63230-300-209B1
12/2005

Instruction Bulletin

PowerLogic® Circuit Monitor

Series 4000 Installation Manual

(Includes Models 4000, 4250, 4000T)

Retain for future use.

Merlin Gerin
Square D
Telemecanique

Schneider Electric

HAZARD CATEGORIES AND SPECIAL SYMBOLS

Read these instructions carefully and look at the equipment to become familiar with the device before trying to install, operate, service or maintain it. The following special messages may appear throughout this bulletin or on the equipment to warn of potential hazards or to call attention to information that clarifies or simplifies a procedure.

The addition of either symbol to a “Danger” or “Warning” safety label indicates that an electrical hazard exists which will result in personal injury if the instructions are not followed.

This is the safety alert symbol. It is used to alert you to potential personal injury hazards. Obey all safety messages that follow this symbol to avoid possible injury or death.

⚠ DANGER

DANGER indicates an imminently hazardous situation which, if not avoided, **will result in** death or serious injury.

⚠ WARNING

WARNING indicates a potentially hazardous situation which, if not avoided, **can result in** death or serious injury.

⚠ CAUTION

CAUTION indicates a potentially hazardous situation which, if not avoided, **can result in** minor or moderate injury.

CAUTION

CAUTION, used without the safety alert symbol, indicates a potentially hazardous situation which, if not avoided, **can result in** property damage.

NOTE: Provides additional information to clarify or simplify a procedure.

PLEASE NOTE

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.

FCC NOTICE

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense. This Class A digital apparatus complies with Canadian ICES-003.

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CHAPTER 1—INTRODUCTION

CIRCUIT MONITOR DESCRIPTION

The circuit monitor is a multifunction, digital instrumentation, data acquisition and control device. It can replace a variety of meters, transducers, and other components. The circuit monitor can be located at the service entrance to monitor the cost and quality of power, and it can be used to evaluate the utility service. When located at equipment mains, the circuit monitor can detect voltage-based disturbances that cause costly equipment downtime. Features in the meter also help users troubleshoot the source and location of these disturbances.

The circuit monitor is equipped with RS-485 and RS-232 communications for integration into any power monitoring and control system. However, the Powerlogic® System Manager™ Software (SMS), written specifically for power monitoring and control, best supports the circuit monitor's advanced features.

The circuit monitor is a true rms meter capable of exceptionally accurate measurement of highly nonlinear loads. A sophisticated sampling technique enables accurate, true rms measurement through the 255th harmonic. Over 50 metered values plus extensive minimum and maximum data can be viewed on the display or remotely using software. Table 1–1 summarizes the readings available from the circuit monitor.

Table 1–1: Summary of Circuit Monitor Instrumentation

Real-Time Readings	Energy Readings
• Current (per phase, N, G, 3-Phase) • Voltage (L–L, L–N, N–G, 3-Phase) • Real Power (per phase, 3-Phase) • Reactive Power (per phase, 3-Phase) • Apparent Power (per phase, 3-Phase) • Power Factor (per phase, 3-Phase) • Frequency • Temperature (internal ambient) • THD (current and voltage) • K-Factor (per phase)	• Accumulated Energy, Real • Accumulated Energy, Reactive • Accumulated Energy, Apparent • Bidirectional Readings • Reactive Energy by Quadrant • Incremental Energy • Conditional Energy
Demand Readings	**Power Analysis Values**
• Demand Current (per phase present, 3-Phase average) • Demand Voltage (per phase present, 3-Phase average) • Average Power Factor (3-Phase total) • Demand Real Power (per phase present, peak) • Demand Reactive Power (per phase present, peak) • Demand Apparent Power (per phase present, peak) • Coincident Readings • Predicted Power Demand	• Crest Factor (per phase) • Displacement Power Factor (per phase, 3-Phase) • Fundamental Voltages (per phase) • Fundamental Currents (per phase) • Fundamental Real Power (per phase) • Fundamental Reactive Power (per phase) • Harmonic Power • Unbalance (current and voltage) • Phase Rotation • Harmonic Magnitudes and Angles (per phase) • Sequence Components

Accessories and Options for the Circuit Monitor

The circuit monitor has a modular design to maximize its usability. In addition to the main meter, the circuit monitor has plug-on modules and accessories, including:

- **Current/voltage module**. A standard part of the circuit monitor is the current/voltage module where all metering data acquisition occurs. The circuit monitor is calibrated at the factory at the time of manufacture and

does not normally need to be recalibrated. However, in special cases where annual calibration is specified by the user, the current/voltage module can be removed and sent to the factory for recalibration without removing the entire circuit monitor. See “Replacing the Current/Voltage Module—CM4250, CM4000T” on page 23 or “Replacing the Current/Voltage Module—CM4000” on page 24 for instructions on replacing the current/voltage module.

- **Current/voltage transient module (CVMT)**. A standard part of the CM4000T and an optional accessory for the CM4000 and CM4250. See “Chapter 11—Transient Circuit Monitor” in the **PowerLogic® Circuit Monitor: Series 4000 Reference Manual** for more information about the CM4000T.
- **Remote display**. The optional remote 4-line display is available with a back-lit liquid crystal display (LCD) or a vacuum fluorescent display (VFD). The VFD model includes an infrared port that can be used to communicate directly with the circuit monitor from a laptop computer. The VFD model can also be used to download firmware, keeping the circuit monitor up to date with the latest system enhancements.
- **I/O Extender**. The I/O extender can be attached to the circuit monitor to allow “plug in” capabilities for up to 8 industry-standard inputs and outputs. Several pre-configured combinations are available, or you can create a custom configuration.
- **Digital I/O Card**. The I/O capabilities of the circuit monitor can be further expanded by adding a digital I/O card (4 inputs and 4 outputs). This card fits into the option slot on the top of the circuit monitor.
- **Ethernet Communications Card**. The Ethernet communications card provides an Ethernet port that accepts a 100 Mbps fiber optic cable or a 10/100 Mbps UTP and provides an RS-485 master port to extend the circuit monitor communications options. This card is easily installed into the option slot on the top of the circuit monitor.

Table 1–2 lists the circuit monitor parts and accessories and their associated instruction bulletins.

