulb Standard XFMR LED Bulb Push to Test XFMR 6 Volt Bulb Push to Test LED Bulb	E30 ①②
Pushbuttons 1 Unit 2 Unit 3 Unit	
Selector Switches 2 Position 3 Position 4 Position Key Operated Adder	
Pilot Lights Standard XFMR 6 Volt Bulb Standard XFMR LED Bulb Push to Test XFMR 6 Volt Bulb Push to Test LED Bulb	

① Maximum 2 devices per starter in dual units.

② Maximum of 6 devices without increasing compartment space.

**Option Group F**

**Options for 6-inch Starter Units**

- Control terminal blocks are 300 volt rated and are limited to 12 points maximum.
- Standard VA control transformer only.

**Table 50. Oiltight Pushbuttons, Lights, Selector Switches**

Device	Device Type
Pushbuttons 1 Unit 2 Unit 3 Unit	E22 ③
Selector Switches 2 Position 3 Position 4 Position Key Operated Adder	
Pilot Lights Standard XFMR 6 Volt Bulb Standard XFMR LED Bulb Push to Test XFMR 6 Volt Bulb Push to Test LED Bulb	

③ On 6-inch (152.4 mm) starter units, pilot devices are limited to (3) E22 devices.

**Cutler-Hammer dc Motor Control Center**

UL listed dc MCCs use combination circuit breaker dc starters suitable for motor starting duty only. Using Cutler-Hammer type ME dc definite purpose contactors, all dc starters are suitable for up to 250 Vdc and have a 22 kA withstand rating. Class 135 starting resistors for reduced voltage starters are sized for 200% starting current. Typical applications include emergency lube oil pumps, emergency seal oil pumps and emergency turning gear motors.

**Table 51. Cutler-Hammer dc Motor Control Center —  
HMCP or Thermal Magnetic Circuit Breaker**

dc Starters HMCP or Thermal Magnetic Circuit Breaker	Interruption Capacity	Hp		MCCB	Unit Size ① Inches (mm)	X Space
		125 Vdc	250 Vdc			
Full Voltage Non-Reversing Size 1	22 kAIC	3	5	150	30 (762.0)	5X
Full Voltage Reversing Size 1					36 (914.4)	6X
Reduced Voltage Non-Reversing Size 2		5	10		30 (762.0) ②	5X
Reduced Voltage Non-Reversing Size 3		10	20		42 (1066.8) ②	7X
Reduced Voltage Non-Reversing Size 4		20	40	250	48 (1219.2) ②	8X

① Not available in NEMA 3R enclosures.

② 21-inch (533.4 mm) deep structure required. Rear is unusable.

**Table 52. Cutler-Hammer dc Motor Control Center —  
Model K Fused Switch (RK5 Fuses not Included)**

dc Starters ③ Model K Fused Switch (RK5 Fuses not Included)	Hp		Switch Size	Unit ④ Size Inches (mm)	X Space
	125 Vdc	250 Vdc			
Full Voltage Non-Reversing Size 1	3	5	30A	36 (914.4)	6X
Full Voltage Reversing Size 1				42 (1066.8)	7X
Reduced Voltage Non-Reversing Size 2	5	10	60A	48 (1219.2) ⑤	8X
Reduced Voltage Non-Reversing Size 3	10	20	100A	60 (1524.0) ⑤	10X
Reduced Voltage Non-Reversing Size 4	20	40	200A	72 (1828.8) ⑤	12X

③ Fused switch units are not UL listed.

④ Not available in NEMA 3R enclosures.

⑤ 21-inch (533.4 mm) deep structure required. Rear is unusable.

**Table 53. Options**

400% Starting Torque Resistors Ammeter and dc Shunt. Starter Mounted Ammeter and dc Shunt. Incoming Line ⑥ Negative Side Line Contactor Negative Overload Relay Shunt Field Discharge Resistor
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⑥ Add 2X space.

**Table 54. Standards**

200% Starting Torque Resistors MME dc Contactors Positive Side Contactor and Overload Relay Only Bus Systems for dc Motor Control Centers are 2-phase. The B-phase Bus Bar is Removed Reduced Voltage Starters include NEMA Class 135 Edgewound Power Resistors MCC Plug-in Combination dc Starters UL 845 Listed
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**Table 55. Incoming Line and Feeder Circuit Breakers — Molded Case Circuit Breakers — Dimensions in Inches (mm)**

Frames reflect standard circuit breakers. Unit spacings shown include sufficient space to terminate cables on any standard breaker lug. If cable sizes exceed those listed, add 12-inch (304.8 mm) space for lug adapters.

Frame Size (Amperes)	Circuit Breaker Frame	Interrupting Capacity (kAIC)			Main Unit Size		Maximum Cable Size See circuit breaker terminal data for variations.
		240 V	480 V	575 V	Inches (mm)	X Space	
150	HFD	100	65	25	18 (457.2)	3X	4/0 (1 per Phase)
	FDC	100	100	35			
225	HFD	100	100	35	18 (457.2)	3X	4/0 (1 per Phase)
	FDC	100	100	35			
250	HJD	100	65	35	30 (762.0)	5X	350 kcmil (1 per Phase)
	JDC	100	100	35			
400	HKD	100	65	25	30 (762.0)	5X	250 kcmil (2 per Phase) or 500 kcmil (1 per Phase)
	KDC	100	100	50			
	CHKD ①	100	65	25			
	CKDC ①	100	100	50			
600	HLD	100	65	35	24 (609.6) ②③	4X	500 kcmil (2 per Phase)
	LDC	100	100	50			
	CHLD ①④ CLDC ①④	100 100	65 100	35 50	24 (609.6) ②③	4X	500 kcmil (2 per Phase)
800	HMDL	100	65	35	30 (762.0) ⑤	5X	750 kcmil (3 per Phase)
	CHMDL ①④	100	65	35	48 (1219.2) ⑤	8X	750 kcmil (3 per Phase)
	NDC	100	100	50	42 (1066.8) ⑤	7X	750 kcmil (3 per Phase)
	CHND ① CNDC ①	100 100	65 100	35 50	72 (1828.8)	12X	750 kcmil (3 per Phase)
1200	HND ⑥ NDC ⑥	100 100	65 100	35 50	42 (1066.8) ⑤	7X	750 kcmil (3 per Phase)
	CHND ①② CNDC ①④	100 100	65 100	35 50	72 (1828.8)	12X	750 kcmil (3 per Phase)
	RD ⑦ RDC ⑦ CRD ⑦ CRDC ⑦	100 100 100 100	65 100 65 100	50 65 50 65	72 (1828.8) ⑤	12X	750 kcmil (6 per Phase)
2500	RD RDC	100 100	65 100	50 65	72 (1828.8) ⑥⑦	12X	750 kcmil (6 per Phase)

① 100% Rated when 90° cable is applied at 75°C ampacity for 100% rating. RMS310LS is required and included in the price.

② Add 6-inch (152.4 mm) for top entry of incoming cables.

③ Install at top or cable top entry or at bottom for bottom cable entry.

④ NEMA 1 gasketed only.

⑤ Digitrip RMS 310 LS is standard and included in the pricing.

⑥ The main breaker requires the complete vertical section. The rear is unusable.

⑦ 24-inch (609.6 mm) wide.

**Table 56. Dual Feeder Units — Molded Case Circuit Breakers — Dimensions in Inches (mm)**

Maximum Amperes	Circuit Breaker Frame	Interrupting Ratings (kAIC)			Enclosure Width Inches (mm)	Main Unit Size		Feeder Unit Size		Maximum Cable Size
		240 V	480 V	600 V		Inches (mm)	X Space	Inches (mm)	X Space	
50/50	HFD	100	65	25	Standard 20 (508.0)	N/A	12 (304.8)	2X	See above breaker frame information	
	FDC	200	100	35						
50/100	HFD	100	65	25			12 (304.8)	2X		
	FDC	200	100	35						
100/100	HFD	100	65	25			12 (304.8)	2X		
	FDC	200	100	35						
100/100	HFD	100	65	25			12 (304.8)	2X		
	FDC	200	100	35						
150/150	HFD	100	65	25			12 (304.8)	2X		
	FDC	200	100	35						

**Table 57. Main Circuit Breakers — Insulated Case Type SPB Stored Energy, Manually or Electrically Operated — Dimensions in Inches (mm)**

Frame Size (Amperes)	Circuit Breaker Type	Interrupting Capacity (kAIC)	Mounting	Enclosure Width Inches (mm)	Main Unit Size		Feeder Unit Size		Maximum Cable Size See circuit breaker terminal data for variations.
					Inches (mm)	X Space	Inches (mm)	X Space	
800	SPB	100	Fixed Drawout ①	20 (508.0) 20 (508.0)	72 (1828.8)	12X	N/A		750 kcmil (6 per Phase)
1600			Fixed Drawout ①	20 (508.0) 20 (508.0)					
2000			Fixed Drawout ①	20 (508.0) 24 (609.6)					
3000			Fixed Drawout ①	20 (508.0) 24 (609.6)					

① Drawout circuit breakers require a 42-inch (1066.8 mm) deep structure.

**Table 58. Main Circuit Breakers — Magnum DS Air Circuit Breakers, Manually or Electrically Operated — Dimensions in Inches (mm)**

Frame Size (Amperes)	Circuit Breaker Type	Interrupting Capacity (kAIC)			Unit Size	Mounting ④	Enclosure Width
		240 V	480 V	575 V			
800	MDS-608	65	65	65	72 (1828.8) ②	Drawout	24 (609.6) ③
	MDS-C08	100	100	100			
1600	MDS-616	65	65	65	72 (1828.8) ②	Drawout	24 (609.6) ③
	MDS-C16	100	100	100			
2000	MDS-620	65	65	65	72 (1828.8) ②	Drawout	24 (609.6) ③
	MDS-C20	100	100	100			
3200	MDS-632	65	65	65	72 (1828.8) ②	Drawout	24 (609.6) ③
	MDS-C32	100	100	100			

② Structure is 42 inches (1066.8 mm) deep, MCC is rear aligned.

③ A 4-inch (101.6 mm) filler section must be added between the main and the rest of the MCC to allow for door opening.

④ Consult factory for Fixed Mounted Magnum Assemblies.

**Table 59. Digitrip Units**

Type	Unit Space Inches (mm)
RMS510LSI	—
RMS510LSIG	—
RMS510MLSI	—
RMS510MLSI	—
RMS1150LSI	—
RMS1150LSI	—

**Options**

Tie Breaker ⑤ Electrically Operated	72 (1828.8) or 12X —
Automatic Throwover Main-Main using IQ Transfer Logic	72 (1828.8)
Automatic Throwover Main-Tie-Main using PLC/Operator Interface ⑥	72 (1828.8)

**Accessories**

UV Release-Instantaneous	—
Shunt Trip (standard on electrically operated breakers)	—
Key Interlock on breaker	—
Auxiliary Switch (3A/3B)	—
Cell Position Switch	—
Operations Counter	—
Auxiliary Power Module (to test Digitrip)	—
Portable Lift Truck	—
Manual Close Pushbutton Cover	—

⑤ Tie breaker adds an additional 20-inch (508.0 mm) wide bus transition section. Also (2) 4-inch (101.6 mm) filler sections will be added to the MCC if the tie breaker is located in the center of the MCC line up. If the tie breaker is located between the two main structures the (2) 4-inch (101.6 mm) fillers are not needed.

⑥ 24-inch (609.6 mm) wide structure.

**Table 60. Incoming Line and Feeder Fusible Switches — Dimensions in Inches (mm)**

3-Pole — 250 V or 600 Vac. Fuses not included.

Switch Rating ① Amperes ②	Fuse Clip Size Amperes	Unit Space			
		Incoming Line		Feeder	
		Inches (mm)	X Space	Inches (mm)	X Space
30	30	18 (457.2)	3X	12 (304.8)	2X
60	60	18 (457.2)	3X	12 (304.8)	2X
30/30 Dual	30/30 Dual	—	—	12 (304.8)	2X
30/60 Dual	30/60 Dual	—	—	12 (304.8)	2X
60/60 Dual	60/60 Dual	—	—	12 (304.8)	2X
100	100	18 (457.2)	3X	18 (457.2)	3X
200	200	30 (762.0)	5X	30 (762.0)	5X
400	400	48 (1219.2)	8X	42 (1066.8)	7X
600	600	54 (1371.8) ③	9X ③	48 (1219.2)	8X
800	800	48 (1219.2) ④	8X ④	48 (1219.2) ⑤	8X ⑤
1200 ⑥	1200	60 (1524.0)	10X	60 (1524.0)	10X

- ① Suitable for 100,000 A interrupting if Class RK fuses are used.
- ② Type of SW K-SW 30 – 800 A.
- ③ For bottom cable entry, add 6 inches (152.4 mm) or 1X space.
- ④ For bottom entry, add 12 inches (304.8 mm) or 2X space.
- ⑤ For top entry, add 6 inches (152.4 mm) or 1X space.
- ⑥ High magnetic molded case switch.

**Table 61. Lighting Panelboards  
120/240 V or 120/208 V Lighting Panelboards Type — PL1A**

Fixed mounted, main lug only panelboards can be either 120/240 V, 1-phase, 3-wire; 208Y/120 V, 3-phase, 4-wire.

Number of Circuits	Chassis Rating (Amperes)		Unit Space	
	1-Phase 3-Wire	3-Phase 4-Wire	1-Phase 3-Wire	3-Phase 4-Wire
18	225	100	24 – 4X	24 – 4X
30	225	100	30 – 5X	30 – 5X
42	225	225	36 – 6X	36 – 6X

**Note:** For MCB, back feed panelboard branch circuit breaker, or select separate feeder unit.

**Note:** Bolt-on 1-, 2-, 3-pole breakers only.

**Table 62. 277/480 V or 480/600 V Lighting Panelboards Type — PRL3A**

Fixed mounted, main lug only panelboards can be either 480 V or 600 V, 3-phase, 3-wire or 480Y/277 V, 3-phase, 4-wire. Mounted in bottom portion of structure.

Number of Circuits	Chassis Rating (Amperes)	Unit Space	
		3-Phase 3-Wire	3-Phase 4-Wire
14	100	—	36 – 6X
18	250	36 – 6X	—
24	100	36 – 6X	—
26	250	—	48 – 8X
32	100	—	48 – 8X
36	250	48 – 8X	—
42	100	48 – 8X	60 – 10X
42	250	60 – 10X	60 – 10X
12	400/600	36 – 6X	—
14	400/600	—	48 – 8X
30	400/600	48 – 8X	60 – 10X
42	400/600	60 – 10X	72 – 12X

**Note:** For MCB, back feed panelboard branch circuit breaker, or select separate feeder unit.

**Note:** Either plug-in or bolt-on 1-, 2-, 3-pole breakers only.

**Table 63. Lighting Panelboard Circuit Breakers**

Cutler-Hammer circuit breakers can be either plug-in or bolt-on, 1-, 2- or 3-pole through 240 V. 600 V maximum 1-, 2- or 3-pole circuit breakers are bolt-on.

Poles	Maximum Voltage	Plug-in	Bolt-on	Ampere Interrupting Capacity
1/2/3	240	HQP	BAB	10,000
1/2/3	240	QPHW	QBHW	22,000
1/2/3	600	—	EHD	14,000
1/2/3	600	—	HFD	65,000

**Table 64. Automatic Transfer Switches — Dimensions in Inches (mm)**

Ampere Rating	Switch Type ①	Interrupting Rating (kA)	Unit Width	Unit Space
100 ②	Cutler-Hammer MTVX, NTVS	65	20 (508.0)	36 (6X)
150 ②	Cutler-Hammer MTVX, NTVS	65	⑦	48 (8X)
100	Cutler-Hammer ATVI	65	24 (609.6) ⑦	72 (12X)
150	Cutler-Hammer ATVI	65		
225	Cutler-Hammer ATVI	65		
300	Cutler-Hammer ATVI	65	44 (1117.6) ⑧	72 (12X)
400	Cutler-Hammer ATVI	65		
600	Cutler-Hammer ATVI	50		
800	Cutler-Hammer ATVI	50	20 (508.0) ⑨	72 (1828.8) or 12X
1000	Cutler-Hammer ATVI	50		
1200	Cutler-Hammer ATVI	50		
1000	Cutler-Hammer ATVISP	100	28 (711.2) ⑩	72 (1828.8) or 12X
1200	Cutler-Hammer ATVISP	100		
1600	Cutler-Hammer ATVISP	100		
2000	Cutler-Hammer ATVISP	100		
100	ASCO Type 7000	65	36 (914.4) ⑪	72 (1828.8) or 12X
150	ASCO Type 7000	65		
260	ASCO Type 7000	65	40 (1016.0) ⑫	72 (1828.8) or 12X
400	ASCO Type 7000	35		
600	ASCO Type 7000	35	40 (1016.0) ⑫	72 (1828.8) or 12X
800	ASCO Type 7000	50		
1000	ASCO Type 7000	50	40 (1016.0) ⑫	72 (1828.8) or 12X
1200	ASCO Type 7000	100		

① ATVI designs include IQ Transfer door mounted microprocessor-based monitoring device for use in open transition transfer switches where rapid, reliable restoration of power in outage situations is essential. The IQ Transfer is a microprocessor-based logic controller to be used with Cutler-Hammer transfer switches. This device provides the operator with an at-a-glance overview of switch status and parameters, as well as key diagnostic data. Real-time values for volts and frequency can be viewed via the front panel LED display, along with an indication of the power source currently in use. The IQ Transfer continuously monitors either single-phase or 3-phase voltages for Source 1, Source 2 and the Load. Depending on the application, the user can customize the IQ Transfer to meet specific application need.

⑩ Manually operated switch: MTVX = Single handle manual operation. NTVS = Electrically operated non-automatic.

⑫ Requires 42-inch (1066.8 mm) deep structure.

**Table 65. Dry-Type Distribution Transformers**

- Transformer 1.0 – 2.0 kVA will include a CB and fuses in a standard 2X unit.
- Transformers 3.0 kVA and above have taps and electrostatic shields as standard.
- Transformers 3.0 kVA and above will include the primary and secondary circuit breakers housed behind a single door.

kVA Rating	Unit Space	Primary Breaker (included in space factor)		Secondary Breaker (included in space factor)
		230 V	480 V	

**Single-Phase**

.5	2X	15	15	—
.75	2X	15	15	—
1	2X	15	15	—
1.5	2X	15	15	—
2	2X	15	15	—
3	4X	15	15	20
5	4X	15	15	30
7.5	4X	20	20	40
10	4X	25	30	60
15	5X	40	40	90
20	5X	50	60	125
25	5X	60	70	150
30	6X	70	80	175
45	7X	100	125	250

**Three-Phase**

9	5X	15	15	40
15	5X	20	25	60
25	6X	40	40	90
30	6X	40	50	125
45	6X	60	70	175

**Table 66. Power Factor Correction Capacitors**

PF capacitors are electrolytic type and are optionally available with external line fuses and blown fuse indicators. Capacitors' sizes must be specified by the customer.

**Caution:** Capacitors on the main bus of the MCC may affect solid-state equipment. Please consult factory.

kVAR Rating	208 V Unit Space		240 V Unit Space		600V Unit Space	
	Inches (mm)	X Space	Inches (mm)	X Space	Inches (mm)	X Space
2	12 (304.8)	2X	12 (304.8)	2X	12 (304.8)	2X
3	12 (304.8)	2X	12 (304.8)	2X	12 (304.8)	2X
4	12 (304.8)	2X	12 (304.8)	2X	12 (304.8)	2X
5	12 (304.8)	2X	12 (304.8)	2X	12 (304.8)	2X
7.5	12 (304.8)	2X	12 (304.8)	2X	12 (304.8)	2X
10	12 (304.8)	2X	12 (304.8)	2X	12 (304.8)	2X
15	12 (304.8)	2X	12 (304.8)	2X	12 (304.8)	2X
20	24 (609.6)	4X	12 (304.8)	2X	12 (304.8)	2X
22.5	24 (609.6)	4X	12 (304.8)	2X	12 (304.8)	2X
25	—	—	24 (609.6)	4X	12 (304.8)	2X
30	—	—	24 (609.6)	4X	12 (304.8)	2X
40	—	—	—	—	12 (304.8)	2X
50	—	—	—	—	24 (609.6)	4X
60	—	—	—	—	24 (609.6)	4X
75	—	—	—	—	24 (609.6)	4X
90	—	—	—	—	24 (609.6)	4X
100	—	—	—	—	36 (914.4)	6X
120	—	—	—	—	36 (914.4)	6X

**Table 67. Current Limiting Reactors — Dimensions in Inches (mm)**

Structures contain three single-phase 60 Hz reactors which limit available short circuit current from 100,000 rms amperes to 14,000 rms amperes. Reactors available with ohmic values of .01, .015, .02 and .025.

Amperes	Unit Space		Mounting
	Inches (mm)	X Space	
600	72 (1828.8)	12X	21 D x 20 W (533.4 D x 508.0 W)
800	72 (1828.8)	12X	21 D x 20 W (533.4 D x 508.0 W)
1000	72 (1828.8)	12X	26 D x 28 W (660.4 D x 711.2 W)
1200	72 (1828.8)	12X	26 D x 28 W (660.4 D x 711.2 W)

**Table 68. TVSS (Clipper Power System) with Circuit Breaker Disconnect**

Includes SuperVisor Monitoring Display with power quality meter for volts, sag, swell, outage, transient counter, Form C contact, alarm enable and disable.

Description	Unit Space ①	
	Inches (mm)	X Space

**Surge Current Per Phase**

100 kA	CPS-100	18 (457.2)	3X
120 kA	CPS-120 (Recommended Branch Unit)	18 (457.2)	3X
160 kA	CPS-160	18 (457.2)	3X
200 kA	CPS-200	18 (457.2)	3X
250 kA	CPS-250 (Recommended Service Entrance)	18 (457.2)	3X
300 kA	CPS-300	18 (457.2)	3X
400 kA	CPS-400	18 (457.2)	3X
500 kA	CPS-500	18 (457.2)	3X

① Also available in 12-inch (304.8 mm) unit (2X) without circuit breaker disconnect.

**Note:** Specify 3-phase Delta or 3-phase Wye.

**Table 69. DeviceNet Communications**

DeviceNet-enabled components in MCCs eliminate up to 90% of the control wiring versus traditional hardwired designs. 24 Vdc DeviceNet is prewired throughout the MCC. Trunk cable is provided in the horizontal wireway. Drop cable is provided for vertical wireways and units.

Part Number	Description	Space Requirements
WPN01DNA	DeviceNet interface for Advantage Starter	No Additional Space
DN65	DeviceNet interface for Freedom Starter	No Additional Space
AF91DNA	AF91 Adjustable Frequency Drives DeviceNet Interface	—
SV9DNA	SV9000 Adjustable Frequency Drives DeviceNet Interface	—
DN50, DN65	Discrete DeviceNet Interface for <i>IT</i> . Solid State Starters	③
PS1	Single 5 ampere Power Supply	2X
PS2	Dual 5 ampere Power Supply	2X
PanelMate 1700	Operator interface for DeviceNet System	12-inch (304.8 mm)/2X
DN50	DeviceNet I/O module	12-inch (304.8 mm)/2X Minimum

③ *IT*. starters up to 66 amperes require additional 6 inches when selecting DN50, DN65 DeviceNet interfaces.

**Earth Leakage Breakers**

Earth Leakage Breakers offer Class 1 ground fault protection down to the 30 mA level.

- Ground fault pickup setting is adjustable from .03 to 30 A in eight steps.
- Ground fault time delay setting is adjustable from instantaneous to 2.0 seconds in six steps.

**Standard Features**

- Built-in push-to-trip for functional testing.
- Tripped window indicates red for ground fault trip.
- Alarm contact for remote indication of trip.

**Table 70. Earth Leakage Breakers**

Frame	HMCP or Thermal-Magnetic	Additional Space Required
F	Yes	1X ①
J	Yes	1X ①
K	Yes	1X ①

① Six-inch (152.4 mm) not required for NEMA size 6 starters.

**Table 71. Electronic Metering Specifications ②**

Description	IQ 100	IQ 320	IQ DP-4130	IQ Analyzer 6400 and 6600
Volts	L-L, L-N	L-L, L-N	L-L, L-N	L-L, L-N
Current	A, B, C	A, B, C	A, B, C	A, B, C, N, G
Power	—	Watt, VAR, VA	Watt, VAR, VA	Watt, VAR, VA
Power Factor	—	Apparent, Displacement	Apparent, Displacement	Apparent, Displacement
Frequency	—	Hertz	Hertz	Hertz
THD	—	—	Amperes, Volts	Amperes, Volts
Demand Values	—	All	All	All
Trend Analysis	—	③	—	Time, Date ④
Programmable Output Relays	—	—	(3) 10A Form C	(4) 10A Form C
Programmable Analog Outputs	—	—	—	(3) 0-10/4-20 mA
Contact Inputs	—	—	(1) kW Demand	(3) + 30 Vdc Differential
Analog Inputs	—	—	—	(1) 0-20/4-20 mA
Display Type	7 Segment LED	Reverse Mode LCD with LED Backlight	7 Segment LED	Graphic LCD with LED Backlight
Communications	—	Cutler-Hammer PowerNet ⑤	Cutler-Hammer PowerNet ⑤	Cutler-Hammer PowerNet ⑤

② Requires 12-inch (1X) unit space.

③ At computer only.

④ Up to 24 data values may be used for Trend Analysis with Time, Date Stamp.

⑤ Communications to Modbus, Ethernet available via optional Communication Modules.

Table 72. Incoming Line Metering and Bus Protection

Type	Description	Unit Space Inches (mm) ①
Switchboard Meters ② 1% Accuracy	Ammeter Ammeter with Switch Voltmeter Voltmeter with Switch	12 (304.8) or 2X
	AM/VM AM/VM with Switches	
Instrument Transformers	600/800A CT 1000 A CT 2000 A CT 2500 A CT	Consult Cutler-Hammer
	480/120 PT	6 (152.4) or 1X
Signal Transducers	Current (Add CT) 1-Phase Voltage (Add PT) Watt (Add CT and PT) 1-Phase	6 (152.4) or 1X

**Voltage Protection**

TVSS (See Table 68)	18 (457.2) or 3X ④
Ground Detection Lights — 3-Phase Underground Systems	
System Voltage Monitor	
Lightning Arrester and Surge Capacitor	6 (152.4) or 1X

**Ground Fault Sensing C-HRG "Safe Ground" High Resistance Ground System**

Current	Requires 21-inch (533.4 mm) deep, 20-inch (508.0 mm) wide structure without a vertical wireway.	72 (1828.8) or 12X
Voltage		

- ① Two electronic meters will fit in a single 12-inch (304.8 mm) (2X) unit.  
 ② 3-phase/3-wire systems require 2 CTs. 3-phase/4-wire systems require 3 CTs.  
 ③ Ammeters require 2 CTs for 3-phase/3-wire systems, and 3 CTs for 3-phase/4-wire systems. Voltmeters require 2 PTs for 3-phase/3-wire systems, and 3-PTs for 3-phase/4-wire systems.  
 ④ Without disconnect 12 inches (304.8 mm) or 2X.

**Harmonic Correction**

Table 73. Clean Control Center

The Cutler-Hammer Clean Control Center is an integrated power correction system that provides harmonic correction directly on the MCC Horizontal Bus. The harmonic correction unit senses the load current and dynamically injects into the Horizontal Bus a synthesized waveform which cancels harmonic content from non-linear loads such as ac drives. The result is a clean waveform. Clean Control Centers are UL 845 listed.

Harmonic Current (Amperes)	Input Voltage	Disconnect Type	Standard Unit Space ⑤ Inches (mm)	Standard Unit Space (X)
50 A Active Harmonic Filter ⑥	Up to 480 V	Molded Case Switch	72 H x 20 W (1828.8 H x 508.0 W)	12X
100 A Active Harmonic Filter ⑥	Up to 480 V	Molded Case Switch	72 H x 20 W (1828.8 H x 508.0 W)	12X

⑤ Clean Control Center model includes 24-inch (609.6 mm) wide MCE structure, current transformers and door-mounted digital interface panel.

⑥ Multiple units can be applied in parallel for additional harmonic correction.

**Standard Structures and Structure Options**

The Standard Freedom or Advantage 2100 Series MCC structure is NEMA 1, gasketed, 90-inch (2286.0 mm) high, 20-inch (508.0 mm) wide with a depth as shown on Figures 1 – 3 right. Each standard structure has a 9-inch (228.6 mm) high horizontal wireway at the top and at the bottom and a 4-inch (101.6 mm) wide full height vertical wireway at the right. All wireway

doors are hinged and secured with 1/4-turn latches. The standard busing is 600 A, UL rated, copper horizontal bus and 300 A, UL rated, copper vertical bus braced for 65,000 symmetrical amperes. Many other bus sizes and types are available. Also included as standard is a vertical bus isolation barrier.

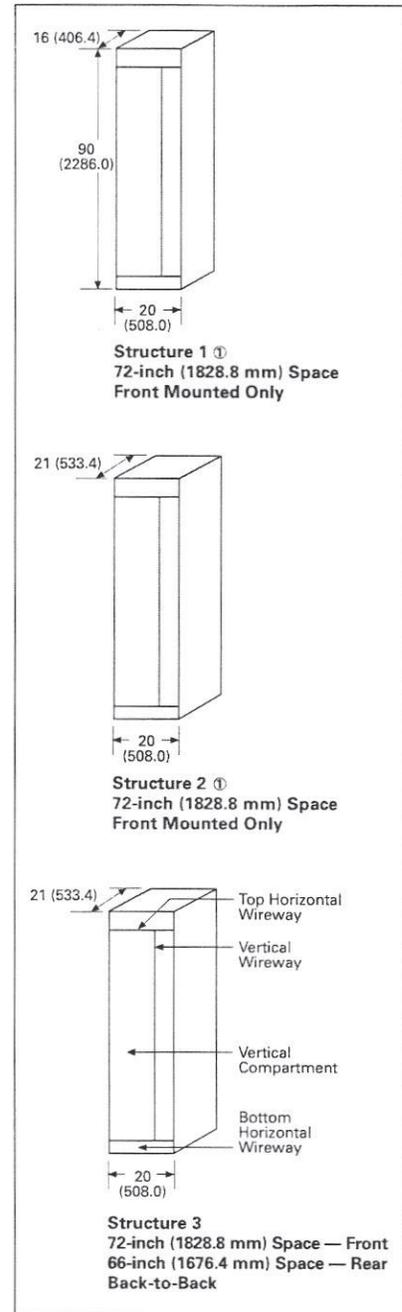
**Table 74. Standard Structures and Structure Options — Dimensions in Inches (mm)**

Description	
<b>Standard Structures</b>	
16 (406.4) deep structure	Structure 1
21 (533.4) deep structure	Structure 2 Structure 3
Front mounting only	
Front and rear mounting	
4 (101.6) of additional structure width, 32 (812.8) maximum	
8 (203.2) vertical wireway in lieu of standard 4-inch (101.6)	
<b>Special Structures</b>	
Single corner section for "L" configuration of MCC	
Transition section	
Series 2100 to Type W	
10 (254.0) wide — front aligned	
Plug-in blank relay mounting space, per 6-inch	Any 6 (152.4) height
Fixed-mounted relay back pan, full depth of structure	
20 (508.0) structure with wireway, 13 (330.2) with usable panel	
24 (609.6) structure with wireway, 17 (431.8) with usable panel	
28 (711.2) structure with wireway, 21 (533.4) with usable panel	
20 (508.0) structure without wireway, 17 (431.8) with usable panel	
24 (609.6) structure without wireway, 21 (533.4) with usable panel	
28 (711.2) structure without wireway, 25 (635.0) with usable panel	
32 (812.8) with double door	
36 (914.4) with double door	
40 (1016.0) with double door	
Programmable controller mounting structure (per complete structure with full fixed mounting back pan)	
20 (508.0) structure with wireway	Complete section
24 (609.6) structure with wireway	Complete section
28 (711.2) structure with wireway	Complete section
20 (508.0) structure without wireway	Complete section
24 (609.6) structure without wireway	Complete section
28 (711.2) structure without wireway	Complete section
Plexiglass see-through door insert for PLC structure	6 (152.4) increments
19 (482.6) instrumentation mounting racks installed in PLC structure	Consult Factory

**Table 75. Structure Modifications — Dimensions in Inches (mm)**

Channel floor sills: 11-gauge, 1 x 3 (25.4 x 76.2)
NEMA 1 gasket
NEMA 12 dust-proof, includes bottom plate
Bottom plate for NEMA 1 gasketed enclosure
150-watt space heater, per structure
Thermostat for space heater control
Pullbox kit for cable and wiring to be field mounted on top structure
12 (304.8) high
18 (457.2) high
24 (609.6) high
Rear hinged structure door, 72 (1828.8) high
NEMA 2 drip shield on top of MCC
NEMA 3R non-walk-in
Front-mounted
Back-to-back
NEMA 3R walk-in aisle-front mounted
NEMA 3R walk-in tunnel type
Special reduced height structures
Seismic certification (earthquake qualification)
UL handle extension ①

① The standard Freedom Series 2100 and Advantage structure is designed to comply with the UL 2-meter requirement. Disconnect operating handle is not more than 2 meters [78 inches (1981.2 mm)] above the bottom of the MCC. Motor Control Centers elevated on a raised pad or installed on unembedded channel sills may require operator handle extensions for the uppermost operators. UL handle extension optionally available when required.



**Figure 2. Structure — Dimensions in Inches (mm)**

**Table 76. Bus Modifications — Dimensions in Inches (mm)**

Freedom and Advantage 2100 Series MCCs bear the UL label. Service entrance labeling is available.

Description			Cu — Tin-Plated (Standard)
Main Bus, Per Vertical Structure			
Copper Horizontal Bus Ratings Tin-Plated	50°C	65°C	
600 A Size	.25 x 2.00 (6.4 x 50.8) — Bars/Phase 1	.25 x 2.00 (6.4 x 50.8) — Bars/Phase 1	—
800 A Size	.25 x 3.00 (6.4 x 76.2) — Bars/Phase 1	.25 x 2.00 (6.4 x 50.8) — Bars/Phase 1	—
1200 A Size	.25 x 2.50 (6.4 x 63.5) — Bars/Phase 2	.25 x 3.00 (6.4 x 76.2) — Bars/Phase 1	—
1600 A Size	.25 x 3.00 (6.4 x 76.2) — Bars/Phase 4	.25 x 3.00 (6.4 x 76.2) — Bars/Phase 2	21 (533.4) Deep ①
2000 A Size	.25 x 2.50 (6.4 x 63.5) — Bars/Phase 6	.25 x 2.50 (6.4 x 63.5) — Bars/Phase 4	21 (533.4) Deep ①
2500 A Size	.25 x 3.00 (6.4 x 76.2) — Bars/Phase 8	.25 x 3.00 (6.4 x 76.2) — Bars/Phase 6	21 (533.4) Deep ②
3200 A Size	N/A	.25 x 3.00 (6.4 x 76.2) — Bars/Phase 8	21 (533.4) Deep ③
Silver-Plated Bus			Optional
Insulated main horizontal bus, per vertical structure (taping)			Optional
Vertical bus, per vertical structure: 300 A — copper (tin-plated)			Standard ④
Increased bus capacity: Rated at 600 A (Front mounted only)			Cu Only
Rated at 600 A (Back-to-back) — copper			Standard
Rated at 800 A (Back-to-back and front)			Cu Only
Rated at 1200 A			Cu Only
Increased mechanical bus bracing, per vertical structure:			Optional
42,000 A rms symmetrical short circuit current			Standard
65,000 A rms symmetrical short circuit current			Optional
100,000 A rms symmetrical short circuit current			Standard
Vertical Bus isolation barrier, per vertical structure			Optional
Labyrinth design insulation-isolation vertical bus barrier			Freedom
Ground bus, 300 A standard, per vertical structure			Standard Cu
Increased capacity ground bus only, 600 A, 1/4- x 2-inch (6.4 x 50.8 mm), per vertical structure			Standard Cu
Plug-in Grounding System, includes 300 A vertical ground bus and unit grounding clips, per vertical structure			Cu
Neutral bus, ungrounded for 3-phase, 4-wire power, per vertical structure ⑤			Cu
Splice plates			—

- ① Requires 21-inch (533.4 mm) deep structure.
- ② Requires 21-inch (533.4 mm) deep structure. Not available in back-to-back structure.
- ③ Contact the Cutler-Hammer business for 3200 A dimensions.
- ④ Vertical bus and unit stabs are tin-plated copper only.
- ⑤ Neutral is half-rating of horizontal bus.

**Table 77. Main Lugs Only — Mechanical Lug Compartment (3-Phase, 3- or 4-wire) — Dimensions in Inches (mm)**

Provisions for terminating incoming line cables directly onto the MCC bus system. Up to 1200 A, all lug landings are bolted to a fully rated vertical bus in that section. MLO sections must be put at the top for top entry cables and at the bottom for bottom entry cables. For smaller cable sizes, cable lugs may also be extended into an optional top hat as shown in this table.

Maximum Cable Size (kcmil)	Bus Rating	Maximum Cables per Phase	Cable Entry (Top or Bottom)	Lug Type	Unit Space	X Space ⑥	Enclosure Width
350	600 A	2		Screw Crimp	12 (304.8) 18 (457.2)	2X 3X	20 (508.0)
			4	Top	Screw Screw Crimp	18 (457.2) 24 (609.6) 36 (914.4)	
		Bottom		Screw Crimp	36 (914.4)	6X	
			18-inch (457.2 mm) Top Hat	Either	—	—	
600	800 A	2		Screw Crimp	18 (457.2) 24 (609.6)	3X 4X	
			4		Screw Crimp	24 (609.6) 36 (914.4)	
				18-inch (457.2 mm) Top Hat	Either	—	
750	1000 A	2		Screw Crimp	24 (609.6) 36 (914.4)	4X 6X	
		4		Screw Crimp	36 (914.4) ⑦ 48 (1219.2) ⑦	12X 12X	
1000	1200 A	2		Screw Crimp	30 (762.0) 36 (914.4)	5X 6X	
1000	2500 A	8		Screw Crimp	72 (1828.8) ⑦ 72 (1828.8) ⑦	12X 12X	
				Screw Crimp	72 (1828.8) ⑦ 72 (1828.8) ⑦	12X 12X	

- ⑥ Requires 12-inch (304.8 mm) (1X) unit space.
- ⑦ Lug landings require the complete vertical section. The rear is unusable.

**Bus Duct Entry Sandwich Type to Horizontal Bus or Main Disconnect — Pull Box**

Pull box and pre-fabricated bus connectors are supplied to match the sandwich type bus duct end flange. Bus duct is assumed to enter the top. Bus duct type and orientation to the MCC must be provided.

**Table 78. Bus Duct Entry to Horizontal Bus or Main Disconnect — Pull Box — Dimensions in Inches (mm)**

Horizontal Bus Rating	Pull Box Height
600 A – 1600 A 2000 A – 2500 A ⑧	18 (457.2) 24 (609.6)

- ⑧ Contact the Cutler-Hammer business for 3200 A dimensions.

**Note:** Consult factory for non-segregated bus requirements.

Table 79. Control Power Transformer Data

All Control Power transformers are encapsulated and will deliver rated secondary voltage at full load. Two primary and one secondary fuses are furnished as standard.