Table 1–2: Circuit Monitor Parts, Accessories, and Custom Cables

Description	Part Number
Circuit Monitor	CM4250 CM4250MG
Current/Voltage Module with anti-aliasing	CVM42
Circuit Monitor Transient	CM4000T CM4000TMG
Current/Voltage Mudule Transient	CVMT
VFD Display with infrared (IR) port and proximity sensor	CMDVF CMDVFMG
LCD Display	CMDLC CMDLCMG
Optical Communications Interface (for use with the VFD display only)	OCIVF
I/O Extender Module ①	
with no preinstalled I/Os, accepts up to 8 individual I/O modules with a maximum of 4 analog I/Os	IOX
with 4 digital inputs (32 Vdc), 2 digital outputs (60 Vdc), 1 analog output (4–20 mA), and 1 analog input (0–5 Vdc)	IOX2411
with 4 analog inputs (4–20 mA) and 4 digital inputs (120 Vac/Vdc)	IOX0404

① For parts list of individual inputs and outputs, see Table 5–1 in the reference manual.

Table 1–2: Circuit Monitor Parts, Accessories, and Custom Cables *(continued)*

Description	Part Number
with 8 digital inputs (120 Vac/Vdc)	IOX08
Digital I/O Card Field installable with 4 digital inputs (120 Vac), 3 (10 A) relay outputs (20-138 Vac/Vdc), 1 pulse output (KYZ)	IOC44
Ethernet Communications Card with 100 Mbps fiber or 10/100 Mbps UTP Ethernet port and 1 RS-485 master port	ECC21
Memory Expansion Kit (32 MB kit)	CM4MEM32M
CM4 Mounting Adapters	CM4MA
4-ft display cable (1.2 m)	CAB-4
12-ft display cable (3.6 m)	CAB-12
30-ft display cable (9.1 m)	CAB-30
10-ft RS-232 cable (3 m)	CAB-106

① For parts list of individual inputs and outputs, see Table 5–1 in the reference manual.

Features

Some of the circuit monitor's many features include:

- True rms metering up to the 255th harmonic
- Accepts standard CT and PT inputs
- 690 volt direct connection on metering inputs for CM4250, CM4000T
  600 volt direct connection on metering inputs for CM4000
- Certified ANSI C12.20 revenue accuracy, IEC 687 Class 0.2S revenue accuracy
  IEC 62053-22 Class 0.2 for CM4250, CM4000T
- High accuracy—0.04% current and voltage
- Min/max readings of metered data
- Power quality analysis readings—THD, K-factor, crest factor
- Anti-aliasing filtering
- Real-time harmonic magnitudes and angles to the 63rd harmonic
- Current and voltage sag/swell detection and recording
- Downloadable firmware
- Easy setup through the optional remote display (password protected), where you can view metered values.
- Setpoint-controlled alarm and relay functions
- Onboard alarm and data logging
- Wide operating temperature range –25° to 70°C
- Modular, field-installable digital and analog I/O modules
- Flexible communications—RS-485 and RS-232 communications are standard, optional Ethernet communications card available with fiber-optic connection
- Two option card slots for field-installable I/O and Ethernet capabilities
- Standard 16 MB onboard logging memory (field upgradable to 32 MB and higher)
- CT and PT wiring diagnostics
- Revenue security with utility sealing capability
- Disturbance direction detection
- EN50160 evaluations
- Power quality, energy, and alarm summaries
- Waveshape alarms
- Alarm setpoint learning

- Harmonic power flows
- Harmonic and interharmonic measurements per IEC 61000-4-7 (CM4250 only)

TOPICS NOT COVERED IN THIS BULLETIN

Some of the circuit monitor's advanced features, such as onboard data logs and alarm log files, can only be set up over the communications link using SMS. This circuit monitor instruction bulletin describes many advanced features, but does not tell how to set them up. For instructions on using SMS, refer to the SMS online help and the SMS Setup Guide. For information about related instruction bulletins, see Table 1–2 on page 2.

CHAPTER 2—SAFETY PRECAUTIONS

BEFORE YOU BEGIN

This section contains important safety precautions that must be followed before attempting to install, service, or maintain electrical equipment. Carefully read and follow the safety precautions outlined below.

⚠ DANGER

HAZARD OF ELECTRIC SHOCK, EXPLOSION OR ARC FLASH

- Apply appropriate personal protective equipment (PPE) and follow safe electrical work practices. In the U.S., see NFPA 70E.
- Only qualified workers should install this equipment. Such work should be performed only after reading this entire set of instructions.
- NEVER work alone.
- Turn off all power supplying this equipment before working on or inside.
- Always use a properly rated voltage sensing device to confirm that all power is off.
- Before performing visual inspections, tests, or maintenance on this equipment, disconnect all sources of electric power. Assume that all circuits are live until they have been completely de-energized, tested, and tagged. Pay particular attention to the design of the power system. Consider all sources of power, including the possibility of backfeeding.
- Beware of potential hazards, wear personal protective equipment, and carefully inspect the work area for tools and objects that may have been left inside the equipment.
- Use caution while removing or installing panels so that they do not extend into the energized bus; avoid handling the panels, which could cause personal injury.
- The successful operation of this equipment depends upon proper handling, installation, and operation. Neglecting fundamental installation requirements may lead to personal injury as well as damage to electrical equipment or other property.
- Before performing Dielectric (Hi-Pot) or Megger testing on any equipment in which the circuit monitor is installed, disconnect all input and output wires to the circuit monitor. High voltage testing may damage electronic components contained in the circuit monitor.

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

CHAPTER 3—GETTING STARTED

SETTING UP THE CIRCUIT MONITOR

The circuit monitor is shipped with factory default settings and can be installed and used “right out of the box.” You can also customize the circuit monitor to suit your particular needs. For more information on customizing the circuit monitor, see the circuit monitor reference manual.

You must complete a minimum installation and setup procedure for the circuit monitor to function and to meter properly.

⚠ DANGER

HAZARD OF ELECTRIC SHOCK, EXPLOSION OR ARC FLASH

- Turn off all power supplying the circuit monitor and the equipment in which it is installed before working on it.
- Use a properly rated voltage testing device to verify that the power is off.
- Never short the secondary of a PT.
- Never open circuit a CT; use the shorting block to short circuit the leads of the CT before removing the connection from the circuit monitor.

Failure to follow this instruction will result in death or serious injury.

Setup Overview

Below is a list of the necessary steps involved in setting up the circuit monitor. Detailed instructions for each step are given in the referenced sections of this manual.