NEMA Size Starter	Starter Type	Freedom		Advantage	
		Standard VA Rating	Maximum <sup>①</sup> VA Rating	Standard VA Rating	Maximum <sup>①</sup> VA Rating
Size 1 Size 1 – 6-inch (252.4 mm) Unit	Full Voltage Non-Reversing and Reversing	100 VA	150 VA	100 VA	150 VA
Size 2		100 VA	100 VA	100 VA	100 VA
Size 2 – 6-inch (252.4 mm) Unit		N/A	N/A	100 VA	100 VA
Size 3		150 VA	250 VA	150 VA	250 VA
Size 4		200 VA	250 VA	150 VA	250 VA
Size 5		200 VA	350 VA	300 VA	350 VA
Size 6	150 VA	250 VA	250 VA	300 VA	350 VA
Size 2 Size 3 Size 4 Size 5 Size 6	Autotransformer	100 VA	150 VA	150 VA	250 VA
Size 3		150 VA	250 VA	150 VA	250 VA
Size 4		200 VA	250 VA	150 VA	250 VA
Size 5		250 VA	350 VA	500 VA	500 VA
Size 6		200 VA	350 VA	500 VA	500 VA
Size 1 Size 2 Size 3 Size 4 Size 5 Size 6	Two-Speed One Winding	100 VA	200 VA	200 VA	250 VA
Size 2		100 VA	200 VA	200 VA	250 VA
Size 3		200 VA	250 VA	200 VA	250 VA
Size 4		350 VA	500 VA	200 VA	250 VA
Size 5		350 VA	500 VA	500 VA	500 VA
Size 6		200 VA	350 VA	500 VA	500 VA
Size 1 Size 2 Size 3 Size 4 Size 5 Size 6	Two-Speed Two Winding	100 VA	150 VA	100 VA	250 VA
Size 2		100 VA	150 VA	100 VA	250 VA
Size 3		150 VA	250 VA	150 VA	250 VA
Size 4		200 VA	250 VA	150 VA	250 VA
Size 5		200 VA	250 VA	300 VA	350 VA
Size 6		200 VA	350 VA	300 VA	350 VA
Size 1 Size 2 Size 3 Size 4 Size 5 Size 6	Part Winding	150 VA	150 VA	200 VA	250 VA
Size 2		150 VA	150 VA	200 VA	250 VA
Size 3		200 VA	250 VA	200 VA	250 VA
Size 4		350 VA	500 VA	200 VA	250 VA
Size 5		350 VA	500 VA	200 VA	250 VA
Size 6		200 VA	350 VA	500 VA	500 VA
Size 2 Size 3 Size 4 Size 5 Size 6	Wye Delta (Open or Closed Transition)	200 VA	200 VA	200 VA	250 VA
Size 3		350 VA	200 VA	200 VA	250 VA
Size 4		350 VA	500 VA	200 VA	250 VA
Size 5		200 VA	500 VA	500 VA	500 VA
Size 6		200 VA	350 VA	500 VA	500 VA

① Maximum size without increasing starter space.

Table 80. Freedom and Advantage MCC Ratings and Highlights

Feature	Freedom	Advantage
Vertical Bus Barrier	Flat Glastic, Labyrinth Available	Labyrinth
Communications from Starter Units	IQ 500 via PowerNet, DN65 via DeviceNet IQ MP-3000 via PowerNet	Advantage WPONI or CMU via PowerNet WPONIDNA via DeviceNet
Bus Bracing	65 kA Standard 42 and 100 kA Available	65 kA Standard 100 kA Available
Control Wire	#16 Standard	#14 Standard <sup>②</sup>
Horizontal Bus Material	Copper	Copper
Pilot Devices	10250T	ACM or 10250T
6-inch (152.4 mm) Starter Compartment	F206 Size 1	W206 Sizes 1 and 2
FVNR Sizes 3 and 4	18-inch (457.2 mm) Compartment	12- or 18-inch (304.8 or 457.2 mm) Compartment
FVNR Size 6	54-inch (1371.6 mm) Compartment	36-inch (914.4 mm) Compartment

② 6-inch (152.4 mm) units available with #16 control wire only.

**Motor Protection**

In line with NEC 430-6(a), circuit breaker, HMCP and fuse rating selections are based on full load currents for induction motors running at speeds normal for belted motors and motors with normal torque characteristics using data taken from NEC Table 430-150 (3-phase). Actual motor nameplate ratings shall be used for selecting motor running overload protection. Motors built special for low speeds, high torque characteristics, special starting conditions and applications will require other considerations as defined in the application section of the NEC.

These additional considerations may require the use of a higher rated HMCP, or at least one with higher magnetic pickup settings.

Circuit breaker, HMCP and fuse ampere rating selections are in line with maximum rules given in NEC 430-52 and Table 430-152. Based on known characteristics of Cutler-Hammer type breakers, specific units are recommended. The current ratings are no more than the maximum limits set by the NEC rules for motors with code letters F to V or without code letters. Motors with lower code letters will require further considerations.

In general, these selections were based on:

1. Ambient — Outside enclosure not more than 40°C (104°F).
2. Motor starting — Infrequent starting, stopping or reversing.
3. Motor accelerating time — 10 seconds or less.
4. Locked rotor — Maximum 6 times motor FLA.

Type HMCP motor circuit protector may not be set at more than 1700% of the motor full-load current, to comply with the NEC, Sec. 430-52. (Except for new E rated motor which can be set up to 1700%.)

Circuit breaker selections are based on types with standard interrupting ratings. Higher interrupting rating types may be required to satisfy specific system application requirements.

For motor full load currents of 208 and 230 volts, increase the corresponding 230-volt motor values by 10 and 15% respectively.

**Table 81. Motor Circuit Protector (MCP), Circuit Breaker and Fusible Switch Selection Guide**

Hp	Full Load Amperes (NEC) FLA	Fuse Size NEC 430-152 Maximum Amperes		Recommended Cutler-Hammer			
		Time Delay	Non-Time Delay	Circuit Breaker		Motor Circuit Protector Type HMCP	
				Amperes	Type	Amperes	Adj. Range
<b>230 Volts, 3-Phase</b>							
1	3.6	10	15	15	HFD	7	21 – 70
1-1/2	5.2	10	20	15	HFD	15	45 – 150
2	6.8	15	25	15	HFD	15	45 – 150
3	9.6	20	30	20	HFD	30	90 – 300
5	15.2	30	50	30	HFD	30	90 – 300
7-1/2	22	40	70	50	HFD	50	150 – 500
10	28	50	90	60	HFD	50	150 – 500
15	42	80	150	90	HFD	70	210 – 700
20	54	100	175	100	HFD	100	300 – 1000
25	68	125	225	125	HFD	150	450 – 1500
30	80	150	250	150	HFD	150	450 – 1500
40	104	200	350	150	HFD	150	750 – 2500
50	130	250	400	200	HFD	150	750 – 2500
60	154	300	500	225	HFD	250	1250 – 2500
75	192	350	600	300	HKD	400	2000 – 4000
100	248	450	800	400	HKD	400	2000 – 4000
125	312	600	1000	500	HLD	600	1800 – 6000
150	360	700	1200	600	HLD	600	1800 – 6000
200	480	1000	1600	700	HND	600	1800 – 6000
<b>460 Volts, 3-Phase</b>							
1	1.8	6	6	15	HFD	7	21 – 70
1-1/2	2.6	6	10	15	HFD	7	21 – 70
2	3.4	6	15	15	HFD	7	21 – 70
3	4.8	10	15	15	HFD	15	45 – 150
5	7.6	15	25	15	HFD	15	45 – 150
7-1/2	11	20	35	25	HFD	30	90 – 300
10	14	25	45	35	HFD	30	90 – 300
15	21	40	70	45	HFD	50	150 – 500
20	27	50	90	50	HFD	50	150 – 500
25	34	60	110	70	HFD	70	210 – 700
30	40	70	125	70	HFD	100	300 – 1000
40	52	100	175	100	HFD	100	300 – 1000
50	65	125	200	110	HFD	150	450 – 1500
60	77	150	150	250	HFD	150	750 – 2500
75	96	175	300	150	HJD	150	750 – 2500
100	124	225	400	175	HJD	150	750 – 2500
125	156	300	500	225	HJD	250	1250 – 2500
150	180	350	600	250	HJD	400	2000 – 4000
200	240	450	800	350	HKD	400	2000 – 4000
<b>575 Volts, 3-Phase</b>							
1	1.4	3	6	15	HFD	3	9 – 30
1-1/2	2.1	6	10	15	HFD	7	21 – 70
2	2.7	6	10	15	HFD	7	21 – 70
3	3.9	10	15	15	HFD	7	21 – 70
5	6.1	15	20	15	HFD	15	45 – 150
7-1/2	9	20	30	20	HFD	15	45 – 150
10	11	20	35	25	HFD	30	90 – 300
15	17	30	60	40	HFD	30	90 – 300
20	22	40	70	50	HFD	50	150 – 500
25	27	50	90	60	HFD	50	150 – 500
30	32	60	100	60	HFD	50	150 – 500
40	41	80	125	80	HFD	100	300 – 1000
50	52	100	175	100	HFD	100	300 – 1000
60	62	110	200	125	HFD	150	750 – 2500
75	77	150	250	150	HFD	150	750 – 2500
100	99	175	300	175	HJD	150	750 – 2500
125	125	225	400	200	HJD	250	1250 – 2500
150	144	300	450	225	HJD	250	1250 – 2500
200	192	350	600	300	HKD	400	2000 – 4000

Table 82. Starter Sizes Selection Guide

Squirrel-Cage Motor Horsepower	230 V, 3-Phase			460 V, 3-Phase			575 V, 3-Phase		
	Control Center Starter NEMA Size	Full Load Current Amperes	Wire Size ② at 75°C Max. at 40°C Amb.	Control Center Starter NEMA Size	Full Load Current Amperes	Wire Size ② at 75°C Max. at 40°C Amb.	Control Center Starter NEMA Size	Full Load Current Amperes	Wire Size ② at 75°C Max. at 40°C Amb.
1/2	1	2.2	14	1	1.1	14	1	.9	14
3/4	1	3.2	14	1	1.6	14	1	1.3	14
1	1	4.2	14	1	2.1	14	1	1.7	14
1-1/2	1	6.0	14	1	3.0	14	1	2.4	14
2	1	6.8	14	1	3.4	14	1	2.7	14
3	1	9.6	14	1	4.8	14	1	3.9	14
5	1	15.2	12	1	7.6	14	1	6.1	14
7-1/2	1	22	10	1	11	14	1	9	14
10	2	28	10	1	14	14	1	11	14
15	2	42	8	2	21	10	2	17	12
20	3	54	6	2	27	10	2	22	10
25	3	68	4	2	34	8	2	27	10
30	3	80	3	3	40	8	3	32	8
40	4	104	1	3	52	6	3	41	8
50	4	130	1/0	3	65	4	3	52	6
60	5	154	3/0	4	77	3	4	62	4
75	5	192	4/0	4	96	2	4	77	3
100	5	248	300 kcmil	4	124	1/0	4	99	2
125	6	312	500 kcmil	5	156	3/0	5	125	1/0
150	6	360	2 - 4/0	5	180	4/0	5	144	2/0
200	6	480	2 - 300 kcmil	5	240	300 kcmil	5	192	4/0
250	—	—	—	6	302	500 kcmil	6	242	300 kcmil
300	—	—	—	6	361	2 - 4/0	6	289	400 kcmil

① Information is based on Table 430-150 of NEC (1999).

② Information is based on use of copper conductors — Table 310-16 and Tables 1, 4 and 5, Ch. 9 of NEC. If aluminum conductors are used refer to Table 310-16 of NEC (1999).

Dimensions

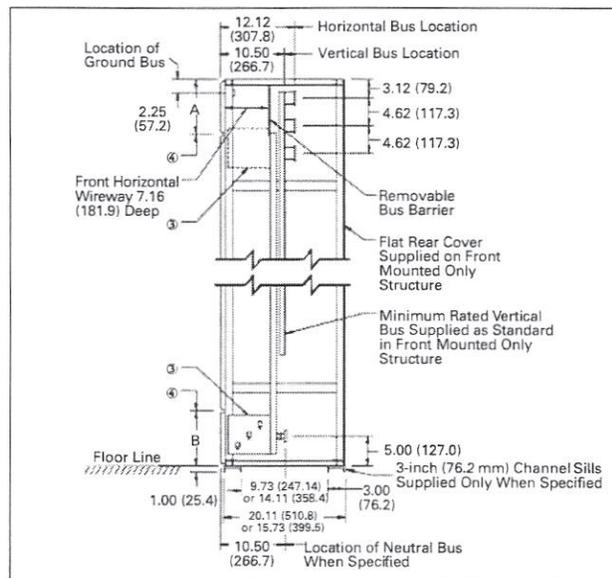


Figure 3. Side View A — Front Mounted Only in Inches (mm)

③ Master terminal block assembly furnished for Type C wiring only. When location not specified, MTB supplied at the bottom.

- ④ Standard structure arrangement in front Without MTB; A & B = 9 (228.6) With MTB at bottom; A & B = 9 (228.6) With MTB at top; A = 15 (381.0), B = 3 (76.2)

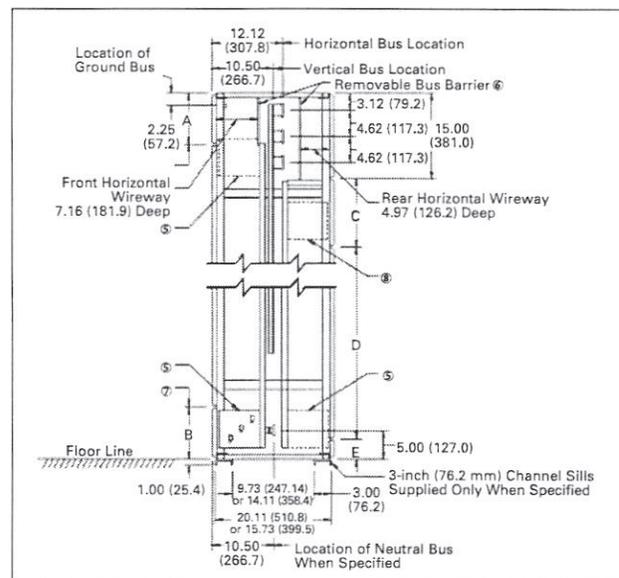
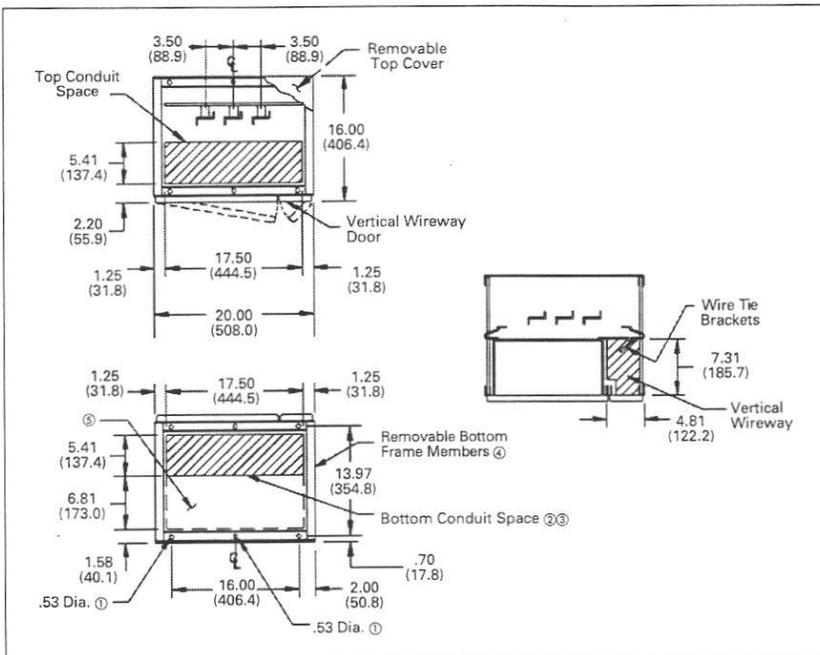


Figure 4. Side View B — Front and Rear Mounted in Inches (mm)

③ Master terminal block assembly furnished for Type C wiring only. When location not specified, MTB supplied at the bottom.

- ⑥ Rear horizontal bus barrier not supplied with front mounted only structure.
- ⑦ Standard structure arrangement in front Without MTB; A & B = 9 (228.6) With MTB at bottom; A & B = 9 (228.6) With MTB at top; A = 15 (381.0), B = 3 (76.2)
- ⑧ Standard structure arrangement in rear Without MTB; C = 9 (228.6), D = 72 (1828.8), E = 3 (76.2) With MTB at bottom; C = 0, D = 66 (1676.4), E = 9 (228.6) With MTB at top; C = 12 (304.8), D = 60 (1524.0), E = 3 (76.2)

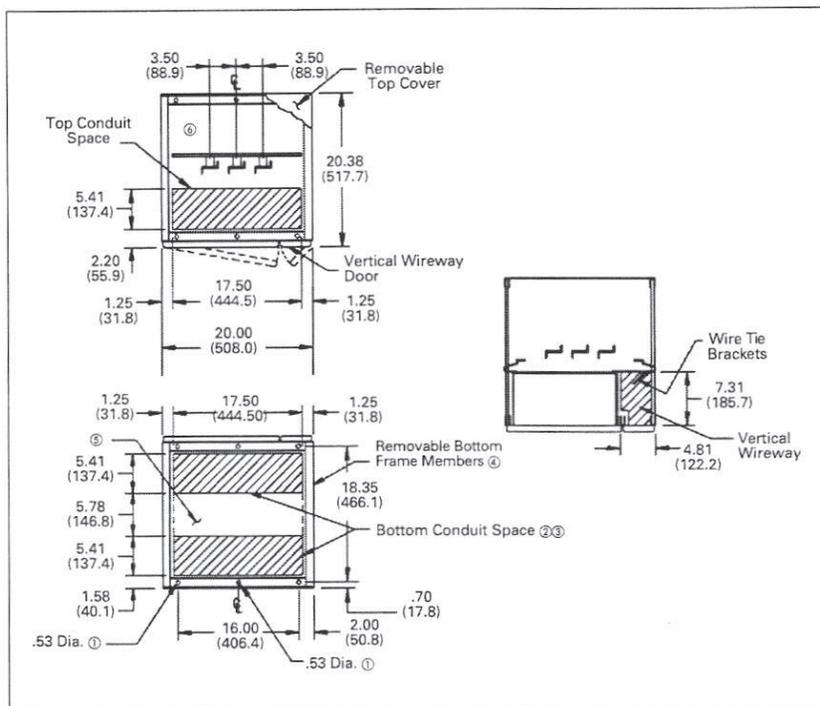
Not to be used for construction purposes unless approved.



**Figure 5. Front Mounted Only (FMO) in Inches (mm)  
20 Inches (508.0 mm) Wide, 16 Inches (406.4 mm) Deep**

- ① Minimum length of anchor bolt 2 (50.8) .36 (9.1) — 16 recommended.
- ② Recommended maximum conduit height above floor line 3.5 (88.9).
- ③ Maximum conduit space with channel sills 17.5 x 9.73 (444.5 x 247.1).
- ④ For multiple structure assemblies. Either one or both of these members are removed to provide maximum unrestricted conduit space at bottom. Not to be removed for Seismic.
- ⑤ This conduit space not recommended when neutral bus required. Otherwise available.
- ⑥ Top rear conduit space not recommended for conduit entry in FMO structure.

See Side View A Page 40 for vertical dimensions.