1. Mount the hardware. (The “Installation” section begins on page 11.)
   a. Install any accessories. (See the instructions that ship with each accessory for installation instructions.)
   b. Mount the circuit monitor.
   c. Mount the display (if present).
2. Wire the components. (The “Wiring” section begins on page 33.)
   a. Wire the circuit monitor.
   b. Wire any inputs and outputs. (See the instructions that ship with the I/Os for wiring instructions.)
   c. Wire the communications.
3. Set up communications and the meter.
   At a minimum, you must set up these parameters:
   — CT primary and secondary
   — PT primary and secondary
   — System type
   — Frequency
   — Address, baud rate, and parity for the selected communications port
   — IP address for the ECC.

If you are using the PowerLogic® System Manager™ Software (SMS), do the following:

a. From the display, set up the address, baud rate, and parity. See "Setting Up the Communications" on page 76 for instructions.

b. Use SMS to configure the circuit monitor and set up the minimum parameters listed above. See "Working with Devices" in the SMS online help for instructions. You can also set up alarms, logs, and I/Os, but these are not required for minimum setup.

If you are NOT using SMS, do the following:

Use the display to configure the circuit monitor. From the main menu, select Setup > Meter to display the Meter Setup menu. See "Setting Up the Metering Functions of the Circuit Monitor" on page 78 for details.

4. Initiate a wiring error test from the circuit monitor display.

   See "Wiring Error Detection" on page 52 for instructions.

5. Initialize the meter. Meter initialization resets energy, demand, files, trending, min/max and disables all alarms.

   If you are using SMS:

   a. Select Control > Resets.

   b. From the Reset Device Data screen, select the device. From the Resets Available screen, select Meter Initialization.

   c. Click Reset. Click Help on this screen for detailed instructions.

FACTORY DEFAULTS

The circuit monitor is preconfigured with the following features enabled:

- On-board alarm log that records the last 100 events.
- On-board memory is allocated for one steady-state waveform, twelve disturbance waveforms, six adaptive waveforms, and twelve 100ms rms event recordings.
- Data Log 1 records every 15 minutes the values for the quantities listed in Table 3–1, retaining the information for the previous seven days.

Table 3–1: Quantities logged in Data Log 1

Parameter	Values
Current	A, B, C, N, G, Average
Voltage L–L	A–B, B–C, C–A, Average
Voltage L–N	A–N, B–N, C–N, N–G, Average
Voltage Unbalance	L-N, Worst L-L, Worst
Real Power	A,B,C, 3-Phase total
Reactive Power	A,B,C, 3-Phase total
Apparent Power	A,B,C, 3-Phase total
True Power Factor	A,B,C, 3-Phase total
Displacement Power Factor	A,B,C, 3-Phase total
Demand Current	A, B, C, N, Average
Power Demand	kWd, kVARd, kVAd
THD Current	A, B, C, N, G
THD Voltage L–N	A–N, B–N, C–N
THD Voltage L–L	A-B, B-C, C-A
Energy	kWhr, kVAhr, kVARhr
Conditional Energy	Real In, Real Out, Reactive In, Reactive Out

- Data Log 2 automatically logs hourly interval-by-interval energy values for the parameters listed in Table 3–2, retaining the values for the previous 31 days .

Table 3–2: Energy and demand parameters logged in Data Log 2

Parameter	Values
Incremental Energy	kWh In, kWh Out, kVAh
Peak Real Power Demand over last incremental energy period	kW
Peak Apparent Power Demand over last incremental energy period	kVA

- Data Log 3 automatically performs a fast rolling log of instantaneous data once every minute retaining the information for the previous 12 hours. The logged values are listed in Table 3–3.

Table 3–3: Instantaneous rms data logged in Data Log 3

Parameter	Values
Current	A, B, C, N, G, Average
Voltage L-L	A-B, B-C, C-A, Average
Voltage L-N	A–N, B–N, C–N, N–G, Average
Real Power	3-Phase total
Reactive Power	3-Phase total
Apparent Power	3-Phase total
True Power Factor	3-Phase total
Displacement Power Factor	3-Phase total
THD Current	A, B, C, N, G
THD Voltage L-N	A–N, B–N, C–N
THD Voltage L-L	A-B, B-C, C-A

- Data Log 4 also performs a fast rolling log of the quantities listed in Table 3–3, but logs them every 5 seconds and retains the information for the previous hour.
- The on-board alarms listed in Table 3–4 are also enabled.

Table 3–4: Enabled on-board alarms

Alarm	Alarm No.	Pickup	Pickup delay	Dropout	Dropout Delay	Priority	Action
Voltage Sag	Disturbance 8 to 10	87% (% relative)	2 cycles	90% (% relative)	4 cycles	Low	Disturbance WFC, Adaptive WFC, 100 ms Event
Over THD Voltage	Standard 39 to 44	5%	300 seconds	5%	300 seconds	Low	Disturbance WFC
Voltage Unbalance	Standard 23 to 24	2%	300 seconds	2%	300 seconds	Low	Disturbance WFC, 100 ms Event
End of Incremental Energy Interval	Digital 1	N/A	N/A	N/A	N/A	None	Forces Data Log 2 Entry

- Incremental energy is configured for an hourly interval starting at midnight.
- The default display password is set to 0.

IMPORTANT PROCEDURES FOR SMS USERS

If you are using SMS and would like to take advantage of the factory configurations, you must do the following in SMS from the PC after the circuit monitor is installed:

- Set up a scheduled task to automatically upload onboard data logs.
- To ensure SMS recognizes the preconfigured onboard alarms, you must place your system online and display the Setup Device dialog (click Setup > Devices/Routing > Configure). The software synchronizes the alarm configuration with the system database. Once the two are synchronized, SMS will announce any alarms that occur after this point.

For more information, see the SMS online help file.

CHAPTER 4—INSTALLATION

CIRCUIT MONITOR INSTALLATION

The following sections describe the circuit monitor hardware, provide dimensional drawings, and explain how to mount the circuit monitor.

Circuit Monitor Parts

Figure 4–1 shows the parts of the circuit monitor. A brief description of each part follows in Table 4–1.