**Figure 6. 20 Front Mounted Only (FMO) in Inches (mm)  
20 Inches (508.0 mm) Wide, 21 Inches (533.4 mm) Deep**

**Not to be used for construction purposes unless approved.**

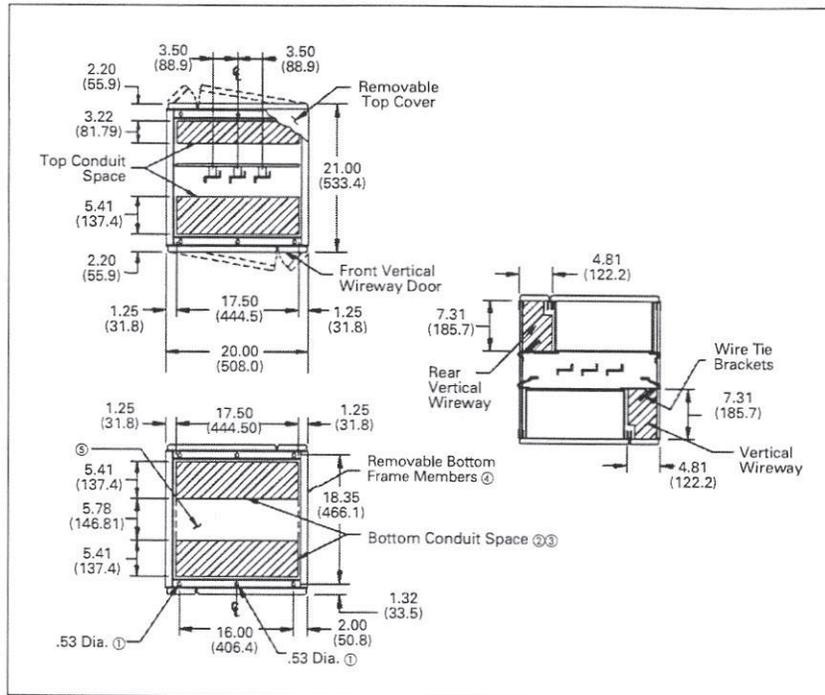


Figure 7. Front Mounted Only (FMO) in Inches (mm)  
20 Inches (508.0 mm) Wide, 21 Inches (533.4 mm) Deep

- ① Minimum length of anchor bolt 2 (50.8) .36 (9.1) — 16 recommended.
- ② Recommended maximum conduit height above floor line 3.5 (88.9).
- ③ Maximum conduit space with channel sills 17.5 x 14.11 (444.5 x 358.4) in 21-inch deep structure. 7.5 x 9.73 (190.5 x 247.1) in 16-inch deep structure.
- ④ For multiple structure assemblies. Either one or both of these members are removed to provide maximum unrestricted conduit space at bottom. Not to be removed for Seismic.
- ⑤ This conduit space not recommended when neutral bus required. Otherwise available.
- ⑥ Channel sills supplied only when specified. For seismic loads channel sills if required must be embedded so top of channel sill is still at floor level.

See Side View B Page 40 for vertical dimensions.

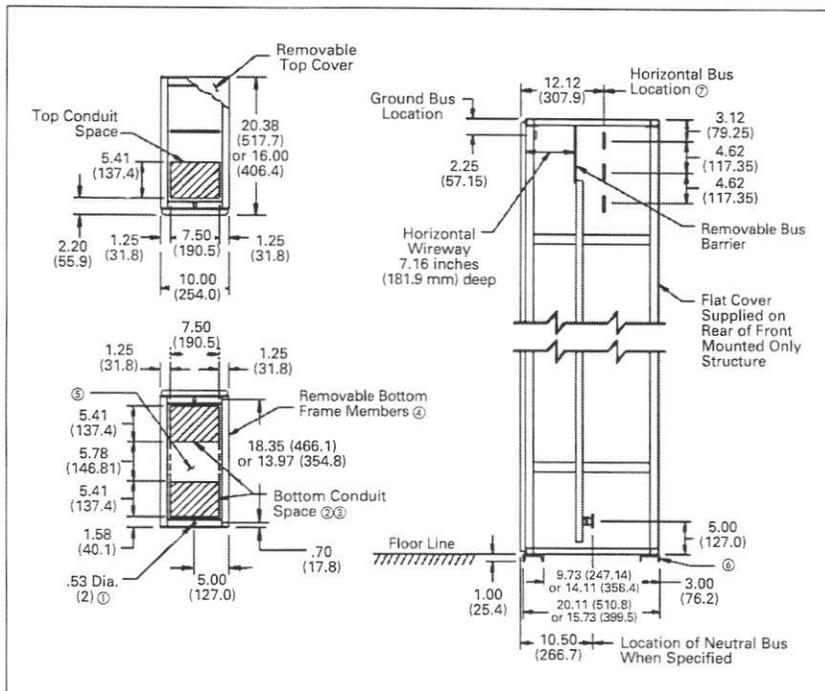
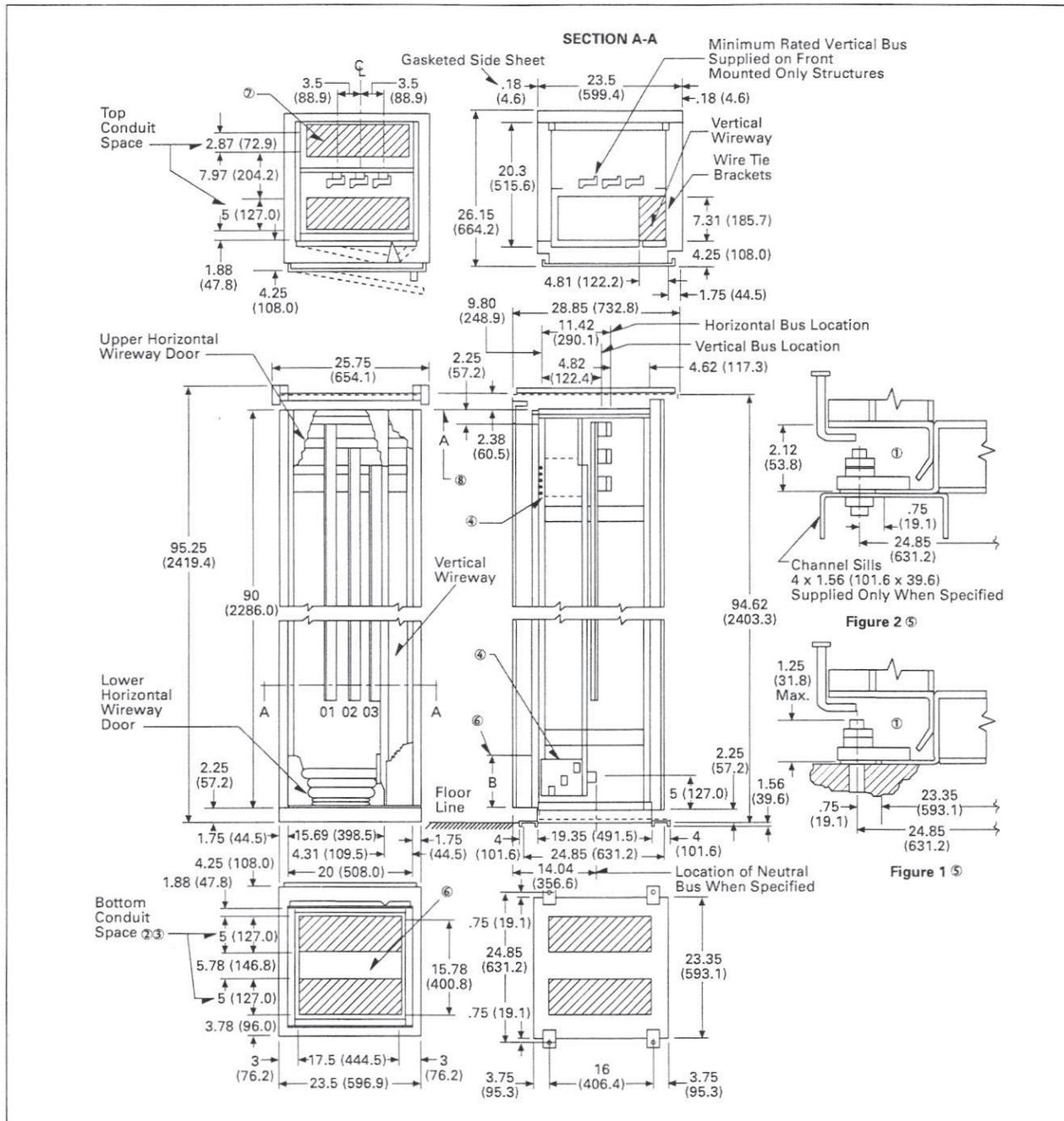


Figure 8. Front Mounted Only (FMO) in Inches (mm)  
10 Inches (254.0 mm) Wide, 16 or 21 Inches (406.4 mm or 533.4 mm) Deep

Not to be used for construction purposes unless approved.



**Figure 9. Freedom Series 2100 Motor Control Center Outline and Floor Plan NEMA 3R 20-inch (508.0 mm) Deep Structure — Dimensions in Inches (mm)**

- ① Minimum length of anchor bolt 2 inches (50.8 mm). 38 (9.7 mm) — 16 recommended.
- ② Recommended maximum conduit height above floor line 3.5 inches (88.9 mm).
- ③ Maximum conduit space with channel sills 15.78 x 16.6 inches (400.8 x 421.6 mm).
- ④ Master terminal block assembly furnished for type "C" wiring only. When location not specified MTB supplied at the bottom.
- ⑤ Recommended standard anchor bolting for Figure 1. When channel sills are used see Figure 2.
- ⑥ This conduit space not recommended when neutral bus required. Otherwise available.
- ⑦ Top rear conduit space not recommended for conduit entry in front mounted only structure.
- ⑧ Standard structure arrangement (in front) without master terminal block, A and B — 9 inches (228.6 mm). With master terminal block at bottom, A and B — 9 inches (228.6 mm). With master terminal block at top: A — 15 inches (381.0 mm), B — 3 inches (76.2 mm).

**Note:** Rear horizontal bus barrier not supplied with front mounted only structure.



### Section 16482 — Motor Control Centers

#### Part 1 General

##### 1.01 Scope

- A. The Contractor shall furnish and install the motor control centers as specified herein and as shown on the contract drawings.

##### 1.02 Related Sections

- A. Section 16475 — Circuit Breakers and Fusible Switches.
- B. Section 16481 — Par. 2.03 — Freedom Electromechanical Motor Control.
- C. Section 16481 — Par. 2.04 — Advantage Microprocessor Motor Control.
- D. Section 16481 — Par. 2.05 — Solid-State Reduced Voltage Motor Control.
- E. Section 16483 — Adjustable Frequency Drives.
- F. Section 16671 — Transient Voltage Surge Suppression.
- G. Section 16901 — Microprocessor Metering Equipment.
- H. Section 16902 — Electric Control Devices.
- I. Section 16903 — Protective Relays.
- J. Section 16905 — Programmable Controllers.
- K. Section 16911 — Electrical Monitoring and Control Systems.

##### 1.03 References

- A. The Motor Control Centers and all components shall be designed, manufactured and tested in accordance with the latest applicable standards of NEMA, ANSI and UL 845.

##### 1.04 Submittals — For Review/Approval

- A. The following information shall be submitted to the Engineer:
1. Master drawing index.
  2. Front view elevation.
  3. Floor plan.
  4. Top view.
  5. Single line.
  6. Unit wiring diagrams depicting remote devices.
  7. Nameplate schedule.
  8. Starter and component schedule.
  9. Conduit entry/exit locations.
  10. Assembly ratings including:
    - a. Short-circuit rating.
    - b. Voltage.
    - c. Continuous current.
  11. Major component ratings including:
    - a. Voltage.
    - b. Continuous current.
    - c. Interrupting ratings.
  12. Cable terminal sizes.
  13. Product data sheets.
- B. Where applicable, the following information shall be submitted to the Engineer:
1. Busway connection.
  2. Connection details between close-coupled assemblies.
  3. Composite floor plan of close-coupled assemblies.
  4. Key interlock scheme drawing and sequence of operations.

##### 1.05 Submittals — For Construction

- A. The following information shall be submitted for record purposes:
1. Final as-built drawings and information for items listed in paragraph 1.04.
  2. Unit wiring diagrams.
  3. Certified production test reports.
  4. Installation information.
  5. Seismic certification and equipment anchorage details.

- B. The final (as-built) drawings shall include the same drawings as the construction drawings and shall incorporate all changes made during the manufacturing process.

##### 1.06 Qualifications

- A. The manufacturer of the assembly shall be the manufacturer of the major components within the assembly.
- B. For the equipment specified herein, the manufacturer shall be ISO® 9001 or 9002 certified.
- C. The manufacturer of this equipment shall have produced similar electrical equipment for a minimum period of five (5) years. When requested by the Engineer, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.
- D. The equipment and major components shall be suitable for and certified to meet all applicable seismic requirements of Uniform Building Code (UBC) for Zone 4 application. Guidelines for the installation consistent with these requirements shall be provided by the switchgear manufacturer and be based upon testing of representative equipment. The test response spectrum shall be based upon a 5% minimum damping factor, UBC: a peak of 2.15g's (3.2–11 Hz), and a ZPA of 0.86g's applied at the base of the equipment. The tests shall fully envelop this response spectrum for all equipment natural frequencies up to at least 35 Hz.

– OR –

- D. The equipment and major components shall be suitable for and certified to meet all applicable seismic requirements of the California Building Code (CBC) through Zone 4 application. Guidelines for the installation consistent with these requirements shall be provided by the switchgear manufacturer and be based upon testing of representative equipment. The test response spectrum shall be based upon a 5% minimum damping factor, CBC: a peak of 2.15g's, and a ZPA of 0.86g's applied at the base of the equipment. The tests shall fully envelop this response spectrum for all equipment natural frequencies up to at least 35 Hz.

– OR –

- D. The equipment and major components shall be suitable for and certified to meet all applicable seismic requirements of the BOCA® National Building Code, paragraph 1612.6. This shall include both vertical and lateral required response spectra as specified. Alternatively, the manufacturer's certification may be based on a detailed computer analysis of the entire assembly structure and its components. Guidelines for the installation consistent with these requirements shall be provided by the switchgear manufacturer and be based upon testing of representative equipment. The equipment manufacturer shall document the requirements necessary for proper seismic mounting of the equipment. The test response spectra shall meet or exceed the required response spectra peak acceleration of 1.6g's (3.2–11 Hz) and a ZPA of 1.0g as specified in the BOCA National Building Code, for all equipment natural frequencies up to at least 35 Hz.
- E. The following minimum mounting and installation guidelines shall be met, unless specifically modified by the above referenced standards.
  - 1. The Contractor shall provide equipment anchorage details, coordinated with the equipment mounting provision, prepared and stamped by a licensed civil engineer in the state. Mounting recommendations shall be provided by the manufacturer based upon approved shake table tests used to verify the seismic design of the equipment.
  - 2. The equipment manufacturer shall certify that the equipment can withstand, that is, function following the seismic event, including both vertical and lateral required response spectra as specified in above codes.
  - 3. The equipment manufacturer shall document the requirements necessary for proper seismic mounting of the equipment. Seismic qualification shall be considered achieved when the capability of the equipment, meets or exceeds the specified response spectra.

**1.07 Regulatory Requirements**

- A. The motor control centers shall bear a UL label. (Certified copies of production test reports shall be supplied demonstrating compliance with these standards when requested by the Engineer.)

**1.08 Delivery, Storage and Handling**

- A. Equipment shall be handled and stored in accordance with manufacturer's instructions. One (1) copy of these instructions shall be included with the equipment at time of shipment.

**1.09 Operation and Maintenance Manuals**

- A. Equipment operation and maintenance manuals shall be provided with each assembly shipped and shall include instruction leaflets, instruction bulletins and renewal parts lists where applicable, for the complete assembly and each major component.

**Part 2 Products**

**2.01 Manufacturers**

- A. The Cutler-Hammer business
- B. \_\_\_\_\_
- C. \_\_\_\_\_

The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety. Products in compliance with the specification and manufactured by others not named will be considered only if pre-approved by the Engineer ten (10) days prior to bid date.

**2.02 Ratings**

- A. The Motor Control Center(s) shall be 600-volt class suitable for operation on a 3-phase, 60-Hz system. The system operating voltage and number of wires shall be as indicated on the drawings.

**2.03 Construction**

- A. Motor Control Center(s) shall be Cutler-Hammer type [F2100] [Advantage] design.

- B. Structures shall be totally enclosed deadfront, free-standing assemblies. They shall be 90 inches high and [16 inches] [21 inches] deep for front-mounted units. Structures shall contain a horizontal wireway at the top, isolated from the horizontal bus and shall be readily accessible through a hinged cover. Adequate space for conduit and wiring to enter the top or bottom shall be provided without structural interference.
- C. Compartments for mounting control units shall be incrementally arranged such that not more than [six (6) size 1 starters for front-mounted only] [eleven (11) size 1 starters for back-to-back] can be mounted within each vertical structure. Guide rails shall be provided.
- D. A vertical wireway with minimum of 35 square inches of cross-sectional area shall be adjacent to each vertical unit and shall be covered by a hinged door. Wireways shall contain steel rod cable supports.
- E. All full voltage starter units through NEMA Size 5 shall be of the drawout type. Drawout provisions shall include a positive guide rail system and stab shrouds to absolutely ensure alignment of stabs with the vertical bus. Drawout units shall have a tin-plated stab assembly for connection to the vertical bus. No wiring to these stabs shall extend into the bus compartment. Interior of all units shall be painted white for increased visibility. Units shall be equipped with side-mounted, positive latch pull-apart type control terminal blocks rated 600 volts. Knockouts shall be provided for the addition of future terminal blocks. In addition, a master terminal block, when Type C wiring is specified, shall be drawout and shall be located in the [top] [bottom] wireway, readily accessible through a hinged cover. All control wire to be [14 gauge] [16 gauge] minimum.
- F. All drawout units shall be secured by a spring-loaded quarter turn indicating type fastening device located at the top front of the unit. Each unit compartment shall be provided with an individual front door.

- G. An operating mechanism shall be mounted on the primary disconnect of each starter unit. It shall be mechanically interlocked with the unit door to prevent access unless the disconnect is in the OFF position. A defaeter shall be provided to bypass this interlock. With the door open, an interlock shall be provided to prevent inadvertent closing of the disconnect. A second interlock shall be provided to prevent removal or re-insertion of the unit while in the ON position. Padlocking facilities shall be provided to positively lock the disconnect in the OFF position with from one (1) to three (3) padlocks with the door open or closed. In addition, means shall be provided to padlock the unit in a partially withdrawn position with the stabs free of the vertical bus.

#### 2.04 Bus

- A. Each structure shall contain a main horizontal [copper tin-plated] [copper silver-plated] bus, with minimum ampacity of 600 amperes or rated [800] [1200] [1400] [1600] [2000] [2500] [3200] amperes as shown on the drawings. The horizontal bus shall be rated at [65] [50] °C temperature rise over a 40°C ambient in compliance with UL standards. Vertical bus feeding unit compartments shall be copper and shall be securely bolted to the horizontal main bus. All joints shall be front-accessible for ease of maintenance. The vertical bus shall have a minimum rating of 300 amperes for front-mounted units and 600 amperes for back-to-back mounted units or fully rated [600] [800] [1200] amperes.
- B. For [F2100] [Advantage] design MCC, the vertical bus shall be completely isolated and insulated by means of a labyrinth design barrier. It shall effectively isolate the vertical buses to prevent any fault-generated gases to pass from one phase to another. The vertical bus shall include a shutter mechanism to provide complete isolation of the vertical bus when a unit is removed.

– OR –

- B. For F2100 design MCC, isolation of the vertical bus compartment from the unit compartment shall be by means of a full height insulating barrier. This barrier shall be a single sheet of glass reinforced polyester with cutouts to allow the unit stabs to engage the vertical bus. Provide snap-in covers for all unused openings.
- C. Buses shall be braced for [65,000] [100,000] amperes rms symmetrical.

#### 2.05 Wiring/terminations

- A. A. Wiring shall be NEMA Class [I] [II], Type [A] [B] [C].
- B. DeviceNet Wiring shall be in accordance with the Open DeviceNet Vendors Association (ODVA) specification. Truck cable shall be provided in the upper wireway, with T connectors for each MCC section. Drop cables and T connectors shall be used in the vertical wireway to connect each DeviceNet device.

#### 2.06 Motor Controllers

##### Note to Spec. Writer:

Two classes of combination motor starters are outlined below. Select one of the paragraphs 2.06 A. The first paragraph is for circuit breaker type combination starters; the second paragraph is for fusible type starters combination starters. Three types of motor starter (contactor/ overload) are available. Select one of the of paragraphs 2.06 B. The first paragraph is for Advantage Microprocessor Motor Starters; the second paragraph is for DeviceNet Compatible Motor Controllers; the third paragraph is for Freedom Series NEMA Electromechanical Motor Starters for F2100 MCC

- A. Combination starter units shall be full-voltage non-reversing, unless otherwise shown, and shall utilize Cutler-Hammer type HMCP Motor Circuit Protectors.
1. Each combination unit shall be rated [65,000] [100,000] AIC symmetrical at 480 V. The HMCP shall provide adjustable magnetic protection and be provided with pin insert to limit magnetic adjustment to a maximum of 1700% motor nameplate full load current to comply with NEC requirements. All HMCP combination starter units shall have a "tripped" position on the unit disconnect and a push-to-test button on the HMCP. Type HMCP

motor circuit protectors shall include transient override feature for motor inrush current. [HMCP shall be used to provide IEC 947-4 Type 2 coordination to 100,000 amperes.]

– OR –

- A. Combination starter units shall be full-voltage non-reversing, unless shown otherwise utilizing fusible switches.
1. Fusible switches shall be quick-make, quick-break and shall accept class R dimension fuses and the combination shall safely interrupt 100,000 amperes. Fusible combination starters shall provide IEC 947-4 Type 2 coordination to 100,000 amperes.
- B. Motor starters shall be Cutler-Hammer type Advantage, electrically operated, electrically held, 3-pole assemblies with arc extinguishing characteristics and shall have silver-to-silver renewable contacts. They shall have provisions for a total of eight (8) NO or eight (8) NC auxiliary contacts. The overload protection shall consist of one (1) current sensor located in each phase monitored by the microprocessor that yields a time-current curve closely paralleling that of motor heating damage boundary, accurate to 2%. Running overload protection shall be DIP switch selectable for the specific motor full load amperes within the starter range. Provide DIP switch selectable overload trip class of 10, 20 and 30.
1. Motor starters shall monitor current in each phase to provide phase loss and phase unbalance protection, such that if the unbalance on any of two phases is greater than 30% of the DIP switch selected trip rating, a phase loss/unbalance trip occurs. Provide phase loss/unbalance protection which requires no time delay for reset.
  2. Motor starters shall provide ground fault protection. Ground fault protection shall be set at 20% of maximum continuous ampere rating and have a start delay of 20 seconds, and a run delay of 1 second to prevent nuisance trip on starting.

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3. Microprocessor shall measure control circuit voltage and prevent closing of the coil on low-voltage (78 Vac) and/or high-voltage (135 Vac) conditions which are outside of the coil ratings.
  4. Microprocessor shall apply voltage to the coil such that a guaranteed maximum of two (2) milliseconds of main contact bounce occurs on contactor closure.
  5. Microprocessor shall continuously measure coil circuit voltage and current so as to maintain constant coil power at a level to maintain main contact closure and minimize coil power consumption.
  6. Provide control modules to perform the indicated input/output control functions shown on the drawings. Module to incorporate faceplates having membrane type pushbuttons and LEDs. All pushbutton and LED functions to be furnished with clearly written identification. Modules to be provided with the ability to replace conventional start, stop, hand, auto, and control functions, and when utilized in starter applications, overload reset function. Modules to be provided with the ability to replace conventional indicating light status of run, off, selector switch pushbutton position, and when utilized in starter applications, overload alarm and overload trip.
  7. Provide, where indicated on the drawings, a metering module capable of displaying control voltage, status and where utilized on starter applications, cause of trip, current at time of trip and current in each phase.
  8. [Provide] [Make provisions for] an addressable communication card capable of transmitting all data over a compatible two-wire local area network to a central personal computer for storage and/or printout. The network shall also be capable of transmitting data in RS232c format via a translator module.
    - a. ON-OFF reset control functions.
    - b. Status (ON, OFF, TRIPPED, NO RESPONSE).
  - c. Current in each phase.
  - d. Percent phase unbalance.
  - e. Control voltage.
  - f. Overload protection settings.
  - g. Cause of trip.
  - h. Trip current magnitude.
- OR -
- C. Motor starters shall be DeviceNet compatible, Cutler-Hammer type Advantage, electrically operated, electrically held, 3-pole assemblies with arc extinguishing characteristics and shall have silver-to-silver renewable contacts. They shall have provisions for a total of eight (8) NO or eight (8) NC auxiliary contacts. The overload protection shall consist of one (1) current sensor located in each phase monitored by the microprocessor that yields a time-current curve closely paralleling that of motor heating damage boundary, accurate to 2%. Running overload protection shall be DIP switch selectable for the specific motor full load amperes within the starter range. Provide DIP switch selectable overload trip class of 10, 20 and 30.
1. Motor starters shall monitor current in each phase to provide phase loss and phase unbalance protection, such that if the unbalance on any of two phases is greater than 30% of the DIP switch selected trip rating, a phase loss/unbalance trip occurs. Provide phase loss/unbalance protection which requires no time delay for reset. Phase unbalance protection shall have the capability of being deactivated by use of a hand-held programmer.
  2. Motor starters shall provide ground fault protection. Ground fault protection shall be set at 20% of maximum continuous ampere rating and have a start delay of 20 seconds, and a run delay of 1 second to prevent nuisance trip on starting. Ground fault protection shall have the capability of being deactivated by use of a hand-held programmer.
  3. Microprocessor shall measure control circuit voltage and prevent closing of the coil on low-voltage (78 Vac) and/or high-voltage (135 Vac) conditions which are outside of the coil ratings.
  4. Microprocessor shall apply voltage to the coil such that a guaranteed maximum of two (2) milliseconds of main contact bounce occurs on contactor closure.
  5. Microprocessor shall continuously measure coil circuit voltage and current so as to maintain constant coil power at a level to maintain main contact closure and minimize coil power consumption.
  6. Provide control modules to perform the indicated input/output control functions shown on the drawings. Module to incorporate faceplates having membrane type pushbuttons and LEDs. All pushbutton and LED functions to be furnished with clearly written identification. Modules to be provided with the ability to replace conventional start, stop, hand, auto, and control functions, and when utilized in starter applications, overload reset function. Modules to be provided with the ability to replace conventional indicating light status of run, off, selector switch pushbutton position, and when utilized in starter applications, overload alarm and overload trip.
  7. Provide, where indicated on the drawings, a metering module capable of displaying control voltage, status and where utilized on starter applications, cause of trip, current at time of trip and current in each phase.
  8. Each Starter shall have an addressable communication card capable of transmitting control and diagnostic data over an open DeviceNet network to either a personal computer or PLC. The addition of the DeviceNet communication module shall not increase the size of the controller. The starter shall be capable of transmitting the following data.
    - a. ON-OFF reset control functions.
    - b. Status (ON, OFF, TRIPPED, NO RESPONSE).
    - c. Current in each phase.
    - d. Percent phase unbalance.
    - e. Control voltage.
    - f. Overload protection settings.
    - g. Trip current magnitude.
    - h. Average motor current.

- i. Hand/Manual/Local control.
  - j. Cause of trip indication:
    1. Phase loss.
    2. Phase unbalance.
    3. Ground fault.
    4. Thermal trip.
- OR –
- B. Motor starters shall be Cutler-Hammer Freedom Series NEMA type electrically operated, electrically held, 3-pole assemblies with arc extinguishing characteristics and shall have silver-to-silver renewable contacts. They shall have provisions for a total of eight (8) NO or eight (8) NC auxiliary contacts. The overload relay assembly shall be of the thermal bimetallic ambient compensated type. Overload relays shall be reset from outside the enclosure by means of an insulated button. The overload relay shall have a built-in push-to-test button, electrically isolated NO-NC contacts and single-phase sensitivity.
- C. Each starter shall be equipped with a fused control power transformer, two (2) indicating lights, HOA selector switch, and two (2) NO contacts, unless otherwise scheduled on the drawings. Device panel to have space to accommodate six (6) oil-tight pilot-control devices or indicating ammeters, voltmeters, or elapsed time meters.
- D. Solid-state reduced-voltage starters, Cutler-Hammer type S801 shall be provided where shown on the contract drawings. The solid-state reduced-voltage starter shall be UL and CSA® listed in the motor control center, and consist of an SCR-based power section, logic board and paralleling bypass contactor. The paralleling bypass contactor shall be energized when the motor reaches full speed. Heat sinks shall not be allowed in the MCC structure. Each starter shall have an addressable communication card capable of transmitting control and diagnostic data over an open DeviceNet network to either a personal computer or PLC.
- Note to Spec. Writer:**  
For more detailed specification information refer to section 16481, paragraph 2.05.
- E. Adjustable frequency controllers shall be provided in MCC(s) where scheduled. Controllers shall be Cutler-Hammer type AF91 and/or SV9000 for variable torque loads unless otherwise indicated on the drawings. Controllers for variable torque loads shall be rated a minimum of 110% overcurrent for one (1) minute. Drives larger than [1 hp] [10 hp] shall have identical keypads, control terminals and programmable parameters. Drives shall be capable of providing 200% starting torque. Drives over 150 hp shall be located next to the main section to reduce bus loading and heating. All controllers shall be combination type and shall include options as specified. Drives shall have communication cards capable of communication using [DeviceNet] [PROFIBUS] [LonWorks] [Modbus RTU] [Interbus S] [SDS]. Drives shall be capable of using a V/Hz, open loop vector, or closed loop vector control architecture.
- Note to Spec. Writer:**  
For more detailed specification information refer to section 16483, paragraph 2.02.
- Note to Spec. Writer:**  
Select paragraph 2.06 F as optional choice on Advantage MCC only.
- F. Advantage Central Monitoring Unit (CMU)
1. Where shown on the drawing, provide a Cutler-Hammer type Advantage Central Monitoring Unit (CMU) or approved equal. The CMU shall be a microprocessor-based, self-contained device (NEMA 3R/12 faceplate) suitable for door mounting and shall perform the following listed functions. Each assembly shall have provisions for a communications module to provide for remote computer monitoring up to 10,000 feet (2540 m).
  2. Monitoring and display parameters of up to 99 Cutler-Hammer type Advantage starters or contactors equipped with product operated network interface card (PONI), or Cutler-Hammer type IQ 500 solid-state overload relays. Communications over the local area network shall be 9,600 baud. Parameters locally displayed at the CMU for each starter and overload relay shall also be capable of being communicated via twisted pair to a remote personal computer. Information displayed at the CMU shall include the following:
    - a. Status – ON, OFF, TRIPPED, NO RESPONSE.
    - b. Standard address.
    - c. Three-phase current.
    - d. Control voltage.
    - e. Overload condition (alarm).
    - f. Cause of device trip.
    - g. Operations count.
    - h. Run time.
    - i. Set points.
    - j. Starter description and identification.
  3. When used with the remote communications option, the CMU shall pass data to a computer from Advantage starters, contactors and overload relays (IQ 500). The master or the host network's baud rate (speed of upper network passing data to a computer) shall be independent of the CMU's subnetwork baud rate. The master or host network's baud rate shall be established via the PONI communications module while the CMU's subnetwork baud rate shall be switch selectable on the rear of the CMU.
  4. The program directing the functions or the CMU shall be permanently stored in the CMU. There shall be no need to reload data after ac power loss.
  5. The addresses, types of devices and descriptions shall be stored in memory during the learn mode and shall also be retained throughout a power loss. Unless there has been a change, it shall not be necessary to re-enter the learn mode after a power loss.
  6. The CMU shall have an 8-digit alphanumeric display to monitor active data, trip data or set points which are available from the individual motor control devices. The CMU shall have three (3) LEDs to indicate which group of data is being displayed, as selected through membrane-type alphanumeric pushbuttons by the user. The CMU shall have a 2-digit alphanumeric display to indicate the address of the control device for which data is

being displayed. The CMU shall have membrane type pushbuttons to allow the user to step up or down to select the control device to be displayed. The CMU shall have two (2) additional LEDs at the top of the CMU to indicate that the CMU is operational and when there is an "alarm" status on one of the motor control devices. The CMU shall have an "acknowledge/reset" membrane-type pushbutton to permit the user to reset the CMU following a motor control device trip.

7. The CMU shall be operated from 120-volt, single-phase input.
8. The CMU shall have a "Help" button function, which shall scroll English explanations in the alphanumeric window for any condition or abbreviations.
9. [Provide] [Make provisions for] an addressable communication card capable of transmitting all data, including trip data over a compatible two-wire, local area network to a central personal computer for storage and or printout. Provide data and time-stamping for all starter/contactor operations. Reprogramming of the CMU shall not be required when adding a communication module. The network shall also be capable of transmitting data in RS232c format via a translator module.

**2.07 Overcurrent Devices**

**A. Circuit Breakers**

1. Individual feeder breakers shall have a minimum interrupting capacity of [65] [100] kAIC at rated voltage or as scheduled on the drawings.

**B. Fusible Switches**

1. Individual feeder switches shall be quick-make, quick-break gang-operated type utilizing class R fuse clips. The fused switch shall be rated 100 kAIC at rated voltage.

**2.08 DeviceNet Devices**

- A. Motor Control Center assemblies shall be provided with a factory assembled DeviceNet fieldbus communications network providing direct connectivity between MCC devices and the system controller and/or HMI.
- B. The DeviceNet system installed in the MCC shall include a complete and tested cabling system compliant and approved by the ODVA DeviceNet standard. The cabling system shall consist of trunk and drop line cabling including all splice and tap connectors and terminating resistors. The trunk and drop cabling shall be 600V insulation and include electrical shielding as per the standard ODVA DeviceNet specification. Non-standard, non-shielded flat cable will not be accepted.
- C. The trunk line shall be installed in the top horizontal wireway of the MCC. The trunk line shall be thick cable as specified by the ODVA standard. Sealed, threaded, and keyed device tap connectors located and mounted in the top horizontal wireway shall "T" off the top wireway to drop cable mounted in each of the vertical wireways. Each DeviceNet device shall have a dedicated drop line connection via T Connector. The drop cable shall be thin cable as specified by the ODVA standard. Each section of motor control shall be connected with sealed, threaded, and keyed device tap connectors located and mounted in the top horizontal wireway. All cabling shall be securely supported and attached to the MCC structure in accordance with the contract drawings and the manufacturer's recommendations.
- D. DeviceNet communications modules shall be provided at each device interfacing to the DeviceNet fieldbus. The communications modules shall be installed in the unit device compartment or bucket, and shall be direct-connected to the DeviceNet drop cable. Each device shall be provided with the appropriate factory fabricated cable for interfacing the communications module with the associated DeviceNet device.

- E. Port expanders shall be provided where required to permit multiple device communications. The port expander shall be installed in the associated unit device compartment.
- F. Motor control centers shall provide required 24 Vdc power to adequately supply power to all the devices in the [MCC] [Total System], and shall be sized as shown in drawings. The power supply shall be installed in an MCC unit with a disconnect switch, supplementary protection and a cable tap box to prevent damage to/ from other power supplies on the network.
- G. Operator interface unit(s) shall be PanelMate Power Series. Operator interface units shall be able to provide the following. Starter status, 3-phase current, control voltage, overload condition (alarm), cause of device trip, operations count, run time, set points, starter description and identification, system process graphics screens. Operator interface shall have the capability of communicating on the DeviceNet network.

**2.09 Miscellaneous Devices**

**2.10 Incoming Feeder Terminations and Device**

- A. Incoming [cable] [busway] shall terminate within the control center on a [main lug] [main breaker] termination point. Main lug terminations shall have adequate dedicated space for the type and size of cable used and the lugs shall be [standard mechanical screw] [compression-type] with antiturn feature. Main breakers shall be provided as indicated on the drawings and shall be [molded case] [insulated case, stored energy device] [air power circuit breakers].

**2.11 Customer Metering**

- A. Where indicated on the drawings, provide a separate customer metering compartment with front hinged door.
- B. Provide current transformers for each meter. Current transformers shall be wired to shorting-type terminal blocks.

- C. Provide [potential transformers including primary and secondary fuses with disconnecting means] [fused potential taps as the potential source] for metering as shown on the drawings.

**Note to Spec. Writer:**

Select devices as required for paragraph 2.11 D.

Refer to section 16901 for detailed specification for metering.

IQ Analyzer Series (Section 16901, paragraph 2.02 A.)

IQ DP-4000 Series (Section 16901, paragraph 2.02 B.)

IQ 300 Series (Section 16901, paragraph 2.02 C.)

IQ 200 Series (Section 16901, paragraph 2.02 D.)

IQ Generator (Section 16901, paragraph 2.02 E.)

IQ Data (Section 16901, paragraph 2.02 F.)

- D. Microprocessor-Based Metering System.

**2.12 Enclosures**

- A. The type of enclosure shall be in accordance with NEMA standards for [type 1A with gasketed doors] [type 12 dust-tight and drip-proof] [type 3R non-walk-in] [type 3R walk-in]. All enclosing sheet steel, wireways and unit doors shall be gasketed.

**2.13 Nameplates**

- A. Each unit will have a 1.0 x 2.5-inch (25.4 x 63.5 mm) engraved nameplate. The lettering shall be black 3/16-inch (4.78 mm) high, on a white background.

**2.14 Finish**

- A. The control center shall be given a phosphatizing pretreatment. The paint coating shall be a polyester urethane, thermosetting powder paint. Manufacturer's standard color shall be used.
- B. The control center finish shall pass 600 hours of corrosion-resistance testing per ASTM B 117.

**Part 3 Execution**

**3.01 Factory Testing**

- A. The motor control centers shall have been tested in a high-power laboratory to prove adequate mechanical and electrical capabilities.
- B. All factory tests required by the latest ANSI, NEMA and UL standards shall be performed.
- C. A certified test report of all standard production tests shall be available to the Engineer upon request.
- D. Factory tests as outlined above shall be witnessed by the owner's representative.
1. The manufacturer shall notify the owner two (2) weeks prior to the date the tests are to be performed.
  2. The manufacturer shall include the cost of transportation and lodging for up to three (3) owner's representatives. The cost of meals and incidental expenses shall be the owner's responsibility.

**3.02 Field Quality Control**

- A. Provide the services of a qualified factory-trained manufacturer's representative to assist the contractor in installation and startup of the equipment specified under this section for a period of \_\_\_\_\_ working days. The manufacturer's representative shall provide technical direction and assistance to the Contractor in general assembly of the equipment, connections and adjustments, and testing of the assembly and components contained therein.
- B. The following minimum work shall be performed by the Contractor under the technical direction of the manufacturer's service representative:

1. Rig the MCC assembly into final location and install on level surface.
  2. Check all removable cells and starter units for easy removal and insertion.
  3. Perform insulation tests on each phase and verify low-resistance ground connection on ground bus.
  4. Connect all power wiring and control wiring and verify basic operation of each starter from control power source.
  5. Torque all bolted connections made in the field and verify all factory bolted connections.
  6. Calibrate any solid-state metering or control relays for their intended purpose and make written notations of adjustments on record drawings. Perform startup of any solid-state starters and adjustable frequency drives.
- C. The Contractor shall provide three (3) copies of the manufacturer's field startup report.

**3.03 Manufacturer's Certification**

- A. A qualified factory-trained manufacturer's representative shall certify in writing that the equipment has been installed, adjusted and tested in accordance with the manufacturer's recommendations. Equipment shall be inspected prior to the generation of any reports.
- B. The Contractor shall provide three (3) copies of the manufacturer's representative's certification.

**Low Voltage  
Motor Control Centers  
(ac/dc)****3.04 Training**

- A. The Contractor shall provide a training session for up to five (5) owner's representatives for \_\_\_\_\_ normal workdays at the jobsite or other office location chosen by the owner.
- B. The training session shall be conducted by a manufacturer's qualified representative.
- C. The training program shall consist of the following:
  1. Review of the MCC one-line drawings and schedules
  2. Review of the factory record shop drawings and placement of the various cells
  3. Review of each type of starter cell, components within, control, and power wiring
  4. Review contactor coil replacement and contact replacement procedures.
  5. Discuss the maintenance timetable and procedures to be followed in an ongoing maintenance program.
  6. Provide three-ring binders to participants complete with copies of drawings and other course material covered.

**3.05 Examination**

- A. Installing Contractor to fully inspect shipments for damage and report damage to manufacturer and file claim upon shipper, if necessary.
- B. Overload relay heater ratings must be properly sized and coordinated for each motor starter unit.

- C. Installing Contractor to verify NEC clearances as dictated on the contract drawings prior to installation. Verify UL labeling of the assembly prior to installation.