Figure 4–1: Parts of the Circuit Monitor (CM4250 shown)

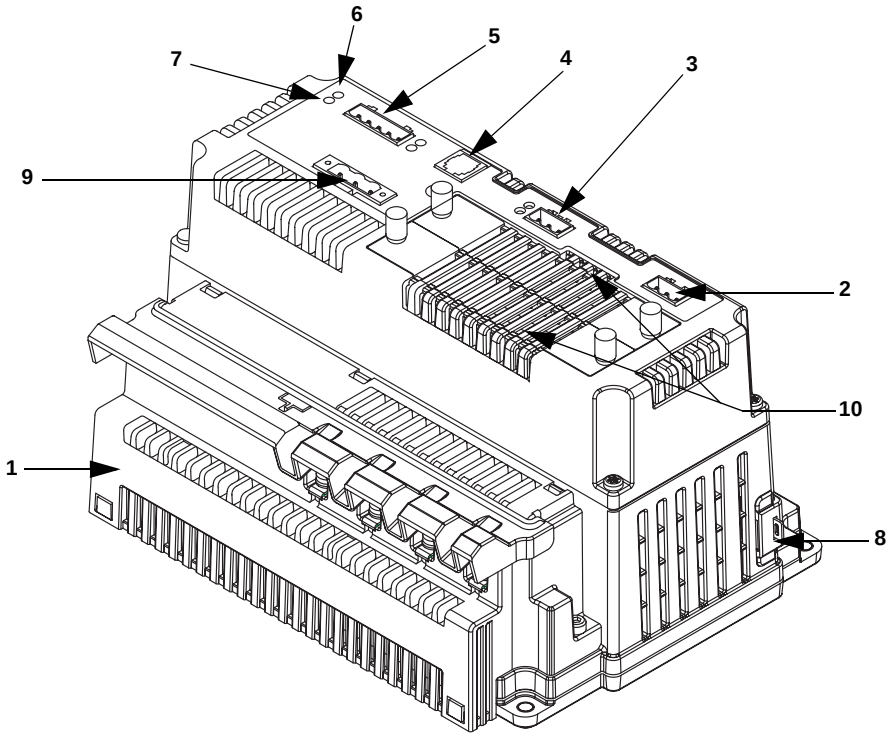


Table 4–1: Parts of the Circuit Monitor

Part		Description
1	Current/voltage module	The current and voltage connections are housed in this removable current/voltage module, which plugs directly into the main housing of the circuit monitor. All metering data is acquired through the current/voltage module. Because the current/voltage module is removable, it can be easily interchanged with enhanced current/voltage modules as they become available without removing the entire circuit monitor. For transient detection, the CVMT module is available.
2	KYZ	KYZ pulse output.
3	RS-232 port (COM2) with transmit and receive LED indicators	The RS-232 port can be used for direct communications to the PC. The port has two corresponding LEDs. The yellow LED illuminates when the circuit monitor is receiving data (RX) across the communications; the green illuminates when data is being transmitted (TX).
4	RJ-12 display Comms port	The RJ-12 port is used for communications and control power connections to the remote display.
5	RS-485 port (COM1) with transmit and receive LED indicators	The RS-485 port is used for communications with daisy-chained devices. The port has two corresponding LEDs. The yellow LED illuminates when the circuit monitor is receiving data (RX) across the RS-485 communications; the green illuminates when data is being transmitted (TX).

Table 4–1: Parts of the Circuit Monitor *(continued)*

Part		Description
6	Power LED indicator*	A steady-state green LED is continuously illuminated when the circuit monitor is powered up.
7	Maintenance LED indicator*	This LED illuminates red if the circuit monitor is experiencing an internal problem and requires service.
8	Access door	The access door provides access to a security switch that, when activated, locks setup information and metering data in the circuit monitor. See “Activating Revenue Security” on page 29 for details. This door also lets you access the memory chip for upgrading the circuit monitor’s memory.
9	Control power supply connector	Connection for control power to the circuit monitor.
10	Option card slots	Optional cards fit in the two slots provided on the top of the circuit monitor, such as a digital I/O card (outputs rated up to 10 A) or an Ethernet communications card.

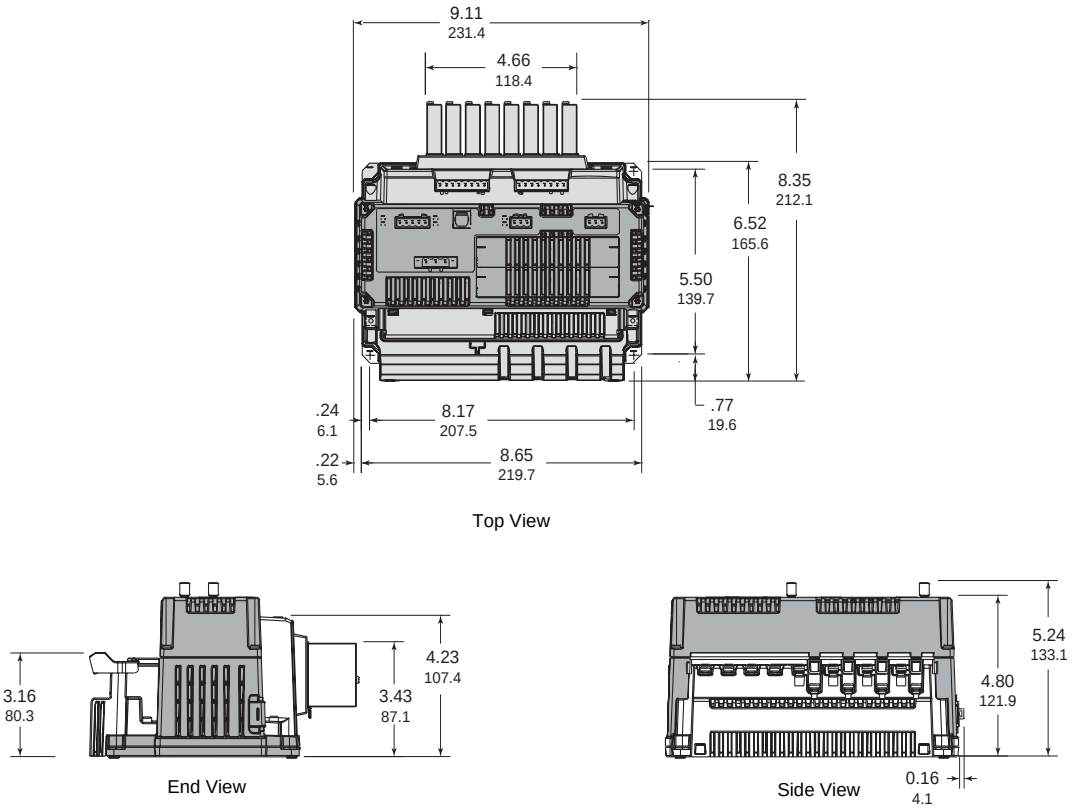
*See Table 8–1 on page 83 in the maintenance section for more about the LEDs on the circuit monitor.