**3.06 Installation**

- A. Contractor to follow the installation instructions supplied by the manufacturer.
- B. Control wiring shall be as shown on the contract drawings except as modified by the approval and submittal process. Interface all local and remote devices into the control wiring and operational systems for each load.
- C. As shown on the contract drawing, provide DeviceNet trunk and drop cabling with threaded, sealed and keyed device taps.

**3.07 Field Adjustments**

- A. Follow the manufacturer's instructions and the contract documents concerning any short-circuit device settings, heater selection, timing relays, or startup of components.

**3.08 Field Testing**

- A. Follow the minimum requirements as stipulated in the NETA testing procedure for this type of motor control center assembly.
- B. Generate a field report on tests performed, test values experienced, etc., and make available to owner upon request.

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National Electrical Code and NEC are registered trademarks of the National Fire Protection Association, Quincy, Mass.

NEMA is the registered trademark and service mark of the National Electrical Manufacturers Association

Uniform Building Code (UBC) is a trademark of the International Conference of Building Officials (ICBO).

ISO is the registered trademark and sole property of the International Organization for Standardization

BOCA is a registered trademark of Building Officials and Code Administrators International, Inc

CSA is a registered trademark of the Canadian Standards Association.

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SDS (Smart Distributed System) is a trademark of Synergistic Micro Systems.

Metasys is a registered trademark of Johnson Controls, Inc.

Siemens is a federally registered trademark of Siemens AG.

For a complete product specification in CSI format, see *Cutler-Hammer Product Specification Guide*, section 16482.

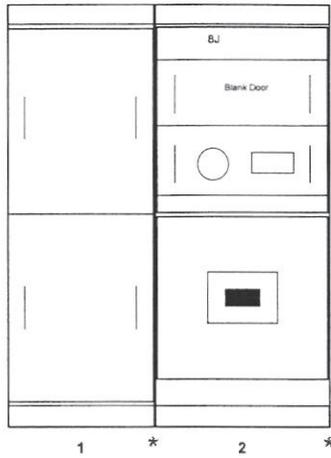
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Switchboards

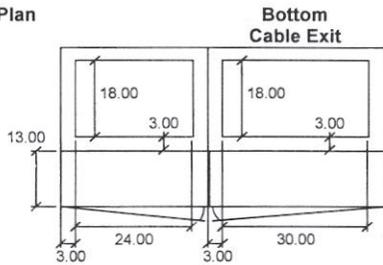


Front View

Power Flow



Floor Plan



Total of 2 Structures, Total Width of 66 Inches with Front Hinged Doors  
 Allow a Minimum of an Additional 6 inches on each end for Seismic Anchoring Brackets.

Width-Inches	30.00	36.00	
Width-MM	762	914	
Depth(Inner)-In.	24.00	24.00	
Depth(Inner)-MM	609	609	
Depth(Outer)-In.	37.00	37.00	
Depth(Outer)-MM	939	939	
Height-Inches	90.00	90.00	
Height-MM	2286	2286	
Weight-Lbs(Est.)	1600	1600	
Weight-Kg(Est.)	725	725	

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	Krogh, Jay P	08/10/09	Sumter, SC		
	APPROVED BY	DATE	JOB NAME	Santa Barbara	
			DESIGNATION	Incoming PG&E	
	VERSION		TYPE	DRAWING TYPE	
	6.7		Switchboards	Customer Appr.	
NEG-ALT NUMBER	REVISION	DWG SIZE	G.O.	ITEM	SHEET
MPY10303H904-0000	1	A		001	2 OF 3

## Switchboard General Information

### Pow-R-Line C -Specifications

Quantity: 1  
 Alignment: Front Access/ Front and Rear Align  
 Service: 480V 3-Phase 3-Wire      Lowest Breaker Interrupt Rating: 65 kA

### Bus Specifications

Bus Amps: 600      Bus Bracing Rating: 65kA  
 Neutral Amps: None  
 Bus Material: Silver Plated Copper      Heat Test  
 Silver Pltd. Cu. .25 X 1.5 Ground Bus Bolted To Frame, (1) 350 kcmil Ground Lug

### Incoming Information

Incoming Entry: Bottom      Incoming Location: Left  
 Incoming Qty & Size: Terminals, Mechanical, (1) 250-500 kcmil, Bottom

### Structure Specifications

Service Entrance  
 Enclosure Type: Type 3R (nonwalk-in) Flat Roof  
 Seismic Label (IBC/CBC Seismic Qualified)  
 Allow a minimum of an additional 6 in. on each end of the switchboard for bolt down brackets (Seismic Anchoring).  
 Refer to seismic installation data sheet 1A32007 and drawing 1A32010 for details.

### Utility Specifications

600 Amps Util. Mtr. Compt. - PACIFIC GAS & ELECTRIC  
 Utility Service Requirements Page References:  
 Lug Drillings Per Page: 10-28      CT Compartment Per Page 10-3,4,5,6,29  
 UGPS Per Page 10-,23,24,25      Meter Door per Page 10-3,29,30,32,34  
 8J Meter Socket(s)      2 Drillings  
 (2) EUSERC Press Bolts

### Enclosure properties

Struct #	Description/Modifications
1	Bussed pulled Structure (Incoming Utility Structures) Vertical isolating barrier - full height Auxiliary Bus
2	Incoming Utility Structures (Incoming Utility Section) Horizontal isolating barrier Auxiliary Bus

The information on this document is created by Eaton Corporation. It is disclosed in confidence and it is only to be used for the purpose in which it is supplied.	PREPARED BY <b>Krogh, Jay P</b>	DATE <b>08/10/09</b>	<b>Eaton Corporation</b>			Sumter, SC
	APPROVED BY	DATE	JOB NAME <b>Santa Barbara</b>	DESIGNATION <b>Incoming PG&amp;E</b>		
	VERSION <b>6.7</b>		TYPE <b>Switchboards</b>	DRAWING TYPE <b>Customer Appr.</b>		
NEG-ALT NUMBER <b>MPY10303H904-0000</b>	REVISION <b>1</b>	DWG SIZE <b>A</b>	G.O.	ITEM <b>001</b>	SHEET <b>1 OF 3</b>	

### Switchboard Units Information

Str#	Unit	Description/Modifications	Nameplate
1			
2		PRLC32_UTILITY-600A Utility Metering - PACIFIC GAS & ELECTRIC  Main Brkr.-200A 3P [HKD 400A Frame], Trip 200 A. Thermal Mag Terminals, Mechanical, (1) 250-500 kcmil, Bottom	

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	APPROVED BY		DATE		JOB NAME <b>Santa Barbara</b>		DESIGNATION <b>Incoming PG&amp;E</b>	
	VERSION <b>6.7</b>		TYPE <b>Switchboards</b>		DRAWING TYPE <b>Customer Appr.</b>			
NEG-ALT NUMBER <b>MPY10303H904-0000</b>	REVISION <b>1</b>	DWG SIZE <b>A</b>	G. O.		ITEM <b>001</b>	SHEET <b>3 OF 3</b>		

Neg# MPY10303H904 Alt# 0000

08/10/09

13:04:27

### Customer Bill of Material

1 PRLC Switchboard

Pow-R-Line C Switchboard, Front Access/ Front and Rear Align, Type 3R (nonwalk-in) Flat Roof  
480V 3-Phase 3-Wire, 600 Silver Plated Copper, Lowest Breaker Interrupt Rating: 65kA, Bus Bracing Rating: 65kA

- 1 Pow-R-Line C
- 1 Seismic Label (IBC/CBC Seismic Qualified)
- 2 Type 3R (nonwalk-in) Flat Roof
- 1 Vertical Isol. Barrier (Service Entrance)
- 1 Horizontal Isol. Barrier (Service Entrance)
- 1 Service Entrance Label
- 1 600 Amp Silver Plated CU Main Structure
- 1 600A Utility Metering - PACIFIC GAS & ELECTRIC
- 1 Utility Meter Socket
- 1 Thermal Mag Trip - Standard
- 1 600 Amp Silver Plated CU Bussed Incoming Pull Section
- 1 200A 3P [HKD 400A Frame], Trip 200 A., Thermal Mag, (1) 250-500 kcmil, Mechanical, Bottom

Designations: Incoming PG&E

General Description

## Application Considerations and Definitions

Eaton's Cutler-Hammer® Pow-R-Line family of distribution switchboards incorporates new design concepts that fit the ever-increasing need for applications on high short circuit systems, while retaining maximum standardization, safety and convenience throughout the line.

### Front Accessibility

Front accessibility switchboards align at the rear, enabling them to be placed against a wall (Cutler-Hammer Type Pow-R-Line C™ front accessible). If the main section is deeper than others, due to physical size of the main device, the necessary offset in lineup will occur in front, and the main section will be accessible from the side as well as from the front. Eaton also offers front accessible switchboards that align at the front and rear.

### Rear Accessibility

Rear accessible switchboards align at the front and the rear. Bus maintenance and cable entry and exit require rear access. There are two types of rear accessible switchboards. Both types utilize the same incoming utility and/or main structures. The first type utilizes group mounted feeder devices with panel construction (Cutler-Hammer Type Pow-R-Line C rear accessible). The second type utilizes individually compartmentalized feeder devices with load side insulated bus bar extensions (Cutler-Hammer Type Pow-R-Line i).

### Standard Switchboard Height

Standard Pow-R-Line switchboard height is 90 inches (2286.0 mm).

### Group Mounting

Group mounted circuit protective devices are an assembly of units mounted on a panelboard type base (panelboard construction). Units may be molded case breakers or fusible switches. Circuit protective devices are accessible from the front.

A main molded case breaker or main fusible switch, within the sizes listed for panelboard design, can be included in the panel mounted assembly in lieu of a separate, individually mounted unit.

### Space Only for Future Devices Group Mounted Construction

Where space only for future circuit protective devices is required, the

proper space and a blank filler plate will be supplied. Connections and mounting hardware are not included.

### Provision for Future Devices

Where provisions for future circuit protective devices are required, space for the device, corresponding vertical bus, device connectors and the necessary mounting hardware will be supplied.

### Bus Bar System

Standard bus in the switchboards is tin-plated aluminum. Copper and silver-plated copper are also available.

Main bus and sub-main buses meet UL® and NEMA® standards for temperature rise on all Pow-R-Line switchboards. Special bus densities are available.

### Overcurrent Devices

To properly select and size overcurrent devices for use in a switchboard, the allowable temperature rise must be taken into account as to its effect on the tripping characteristics of the devices in question.

Accordingly, Article 215.3 of the NEC® requires overcurrent devices to be rated not less than 125% of the continuous load they are protecting. To comply with this, an 80% derating factor must be used with all overcurrent devices such as molded case breakers and FDPW fusible switches unless they are tested and approved for application at 100% of the rating.

### Short Circuit Rating

Standard bus and connectors on all switchboards are rated for use on systems capable of producing up to 65,000 amperes rms symmetrical short circuit current at the incoming terminals.

Increased bus short circuit ratings equal to that of connected switchboard devices, up to 200,000 amperes rms symmetrical, are available in most Pow-R-Line C switchboards when approved main devices are installed. Contact Eaton for more information. UL labeled switchboard sections are marked with their applicable short circuit rating.

### Provision for Busway Entrance and Exit

Busway connections to switchboard sections include cutout and drilling in the top of the switchboard with riser connections from the switchboard

device or bus, up to the point where the bus duct enters the switchboard. No connections are furnished external to the switchboard.

**In all transactions involving busway attached to switchboards, it is essential that information regarding orientation of the busway with respect to the front of the switchboard be supplied to the coordinating assembly plant.**

On Pow-R-Line C switchboards, solid bus bar is used to connect the bus duct to the individually mounted main device, main or sub-main switchboard bus, or vertical main bus of panel mounted circuit protective device panels. **Busway fed by group mounted branch devices are cable connected.**

Aluminum riser connections are standard. Copper- or silver-plated copper is available as an option.

### Transitions

Transition structures are required for connecting switchboards to the secondary of power center transformer (dry or fluid filled), motor control centers, and for other special switchboard configurations such as "L" or "U" shaped lineups. In some applications, an extra structure complete with connections is required; in others, where switchboard depth and space permit, only the connection conductors are required. (Refer to factory for these applications.)

### Auxiliary Structures

These are normally mounted adjacent to service structures or distribution structures and used where incoming service or feeder conductors require additional space or facilities not included in the standard switchboard, such as:

1. Mounted adjacent to a top connected service structure and used as a cable pull structure where service conductors are brought in underground. Auxiliary structures are the same depth and height as the service structure, and are wide enough to accommodate the incoming cables.
2. Mounted adjacent to a service structure and used as a bus transition compartment for running riser bus from the load-side of the service structure up to top outgoing bus duct connection when distribution structures are not required. Auxiliary structure are the same depth and height as service structures.

## General Description

In addition to the above applications, auxiliary structures may be mounted adjacent to a distribution structure and used as a structure for lighting panel or other device which may be cable-connected to a branch circuit device in the distribution structure. Dimensions are compatible with arrangements required.

## Switchboards Used as Service Equipment

Service equipment is the electrical equipment that constitutes the main control and means of power cutoff the electric service (normally Power Company supply) brought into the building.

Where switchboards are to be used as service equipment, certain NEC and UL requirements apply that necessitate modifications not normally supplied in switchboards.

The following is a summary of the requirements which are pertinent to the application of a switchboard for service equipment:

- A. A switchboard with main lugs only (no main disconnect) must be designed so that all circuits in the switchboard can be disconnected from the supply source by the operation of no more than six operating handles (breaker or switch).

Switchboard equipped with main disconnect devices are not subject to the above six disconnect limitation, as the entire board can be de-energized with the main disconnect device.

Ground fault protection of equipment should be provided for solidly grounded wye electrical services of more than 150 volts to ground, but not exceeding 600 volts phase-to-phase for each service disconnecting means rated 1000 amperes or more.

- B. For testing purposes, means are also required to disconnect the switchboard neutral bus from the grounded service neutral conductor (1-phase, 3-wire and 3-phase, 4-wire systems). To comply with this requirement, a removable link (solid bar) is provided in the switchboard neutral bus. This link is generally located near the point where the main feeders enter the switchboard or in the area of the main disconnect device where one is provided.

To further comply with NEC and UL requirements, a separate bonding strap is connected from the neutral bus to the switchboard frame. This bonding connection is located on the line side of the removable neutral link, maintaining a service ground to the switchboard frame when the test link is removed. See **Figure 21.0-1**.

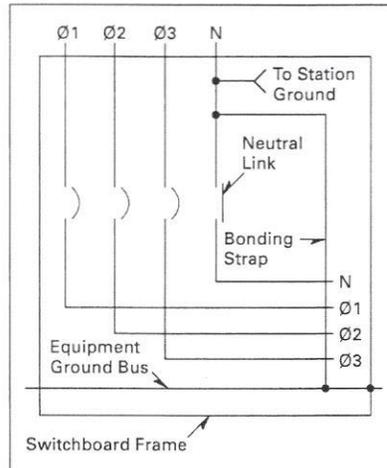


Figure 21.0-1. Neutral Link

Where switchboards are to be used for service equipment, it should be clearly indicated.

## Underwriters Laboratories Requirements and Labeling

The basic requirement for obtaining an Underwriters Laboratories label on a switchboard, is that all the component devices (breakers, switches, etc.) in the switchboard assembly are UL listed. In addition, the switchboard must comply with all applicable provisions of UL 891.

Today's modern electrical systems require that switchboards offer a wide selection of electrical devices, many of which do not fall within the scope of Underwriters' listed devices. Therefore, the conditions under which a switchboard may be labeled are limited.

Listed below are several important guidelines for consideration when an Underwriter Laboratories label is specified:

1. Underwriters' nameplates, where applicable, are supplied for each vertical structure rather than one common nameplate for the complete switchboard lineup. Where all of the component devices in the switchboard are UL listed and all applicable provisions of UL 891

are met, each of the switchboard may be labeled.

2. Individual vertical structures of a switchboard may be labeled where they comply with underwriters' requirements, although other vertical structures in the same switchboard lineup may not meet the UL standards, and will not be labeled.
3. All Pow-R-Line C switchboards are UL labeled if all mounted devices are UL listed.

## Automatic Transfer Equipment

For continuity of service, automatic transfer equipment between two (2) incoming services may be required. This equipment transfers the load upon failure of the normal (or preferred) source to the standby (or emergency) source. Upon restoration of the normal source, the load is automatically transferred back to it. To accomplish this, electrically operated main protective devices (and bus tie devices, if required) must be employed. Additional relays also are required to detect source voltage failure and to transfer control power when required. A manual selector switch is usually provided to select the mode of operation — automatic or manual transfer.

## Seismic Considerations

The Uniform Building Code®, as well as local and state building codes, place an emphasis on seismic building design requirements. Electrical distribution systems are treated as attachments to the building, and therefore, fall into this category.

All Cutler-Hammer switchboards are seismic qualified at the highest possible level, Seismic Zone 4, and have been tested in accordance with ANSI C37.81. This standard quantifies actual earthquake conditions, as well as equipment seismic capability through use of the acceleration frequency response spectrum. Additionally, verification tests are conducted on structural integrity, relative motion and hold-down requirements by repeated exciting the equipment at all its natural frequencies.

Three 0.2g sine sweep single axis resonance search tests and three triaxial multifrequency seismic tests were also performed at increasing levels of severity. Summaries of these tests are available from Eaton.

### **Type 1 Cutler-Hammer Pow-R-Line C Switchboards**

Meets NEMA Standard PB-2 and UL 891.

#### **Construction Details**

- 6000 ampere main bus maximum.
- Front accessible — main sections front and/or side accessible.
- Feeder devices group mounted.
- Sections rear aligned or front and rear aligned.
- Designed for mounting against a wall, but self-supporting, or with code clearance to a wall.

#### **Main Devices, Individually Mounted**

- Molded Case Circuit Breakers, 400 – 2500 amperes, fixed or drawout.
- Air Power Circuit Breakers, Magnum™ DS, 800 – 5000 amperes, fixed or drawout.
- Air Power Circuit Breakers with Current Limiting Fuses, DSL, 800 – 5000 amperes.
- Bolted Pressure Switches, 800 – 5000 amperes, fixed.
- Fusible Switches, 400 – 1200 amperes, fixed.

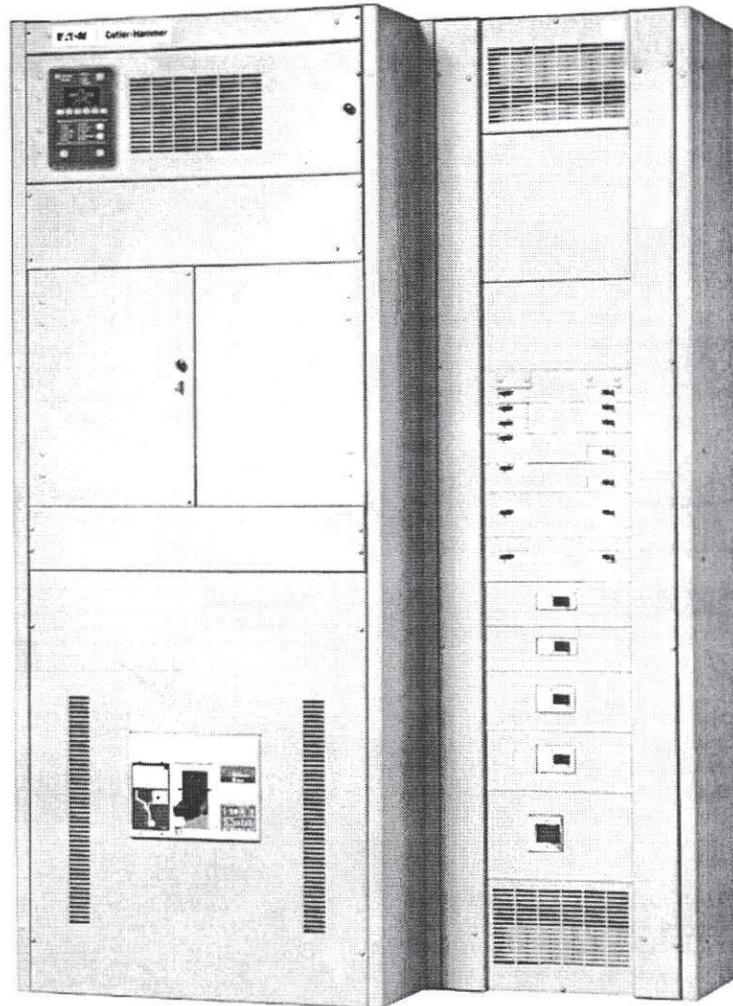
#### **Feeder Devices, Group Mounted**

- Molded Case Circuit Breakers, 15 – 1200 amperes.
- Fusible Switches, 30 – 1200 amperes.

#### **Feeder Devices, Individually Mounted**

- Molded Case Circuit Breakers, 800 – 2500 amperes, fixed.
- Air Power Circuit Breakers, DS and Magnum DS, 800 – 4000 amperes.
- Bolted Pressure Switches, 800 – 1600 amperes, fixed.

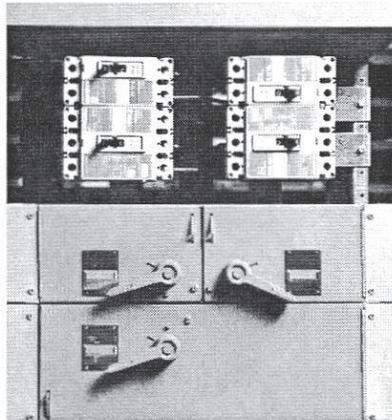
**Note:** For selection and layout guidelines, please reference **Page 21.1-1**.



*Type 1 Pow-R-Line C Switchboard*

**Features**

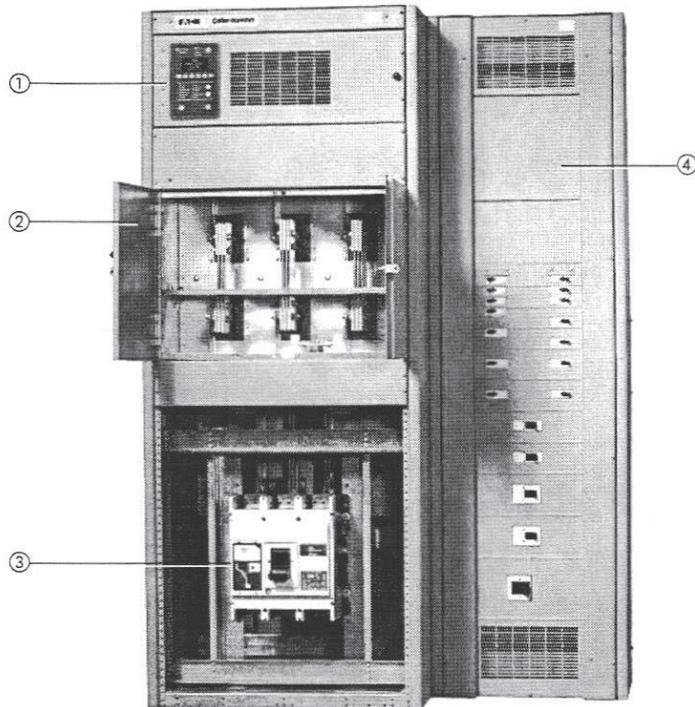
- Eaton’s Cutler-Hammer circuit breakers provide higher ratings in a standard chassis and increased series ratings.
- Available with circuit breakers and fusible switches on the same chassis.
- UL listed and labeled. Meets NEC and NEMA standards.
- Cutler-Hammer IQ microprocessor-based metering device is standard when metering is specified. Conventional metering is available. IQ devices can provide a communications capability. See **Section 3**.
- Optional integral Cutler-Hammer Visor Series TVSS is available in Pow-R-Line C switchboards, when specified. See **Section 36**.
- Front accessible.
- Aluminum, copper, or silver-plated copper main bus.
- A full range of device modifications is available.
- Available in NEMA Type 1 and 3R enclosures, UL listed.



*The Single Chassis Design Provides Device Flexibility*

**Modifications**

- Ground fault protection on mains and distribution devices.
- Coordination with other Cutler-Hammer divisions for busway and transformer connections.



*Type 1 Pow-R-Line C Features*

- ① Customer metering.
- ② NEMA utility metering.
- ③ Main.
- ④ Group mounted distribution.

**Table 21.0-1. Pow-R-Line C Group Mounted Switchboards**  
Voltage: 240 – 480 – 600 Vac, 250 Vdc  
Mains: 400 through 6000 Amperes

Main Device Type	Amperes	Short Circuit Symmetrical Rating (kA)
Molded Case Circuit Breakers	400 – 2500	14 – 200
Air Power Circuit Breakers, DS and Magnum DS	800 – 5000	30 – 100
Air Power Circuit Breakers with CL Fuses, DSL	800 – 5000	200
Bolted Pressure Switches	800 – 5000 ①	200
Fusible Switches	400 – 1200	200
Main Lugs Only	400 – 6000	Rating Determined by Distribution Device

Feeder Device Type	Amperes	Short Circuit Rating (kA)
Molded Case Circuit Breakers	15 – 1200	10 – 200
Fusible Switches	30 – 1200	200
Stacked — Main with Branch Devices	400 – 2500	18 – 200

① 5000 ampere bolted pressure switches are not UL listed.

**Features**

- Eaton's Cutler-Hammer Circuit Breakers provide higher ratings in a standard chassis and increased series ratings.
- Available with circuit breakers and fusible switches on the same chassis.
- UL listed and labeled. Meets NEC and NEMA standards.
- IQ microprocessor-based metering device is standard when metering is specified. Conventional metering is available. IQ devices can provide a communications capability. See **Section 3**.
- Optional integral Cutler-Hammer Visor Series TVSS is available in Pow-R-Line C switchboards, when specified. See **Section 36**.
- Front and rear accessible.
- Aluminum, copper, or silver-plated copper main bus.
- A full range of device modifications is available.
- Available in NEMA Type 1 and 3R enclosures, UL listed.

**Modifications**

- Ground fault protection on mains and distribution devices.
- Coordination with other Cutler-Hammer divisions for busway and transformer connections.

**Table 21.0-2. Pow-R-Line C Group Mounted Switchboards****Voltage: 240 – 480 – 600 Vac, 250 Vdc****Mains: 400 through 6000 Amperes**

Main Device Type	Amperes	Short Circuit Symmetrical Rating (kA)
Molded Case Circuit Breakers	400 – 2500	18 – 200
Air Power Circuit Breakers, Type Magnum DS	800 – 5000	30 – 100
Air Power Circuit Breakers with CL fuses, DSL	800 – 5000	200
Bolted Pressure Switches	800 – 5000 ①	200
Fusible Switches	400 – 1200	200
Main Lugs Only	400 – 6000	Rating Determined by Distribution Device

Feeder Device Type	Amperes	Short Circuit Rating (kA)
Molded Case Circuit Breakers	15 – 1200	10 – 200
Fusible Switches	30 – 1200	200
Stacked — Main/Branch Devices ②	400 – 3000	18 – 200

① 5000 ampere bolted pressure switches are not UL listed.

② Type 2 Switchboards are capable of utilizing any of the main devices listed above as stacked (one above another in the same structure) branch devices, subject to ampacity limitations. See Type 2 layout data on **Page 21.2-13**.

Circuit Breaker and Fusible Switch Technical Data

Table 21.0-3. Molded Case Circuit Breakers

Circuit Breaker Type	Cont. Ampere Rating at 40°C	No. of Poles	Volts		Type of Trip ①	Federal Spec. W-C-375b	UL Listed Interrupting Ratings rms Symmetrical Amperes								
			ac	dc			ac Ratings Volts						dc ②		
							120	120/240	240	277	480	600	125	250	125/250
EDB	100 – 225	2, 3	240	125	N.I.T.	12b	—	—	22,000	—	—	—	10,000	—	—
EDS	100 – 225	2, 3	240	125	N.I.T.	12b	—	—	42,000	—	—	—	10,000	—	—
ED	100 – 225	2, 3	240	125	N.I.T.	12b	—	—	65,000	—	—	—	10,000	—	—
EDH	100 – 225	2, 3	240	125	N.I.T.	14b	—	—	100,000	—	—	—	10,000	—	—
EDC	100 – 225	2, 3	240	125	N.I.T.	1	—	—	200,000	—	—	—	10,000	—	—
EHD	15 – 100	1	277	125	N.I.T.	13a	—	—	—	14,000	—	—	10,000	—	—
EHD	15 – 100	2, 3	480	250	N.I.T.	13b	—	—	18,000	—	14,000	—	—	10,000	—
FDB	15 – 225	2, 3	600	250	N.I.T.	18a	—	—	18,000	—	14,000	14,000	—	10,000	—
FDB	15 – 225	4	600	250	N.I.T.	④	—	—	18,000	—	14,000	14,000	—	10,000	—
FD	15 – 225	1	277	125	N.I.T.	13a	—	—	—	35,000	—	—	10,000	—	—
FD	15 – 225	2, 3	600	250	N.I.T.	22a	—	—	65,000	—	35,000	18,000	—	10,000	—
FD	15 – 225	4	600	250	N.I.T.	④	—	—	65,000	—	35,000	18,000	—	10,000	—
HFD	15 – 225	1	277	125	N.I.T.	13a	—	—	—	65,000	—	—	10,000	—	—
HFD	15 – 225	2, 3	600	250	N.I.T.	23a	—	—	100,000	—	65,000	25,000	—	22,000	—
HFD	15 – 225	4	600	250	N.I.T.	④	—	—	100,000	—	65,000	25,000	—	22,000	—
FDC	15 – 225	2, 3	600	250	N.I.T.	24a	—	—	200,000	—	100,000	35,000	—	22,000	—
FDC	15 – 225	4	600	250	N.I.T.	④	—	—	200,000	—	100,000	35,000	—	22,000	—
JD	70 – 250	2, 3	600	250	I.T.	22a	—	—	65,000	—	35,000	18,000	—	10,000	—
HJD	70 – 250	2, 3	600	250	I.T.	22a	—	—	100,000	—	65,000	25,000	—	22,000	—
JDC	70 – 250	2, 3	600	250	I.T.	22a	—	—	200,000	—	100,000	35,000	—	22,000	—
DK	250 – 400	2, 3	240	250	N.I.T.	14b	—	—	65,000	—	—	—	—	10,000	—
KD	70 – 400	2, 3	600	250	I.T.	23a	—	—	65,000	—	35,000	25,000	—	10,000	—
CKD ③	70 – 400	3	600	250	I.T.	23a	—	—	65,000	—	35,000	25,000	—	10,000	—
HKD	70 – 400	2, 3	600	250	I.T.	23a	—	—	100,000	—	65,000	35,000	—	22,000	—
CHKD ③	70 – 400	3	600	250	I.T.	23a	—	—	100,000	—	65,000	35,000	—	22,000	—
KDC	70 – 400	2, 3	600	250	I.T.	23a	—	—	200,000	—	100,000	50,000	—	22,000	—
LGE	300 – 600	2, 3	600	250	I.T.	23a	—	—	65,000	—	35,000	25,000	10,000	22,000	—
LGH	300 – 600	2, 3	600	250	I.T.	23a	—	—	100,000	—	65,000	35,000	10,000	22,000	—
LD	300 – 600	2, 3	600	250	I.T.	23a	—	—	65,000	—	35,000	25,000	—	22,000	—
CLD ③	300 – 600	3	600	250	I.T.	23a	—	—	65,000	—	35,000	25,000	—	22,000	—
HLD	300 – 600	2, 3	600	250	I.T.	23a	—	—	100,000	—	65,000	35,000	—	25,000	—
CHLD ③	300 – 600	3	600	250	I.T.	23a	—	—	100,000	—	65,000	35,000	—	25,000	—
LDC	300 – 600	2, 3	600	250	I.T.	23a	—	—	200,000	—	100,000	50,000	—	25,000	—
CLDC ③	300 – 600	3	600	250	I.T.	23a	—	—	200,000	—	100,000	50,000	—	25,000	—
MDL ④	400 – 800	2, 3	600	250	N.I.T.	21a	—	—	65,000	—	50,000	25,000	—	22,000	—
CMDL ③④	400 – 800	3	600	—	N.I.T.	21a	—	—	65,000	—	50,000	25,000	—	22,000	—
HMDL ④	400 – 800	2, 3	600	—	N.I.T.	21a	—	—	100,000	—	65,000	35,000	—	25,000	—
CHMDL ③④	400 – 800	3	600	—	N.I.T.	21a	—	—	100,000	—	65,000	35,000	—	25,000	—
ND	600 – 1200	2, 3	600	—	N.I.T.	23a	—	—	65,000	—	50,000	25,000	—	—	—
CND ③	600 – 1200	3	600	—	N.I.T.	23a	—	—	65,000	—	50,000	25,000	—	—	—
HND	600 – 1200	2, 3	600	—	N.I.T.	23a	—	—	100,000	—	65,000	35,000	—	—	—
CNDC ⑤	600 – 1200	3	600	—	N.I.T.	24a	—	—	200,000	—	100,000	50,000	—	—	—
NDC	600 – 1200	2, 3	600	—	N.I.T.	24a	—	—	200,000	—	100,000	50,000	—	—	—
CHND ⑤	600 – 1200	3	600	—	N.I.T.	23a	—	—	100,000	—	65,000	35,000	—	—	—
RD 1600	800 – 1600	3	600	—	N.I.T.	24a	—	—	125,000	—	65,000	50,000	—	—	—
CRD 1600 ③	800 – 1600	3	600	—	N.I.T.	24a	—	—	125,000	—	65,000	50,000	—	—	—
RD 2000	1000 – 2000	3	600	—	N.I.T.	24a	—	—	125,000	—	65,000	50,000	—	—	—
RD 2500	1000 – 2500	3	600	—	N.I.T.	24a	—	—	200,000	—	65,000	50,000	—	—	—
CRD 2000 ③	1000 – 2000	3	600	—	N.I.T.	24a	—	—	125,000	—	65,000	50,000	—	—	—
RDC 1600	800 – 1600	3	600	—	N.I.T.	25a	—	—	200,000	—	100,000	65,000	—	—	—
CRDC 1600 ③	800 – 1600	3	600	—	N.I.T.	25a	—	—	200,000	—	100,000	65,000	—	—	—
RDC 2000	1000 – 2000	3	600	—	N.I.T.	25a	—	—	200,000	—	100,000	65,000	—	—	—
RDC 2500	1000 – 2500	3	600	—	N.I.T.	25a	—	—	200,000	—	100,000	65,000	—	—	—
CRDC 2000 ③	1000 – 2000	3	600	—	N.I.T.	25a	—	—	200,000	—	100,000	65,000	—	—	—

① N.I.T. is non-interchangeable trip unit and I.T. is interchangeable trip unit.

② Two-pole circuit breaker, or 2 poles of 3-pole circuit breaker at 250 Vdc.

③ 100% rated.

④ Not available in Type 3 Pow-R-Line / switchboards.

# 21.0-12 Switchboards — Low Voltage Type 1, Type 2 and Type 3 Switchboards



Cutler-Hammer

June 2006  
Sheet 0710

## Circuit Breaker and Fusible Switch Technical Data

Table 21.0-4. Magnum DS Power Breaker Interrupting Ratings

Circuit Breaker Type	Frame Amperes	Ratings rms Symmetrical Amperes (000)					
		Interrupting Ratings			Short-Time Rating <sup>①</sup>		
		208/240 V	480 V	600 V	208/240 V	480 V	600 V
MDS-408	800	42	42	42	42	42	42
MDS-608	800	65	65	65	65	65	65
MDS-808	800	85	85	85	85	85	85
MDS-C08	800	100	100	100	85	85	85
MDS-616	1600	65	65	65	65	65	65
MDS-816	1600	85	85	85	85	85	85
MDS-C16	1600	100	100	100	85	85	85
MDS-620	2000	65	65	65	65	65	65
MDS-820	2000	85	85	85	85	85	85
MDS-C20	2000	100	100	100	85	85	85
MDS-632	3000	65	65	65	65	65	65
MDS-832	3000	85	85	85	85	85	85
MDS-C32	3000	100	100	100	85	85	85
MDS-840	4000	130	85	85	85	85	85
MDS-C40	4000	130	100	100	100	100	100
MDS-850	4000	130	85	85	85	85	85
MDS-C50	5000	130	100	100	100	100	100

<sup>①</sup> Also ratings without instantaneous trip.

Table 21.0-5. Current Limit-R Current Limiting Circuit Breakers — Non-Fused Type

Circuit Breaker Type	Cont. Ampere Rating at 40°C	No. of Poles	Volts		Type of Trip <sup>②</sup>	Federal Spec. W-C-375b	UL Listed Interrupting Ratings rms Symmetrical Amperes								
			ac	dc			ac Ratings Volts						dc <sup>③</sup>		
							120	120/240	240	277	480	600	125	250	125/250
FCL	15 – 100	2, 3	480	—	N.I.T.	<sup>④</sup>	—	—	200,000	—	150,000	—	—	—	
LCL	125 – 400	2, 3	600	—	N.I.T.	<sup>④</sup>	—	—	200,000	—	200,000	100,000	—	—	

<sup>②</sup> N.I.T. is non-interchangeable trip unit and I.T. is interchangeable trip unit.

<sup>③</sup> Two-pole circuit breaker, or 2 poles of 3-pole circuit breaker at 250 Vdc.

<sup>④</sup> Not defined in W-C-375b.

Table 21.0-6. TRI-PAC Current Limiting Circuit Breakers — Fused Type

Circuit Breaker Type	Cont. Ampere Rating at 40°C	No. of Poles	Volts		Type of Trip <sup>⑤</sup>	Federal Spec. W-C-375b	UL Listed Interrupting Ratings rms Symmetrical Amperes								
			ac	dc			ac Ratings Volts						dc <sup>⑥</sup>		
							120	120/240	240	277	480	600	125	250	125/250
FB	15 – 100	2, 3	600	250	N.I.T.	16a, 16b, 17a, 26a	—	—	200,000	—	200,000	200,000	—	—	100,000
LA	70 – 400	2, 3	600	250	I.T.	16a, 16b, 17a, 26a	—	—	200,000	—	200,000	200,000	—	—	100,000
NB	300 – 800	2, 3	600	250	I.T.	16b, 17a, 26a	—	—	200,000	—	200,000	200,000	—	—	100,000
PB	600 – 1600	2, 3	600	250	I.T.	17a, 26a	—	—	200,000	—	200,000	200,000	—	—	100,000

<sup>⑤</sup> N.I.T. is non-interchangeable trip unit and I.T. is interchangeable trip unit.

<sup>⑥</sup> Two-pole circuit breaker, or 2 poles of 3-pole circuit breaker at 250 Vdc.

## Circuit Breaker and Fusible Switch Technical Data

Table 21.0-7. Electrical Characteristics of Fusible Switches

Device Type	System Voltage	Ampere Rating	Interrupting Capacities kA Symmetrical Amperes
Fusible Switch	240 or 600	30 – 600 300 – 1200 30 – 600 800, 1200	200 K with Class R Fuses 200 K with Class T Fuses 200 K with Class R and J Fuses 200 K with Class L Fuses
Bolted Pressure Switch	240 or 480	800, 1200, 1600 2000, 2500, 3000, 4000, 5000 ①	200 K with Class L Fuses 200 K with Class L Fuses 200 K with Class L Fuses

① 5000 ampere bolted pressure contact switch is not UL listed.