Circuit Monitor Dimensions

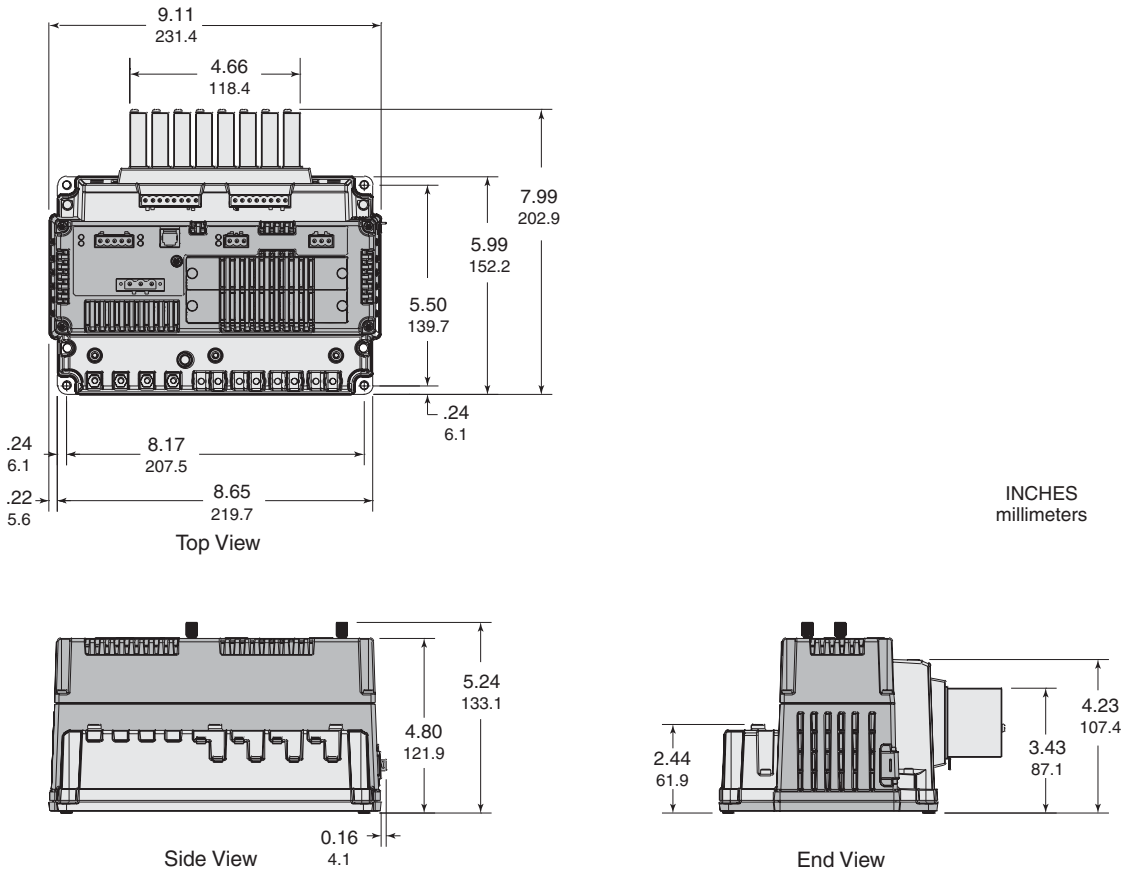
The dimensions for the circuit monitor are shown in Figure 4–2.

Figure 4–2: Circuit Monitor Dimensions

CM4250/4000T Dimensions



CM4000 Dimensions

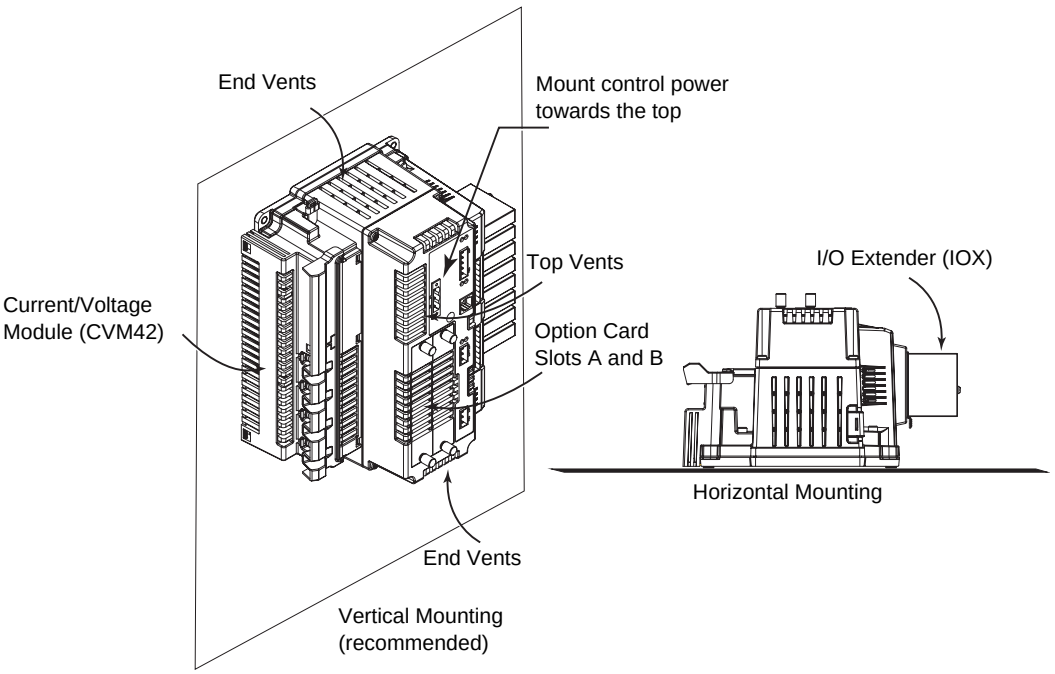


MOUNTING CONSIDERATIONS

When choosing a mounting location, consider the following points:

- Allow for easy access to all parts of the circuit monitor. Allow extra space for all wires, fuse disconnects, shorting blocks, accessories, or other components. Make sure to route the wires so that they do not cover the option card slots, I/O extender, current/voltage module, or cooling vents on the circuit monitor. Refer to Figure 4–4 and Figure 4–5 for required clearances.
- For European Community (CE) compliance, see “Required Protection for CE Compliance” on page 38.
- The circuit monitor can be mounted horizontally or vertically. The recommended orientation is to mount it vertically in an equipment metering compartment, making sure the control power connector is towards the top. See Figure 4–3 for the two correct mounting positions.

Figure 4–3: Possible ways to orient the circuit monitor



⚠ CAUTION

IMPROPER VENTILATION

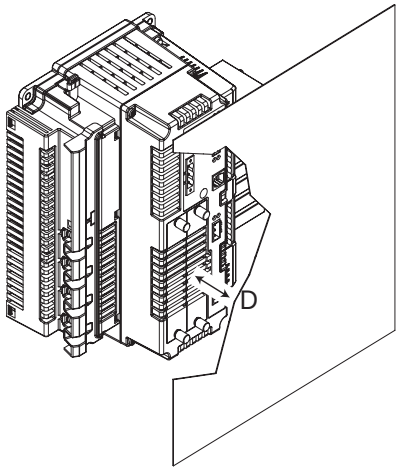
- Do not mount the circuit monitor to a ceiling or in vertical orientations other than the one indicated in this instruction bulletin.
- Provide the clearances around the circuit monitor as illustrated in Figures 4–4 and 4–5 and Table 4–2 on page 15.

Failure to follow these instructions can result in equipment damage.

Clearances

Clearances for the circuit monitor are shown in Figures 4–4 and 4–5. Use Table 4–2 to determine clearence values.

Figure 4–4: Clearance for vertically mounted circuit monitors



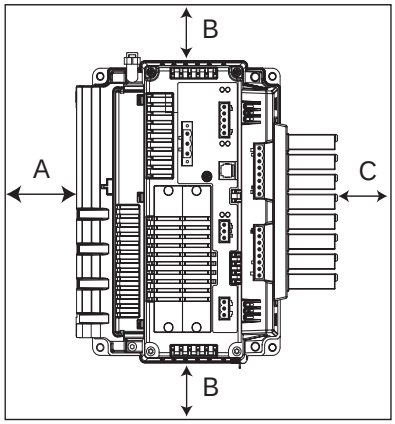
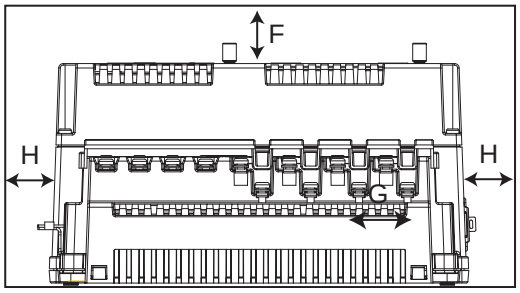


Figure 4–5: Clearance for horizontally mounted circuit monitors



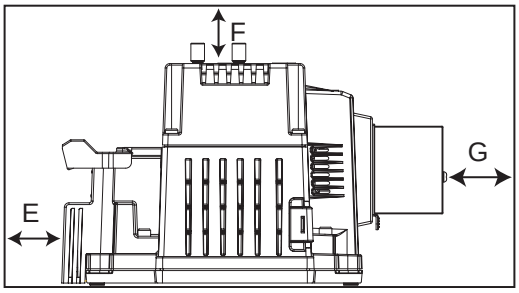


Table 4–2: Clearance values based on ambient temperature

Ambient Temperature	Inches (millimeters)							
	A	B	C	D	E	F	G	H
less than or equal to 50°C (122°F)	1.0 (25)	1.0 (25)	2.5 (64)	1.0 (25)	1.0 (25)	2.0 (51)	2.5 (64)	1.0 (25)
greater than 50°C (122°F)	1.5 (38)	3.0 (76)	3.0 (76)	2.0 (51)	1.5 (38)	3.0 (76)	3.0 (76)	2.0 (51)

- Locate the circuit monitor in an area where ambient conditions fall within the acceptable range. The circuit monitor's ambient temperature range is - 20°C to +70°C when mounted vertically with one or no option cards installed and an I/O extender (IOX) with digital I/O modules installed. See Table 4–3 for operating temperatures.

Table 4–3: Operating temperatures

Mounting Orientation	Number of Options Cards	Ambient Temperature Rating ②
Vertical	0 or 1	-20°C to +70°C
Vertical	2	-20°C to +65°C
Horizontal	0 to 1	
Horizontal	2	-20°C to +60°C
With I/O Extender (IOX) Option equipped with analog I/O modules①		
IOX-2411 (or custom IOX with up to 2 analog modules)		0 to +60°C
IOX-0404 (or custom IOX with 4 analog modules)		0 to +50°C

①No more than four analog I/Os can be installed in the I/O Extender (IOX). Do not mount two analog modules side by side. If using two analog modules, place them at opposite ends of the extender. See the documentation that ships with the I/Os for instructions on installing I/Os.

②Ambient temperature refers to the immediate environment of the circuit monitor, including the temperature within the enclosure in which it is mounted.

Mounting Procedure

To mount the circuit monitor, follow these instructions:

⚠ DANGER

HAZARD OF ELECTRIC SHOCK, EXPLOSION OR ARC FLASH

- Only qualified workers should install and wire the circuit monitor. Perform this work only after completely reading the installation and wiring chapters.
- Turn off all power supplying the circuit monitor and the equipment in which it is installed before working on it.
- Always use a properly rated voltage sensing device to confirm that all power is off.