Table 21.0-8. Standard Switchboard Terminals  
Standard Main Breaker, Branch Breaker, Main Switch or Branch Switch Terminals

Type Breaker	Ampere Rating	Wire Size Ranges
EDB, EDS, ED, EDH, EDC	100 – 225	# 4 – #4/0 or # 6 – 300 kcmil
EHD, FDB, FD, HFD, FDC	15 – 100 125 – 150	#14 – #1/0 # 4 – #4/0
FCL	15 – 100	#14 – #1/0
JD, HJD, JDC	70 – 250	# 4 – 350 kcmil
DK	250 – 350 400	(1) 25 – 500 kcmil (2) 3/0 – 250 kcmil or (1) 3/0 – 500 kcmil
KD, HKD, KDC, CKD ②, CHKD ②	100 – 225 250 – 350 400	(1) #3 – 350 kcmil (1) 250 – 500 kcmil (2) 3/0 – 250 kcmil (1) 3/0 – 500 kcmil
LGE, LGH, LD, HLD, LDC, CLD ②, CHLD ②, CLDC ②	300 – 500 600	(2) 250 – 350 kcmil (2) 400 – 500 kcmil
MDL, CMDL ②, HMDL, CHMDL	400 – 600 700 – 800	(2) #1 – 500 kcmil (3) 3/0 – 400 kcmil (2) 500 – 750 kcmil
ND, HND, NDC, CND ②, CHND ②, CNDC ②	600 – 1000 1200	(3) 3/0 – 400 kcmil (4) 4/0 – 500 kcmil
LCL	125 – 225 250 – 400	(1) #6 – 350 kcmil (1) #4 – 250 kcmil and (1) 3/0 – 600 kcmil
FB-P	15 – 100	#14 – 1/0
LA-P	70 – 225 250 – 400	(1) #6 – 350 kcmil (1) #4 – 250 kcmil and (1) 3/0 – 600 kcmil
NB-P	350 – 700 800	(2) #1 – 500 kcmil (3) 3/0 – 400 kcmil

② 100% rated breaker.

**Note:** All terminal sizes are based on wire ampacities corresponding to those shown in NEC Table 310-16 under the 75°C insulation columns (75°C wire). The use of smaller size (in circular mills), regardless of insulation temperature rating is not permitted without voiding UL labels on devices and equipment.

**Note:** For other terminals available on some ratings of molded case circuit breakers and fusible switches, refer to Section 27.

Cable Ranges for Standard  
Secondary Device Terminals

Wire and cable terminals supplied on switchboard mounted devices for making up incoming or outgoing cable connections are of the mechanical screw clamp pressure type. All standard terminals are suitable for use with either aluminum or copper cable except as noted in the table. Panel mounted devices utilize the standard terminal provided with that device.

Table 21.0-9. Fusible Switches

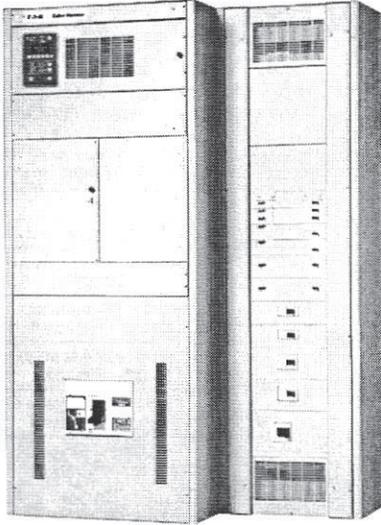
Ampere Rating	Wire Size Ranges
30, 60, 100 200	#14 – 1/0 #4 – 300 kcmil
400	250 – 750 kcmil or (2) 3/0 – 250 kcmil
600	(2) #4 – 600 kcmil or (4) 3/0 – 250 kcmil
800	(3) 250 – 750 kcmil or (6) 3/0 – 250 kcmil
1200	(4) 250 – 750 kcmil or (8) 3/0 – 250 kcmil

Table 21.0-10. Standard Incoming Terminal  
Ranges for Main Lugs Only and Main Devices

Ampere Rating	Cable Range
400	(2) #2 – 500 kcmil
600	(2) #2 – 500 kcmil
800	(3) #2 – 500 kcmil
1000	(4) #2 – 500 kcmil
1200	(4) #2 – 500 kcmil
1600	(5) #2 – 500 kcmil
2000	(6) #2 – 500 kcmil
2500	(7) #2 – 500 kcmil
3000	(10) #2 – 500 kcmil

**General Description**

**Selection and Layout Guide  
for Type 1, Pow-R-Line C,  
Front Accessible, Group  
Mounted Feeders**



*PRLC Switchboard — Front Access*

**Table 21.1-1. Type 1 — Front Accessible Group Mounted Feeders Pow-R-Line C**

Steps	Description	Page
Step 1 ①	Layout incoming main section (with or without main device) as follows: Special Utility Metering Compartment West Coast Utility Metering Compartment Standard NEMA® Utility Metering Compartment Customer Only Metering Compartment No Metering Compartment	21.1-2 21.1-6 21.1-8 21.1-9 21.1-9
Step 2	Layout Feeder Devices in Distribution Sections Pow-R-Line C Group Mounted Type Individually Mounted Type ② OPTIM Devices Outdoor Enclosures	21.1-10 21.1-13 21.1-14 21.4-1
Step 3	Technical data, e.g., interrupting ratings, terminal size.	21.0-11
Step 4	Specification Data	For a complete product specification in CSI format, see Cutler-Hammer Product Specification Guide, Section 16429.

① Since utility compartment dimensions are the minimum required by utility, check “no metering” main device widths and use the larger width of either the main device or utility metering compartment.  
② Feeders are individually mounted, not compartmentalized.

# 21.1-8 Switchboards — Low Voltage Type 1 Switchboards

EAT•N

Cutler-Hammer

June 2006  
Sheet 0722

Layout Dimensions — Type 1, Pow-R-Line C, Front Accessible, Group Mounted Feeders

## Main Structure — With Standard (NEMA) Utility CT Compartments and/or Main Device

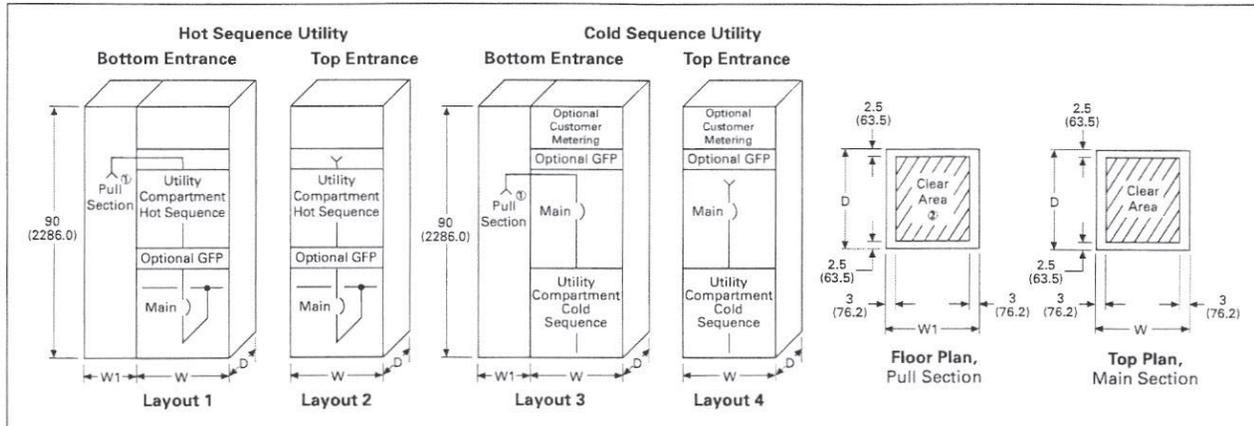


Figure 21.1-4. NEMA Utility Compartment Layouts — Dimensions in Inches (mm)

- ① Rigid bus extension into Pull Section is required above 2000 amperes.
- ② Clear area assumes no floor channels used under bottom frame.
- ③ IQ meter mounted to disconnect door as an alternate location. (When K, L, M, N and R fixed mounted frames and fixed mounted power circuit breakers are used.)

Table 21.1-5. Main Device Structure Size for Figure 21.1-4 Layouts

Main Device	Max. Amp. Rating	Width (W)	Depth (D)	Pull Section Width (W1)
<b>Fixed Mounted Devices</b>				
<b>Molded Case Breakers</b> Available with Optional Integral GFP				
KD, HKD, KDC	400	36	30	20
LD, HLD, LDC	600	36	30	20
MDL, HMDL	800	36	30	20
ND, HND, NDC	1200	36	30	26
RD, RDC	1600	36	30	26
RD, RDC	2000	36	30	26
RD, RDC	2500	36	30	26
<b>100% Rated Molded Case Breakers</b> Available with Optional Integral GFP				
CKD, CHKD	400	36	30	20
CLD, HCLD, CLDC	600	36	30	20
CMDL, CHMDL	800	36	30	20
CND, CHND, CNDC	1200	36	30	20
CRD, CRDC	1600	36	30	26
CRD, CRDC	2000	36	30	26
<b>TRI-PAC Fuse Type Current Limiting Breakers</b>				
LA-P	400	36	30	20
NB-P	800	36	30	20
PB-P	1600	36	30	26

**Note:** Dimensions for Figure 21.1-4.  
**Note:** Refer to Pages 21.1-2 to 21.1-4 for dimensions on special utility CT compartments.

Main Device	Max. Amp. Rating	Width (W)	Depth (D)	Pull Section Width (W1)
<b>Fixed Mounted Devices</b>				
<b>100% Rated Power Circuit Breakers</b> Available with Optional Integral GFP				
Magnum DS	800	36	36	26
	1600	36	36	26
	2000	36	36	26
	3000	45	48	30
	4000	45	48	30
	5000	45	48	—
<b>Fusible Switches</b>				
400	400	36	30	20
600	600	36	30	20
800	800	36	30	20
1200	1200	36	30	26
<b>100% Rated Electric Trip Bolted Pressure Switches</b> Available with Optional GFP				
CBC-800	800	36	30	20
CBC-1200	1200	36	30	26
CBC-1600	1600	36	30	26
CBC-2000	2000	36	30	26
CBC-2500	2500	45	36	30
CBC-3000	3000	45	36	30
CBC-4000	4000	45	36	30
CBC-5000 ④	5000	⑤	—	—

**Note:** See Pages 21.1-10 to 21.1-12 for layout of distribution sections. See Pages 21.4-1 and 21.4-2 for outdoor rainproof enclosures.  
Top mounted pull boxes are available with heights of 12, 18, 24 and 30 inches (304.8, 457.2, 609.6 and 762.0 mm).

Main Device	Max. Amp. Rating	Width (W)	Depth (D)	Pull Section Width (W1)
<b>Fixed Mounted Devices</b>				
<b>100% Rated Manual Bolted Pressure Switches</b> Not Available with Ground Fault Protection				
QA-800	800	36	30	20
QA-1200	1200	36	30	26
QA-1600	1600	36	30	26
QA-2000	2000	36	30	26
QA-2500	2500	45	36	30
QA-3000	3000	45	36	30
QA-4000	4000	45	36	30
QA-5000 ④	5000	Refer to Eaton		
<b>Drawout Mounted Devices</b>				
<b>100% Rated Insulated Case and Power Circuit Breakers Available with Optional Integral GFP</b>				
Magnum DS	800	36	48	26
	1600	36	48	26
	2000	36	48	26
	3000	45	48	30
	4000	45	54	30
	5000	45	66	—
DSL-206	800	36	54	26
DSL-416	1600	36	54	26
DSL-632	3200	45	66	30
Fuse Truck	—	45	66	N/A
DSL-840	4000	45	66	30
Fuse Truck	—	45	66	N/A

- ④ Not UL listed.
- ⑤ Refer to Eaton.

Layout Dimensions — Type 1, Pow-R-Line C, Front Accessible, Group Mounted Feeders

### Distribution Sections — Group Mounted Devices

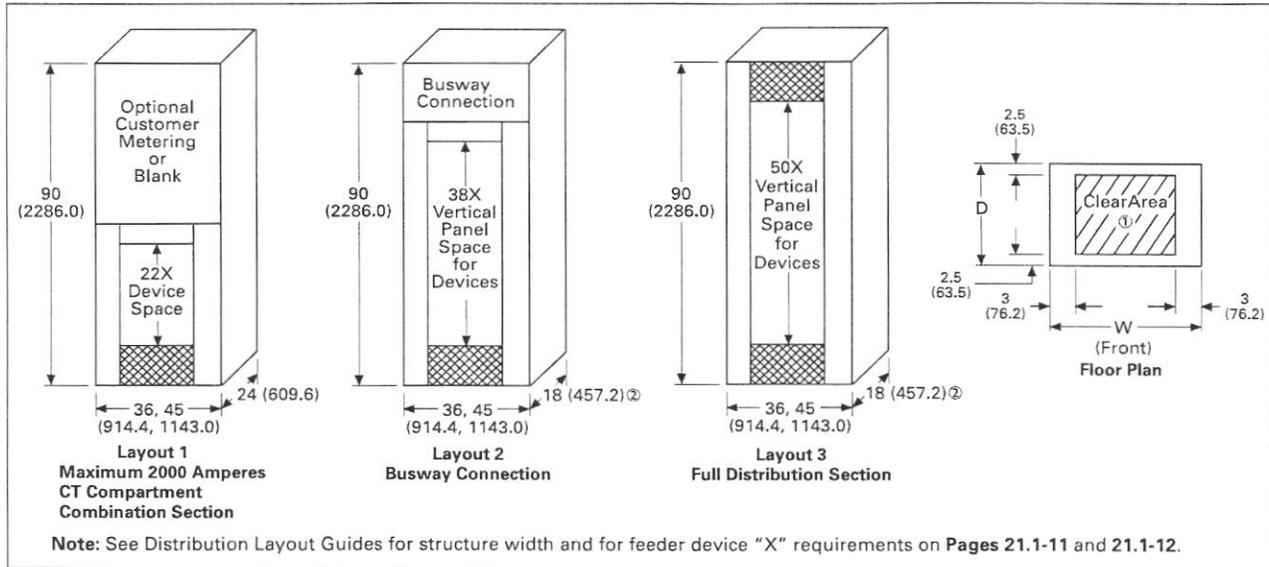


Figure 21.1-6. Distribution Section Layouts — Dimensions in Inches (mm)

- ① Clear area assumes no floor channels used under bottom frame.
- ② For panels rated above 2000 amperes, minimum depth is 24 inches (609.6 mm).
- ③ Busway connection can be either incoming service or exiting load from a feeder breaker. Increased depth will be required.

### Main Lug Distribution Sizing

Most switchboard layouts feed the distribution section(s) from adjacent main breaker sections, however, a single distribution section may have a set of incoming main lugs only.

Main lugs may be positioned in two ways.

1. Main lugs on distribution panel using space requirements in Table 21.1-7.
2. With a bussed auxiliary structure for incoming cable per Figure 21.1-7.

Table 21.1-7. Main Lug Only Space Requirements — Dimensions in Inches (mm)

Amperes	Lug ④ Range (kcmil)	"X" Space Required	
		50X Chassis	38X Chassis ⑤
400 & 600	2 - #2 - 500	10 (254.0)	10 (254.0)
	2 - #250 - 750	16 (406.4)	10 (254.0)
800	3 - #2 - 500	10 (254.0)	10 (254.0)
	3 - #250 - 750	16 (406.4)	10 (254.0)
1200	4 - #2 - 500	12 (304.8)	12 (304.8)
	4 - #250 - 750	16 (406.4)	12 (304.8)
1600	5 - #2 - 500	12 (304.8)	12 (304.8)
	5 - #250 - 750	16 (406.4)	12 (304.8)
2000	6 - #2 - 500	12 (304.8)	12 (304.8)
	6 - #250 - 750	16 (406.4)	12 (304.8)

- ④ For compression lugs use #250 - 750 kcmil lug dimensions.
- ⑤ Dimensions shown are for top entry on 38X Chassis only. For bottom entry use 50X Chassis space requirements.

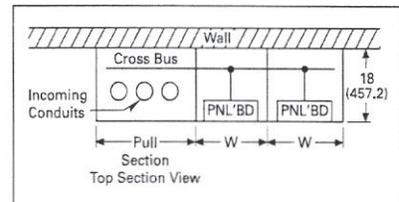


Figure 21.1-7. Section Plan View

**For 3000 - 4000 amperes:** Incoming cable or busway enters top or bottom of pull section, terminating in cross bus extension. For pull section dimensions, refer to Page 21.1-8.

Distribution Layout Guide — Molded Case Breakers

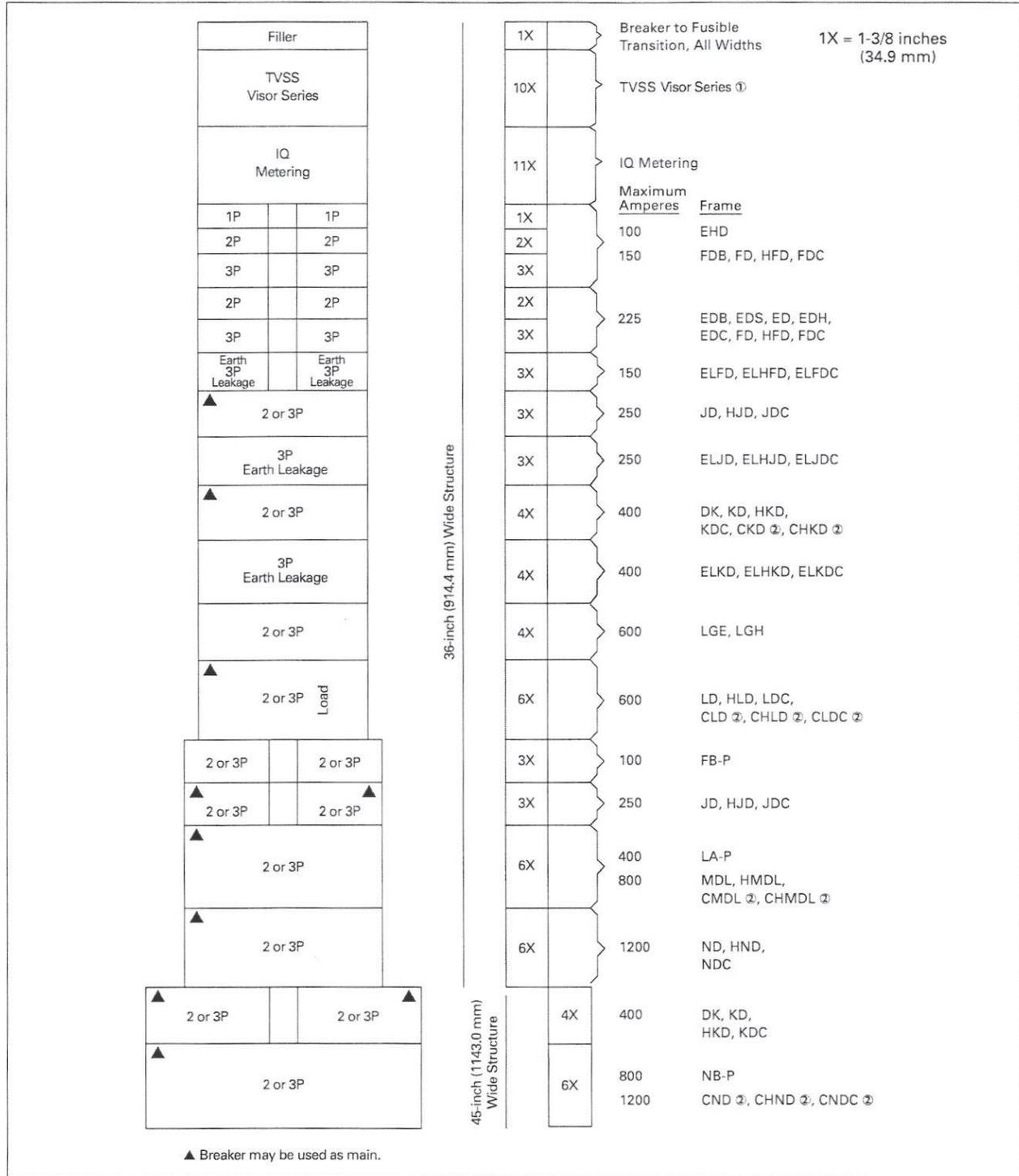


Figure 21.1-8. Circuit Breaker "X" Space Requirements — Dimensions in Inches (mm)

① Preferred location of TVSS is mounted at the top of first distribution section. See Section 36 for further information.

② 100% rated breakers.

Note: For breaker interrupting rating and terminal data, see Section 27.