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

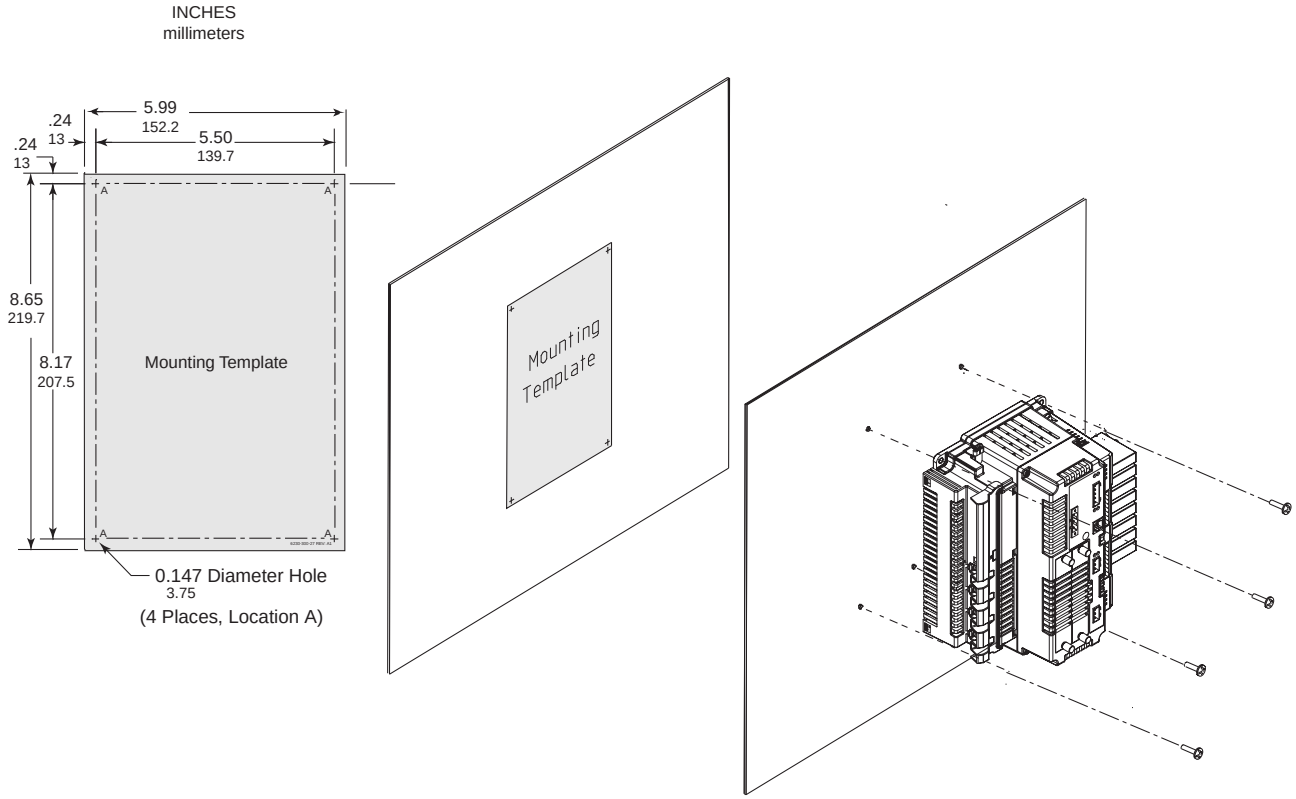
1. Determine a location for the circuit monitor, making sure you understand all mounting considerations discussed in “Mounting Considerations” on page 13.
2. Tape the mounting template, included in the circuit monitor shipping carton, to the selected location. Refer to Figure 4–6 on page 17.
3. Making sure wires or equipment on the other side of the enclosure will not be damaged, drill four 0.147 in (3.75 mm) diameter mounting holes in location “A” marked on the template. Remove the template.

If mounting from the rear of the circuit monitor, drill four 0.225 in. (5.75 mm) diameter mounting holes in location “A” marked on the template.

4. Position the circuit monitor against the front of the panel, aligning the four mounting holes in the panel with the mounting holes of the circuit monitor.
5. Referring to Figure 4–6 on page 17, secure the circuit monitor. Using the (M4 x 10 mm) thread-forming mounting screws provided in the circuit monitor hardware kit, insert the screws through the mounting holes of the circuit monitor into the pre-drilled holes in the panel. Torque the screws 6–9 lb.-in. (0.68–1 N•m).

If mounting from the rear, use an M5 x 7 mm thread-forming screw. Depending on the thickness of the panelboard, you might need a longer thread-forming screw.

Figure 4–6: Circuit monitor mounting hole dimensions and locations



INSTALLING THE DISPLAY

This section describes the display, provides dimensional drawings, and explains how to mount it. Operating the circuit monitor from the display is described in “Operating the Display” on page 71.

Display Description

The display is an optional accessory used to operate the circuit monitor directly, without using software. The display can be connected to only one circuit monitor at a time. You can permanently mount it with an individual circuit monitor, or you can carry it around to each circuit monitor and plug in as needed. See the section on using the display in the Operations section.

Two display models are available:

- LCD display
- VFD display that has an additional proximity sensor and infrared port

The displays are shown in Figure 4–7. Table 4–4 describes the parts of the display.

Figure 4–7: LCD and VFD Displays

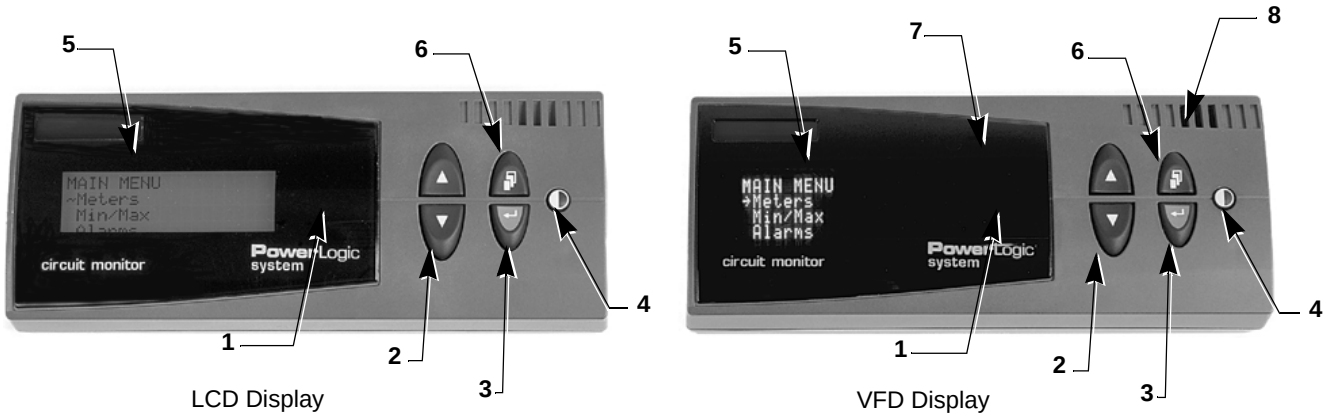


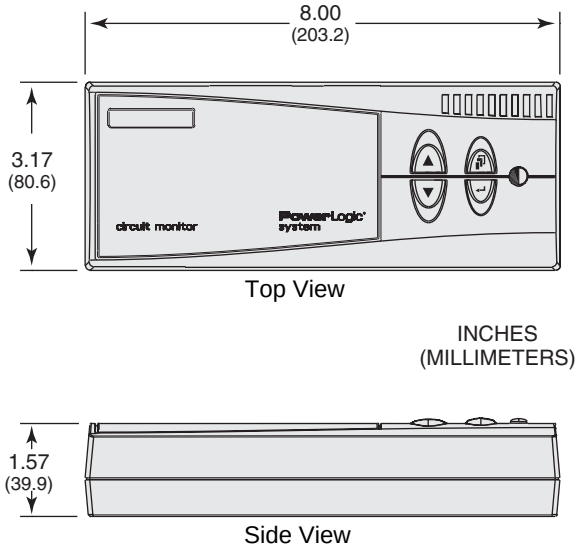
Table 4–4: Parts of the Display

Component	Description
1 Alarm LED	Red flashing light illuminates when an alarm is active.
2 Arrow buttons	Press the arrow buttons to scroll through and view the options or values displayed on a menu.
3 Enter button	Press to select information.
4 Contrast button	Press to change the light and dark contrast of the display.
5 Display screen	Use the 4-line LCD or VFD display to view information such as metered quantities, setup parameters, diagnostic information, and active alarm descriptions. The display illuminates on the VFD model when you cross the path of the proximity sensor or press a button on it. Both displays can be set to stay lit for a specified number of minutes. The LCD model is back lit. To activate backlighting, press any button on the display.
6 Menu button	Press to go back one menu level.
7 Infrared port	For use with the optical communications interface (OCIVF) and a laptop (VFD display only).
8 Proximity sensor	Detects when you are approaching and turns on the display and buttons (VFD display only).

Display Dimensions

Figure 4–8 shows the dimensions for the display.

Figure 4–8: Display Dimensions



Display Mounting

Before mounting the display, please read and consider the next section on mounting considerations.

Mounting Considerations

When choosing a mounting location, consider these points:

- Allow for easy access to the front and back of the display.
- Be sure that ambient conditions fall within the acceptable range as listed in the “Specifications” on page 85.
- To meet the NEMA 12 rating, you must install a gasket between the display and the mounting surface.
- Mount the display in a horizontal, upright position (as illustrated in the top view in Figure 4–8).
- Use the four mounting screws (M3.5 x 10mm Phillips pan-head threaded screws) provided in the display hardware kit. If using screws other than those provided, the screws can be no longer than 0.31 in. (6.35 mm) plus the panel thickness. For example, if the panel is 0.09 in. thick, the screw will be a maximum of 0.31 + 0.09 = 0.40 in. (7.8 + 2.2 = 10 mm).

Typical locations for mounting the display are listed in Table 4–5.

Table 4–5: Typical display mounting locations

Equipment Type	Mounting Location
QED Switchboards	Disconnect door
POWER-ZONE® IV Switchgear	Main instrument compartment door
HVL and VIS/VAC Switchgear	Instrument door
Metal-clad and Substation Circuit Breakers	Standard relaying locations
ISO-FLEX® Medium Voltage Motor Control Center	Low voltage door
Model 6 Motor Control Center	Main meter location or auxiliary section

Mounting Procedure

Follow these steps to mount the display:

⚠ DANGER

HAZARD OF ELECTRIC SHOCK, EXPLOSION OR ARC FLASH

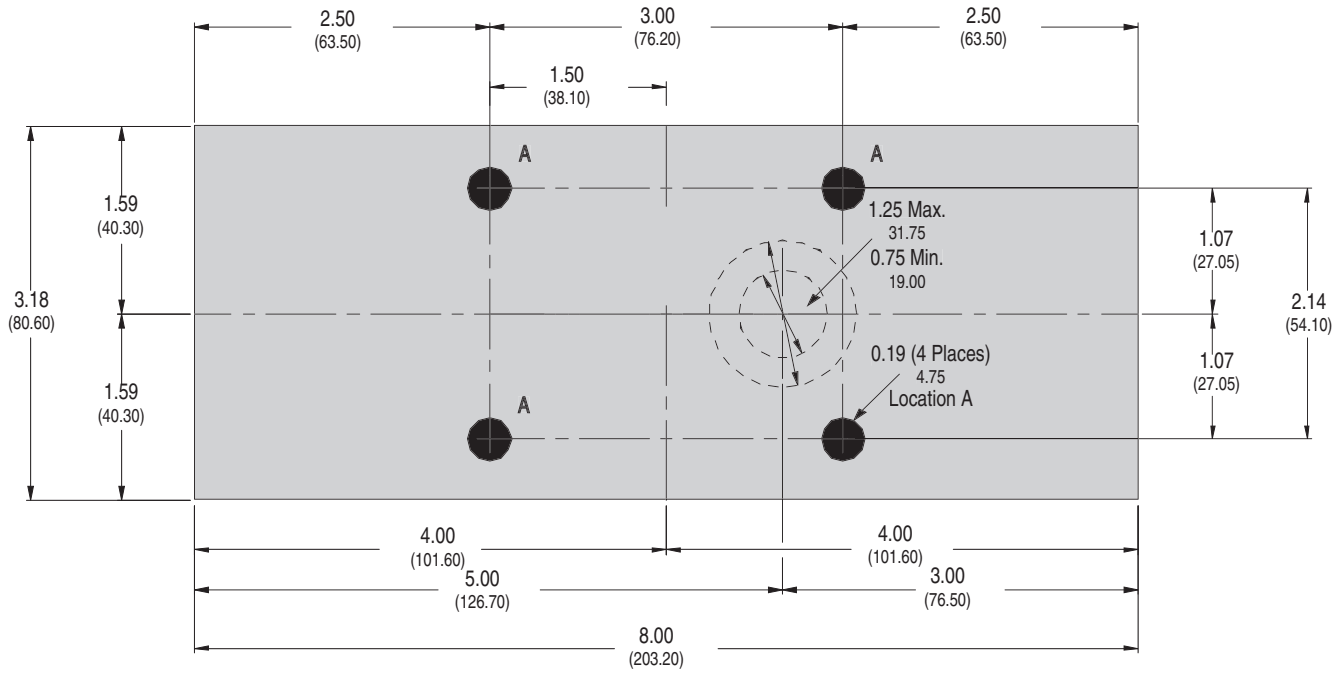
- Only qualified workers should install and wire the circuit monitor. Perform this work only after completely reading this entire instruction bulletin.
- Turn off all power supplying the equipment in which the display is being installed before working on it.
- Always use a properly rated voltage sensing device to confirm that all power is off.
- Do not use mounting screws longer than 0.31 in. (7.8 mm) plus the panel thickness to avoid damage to the internal circuit boards of the display.

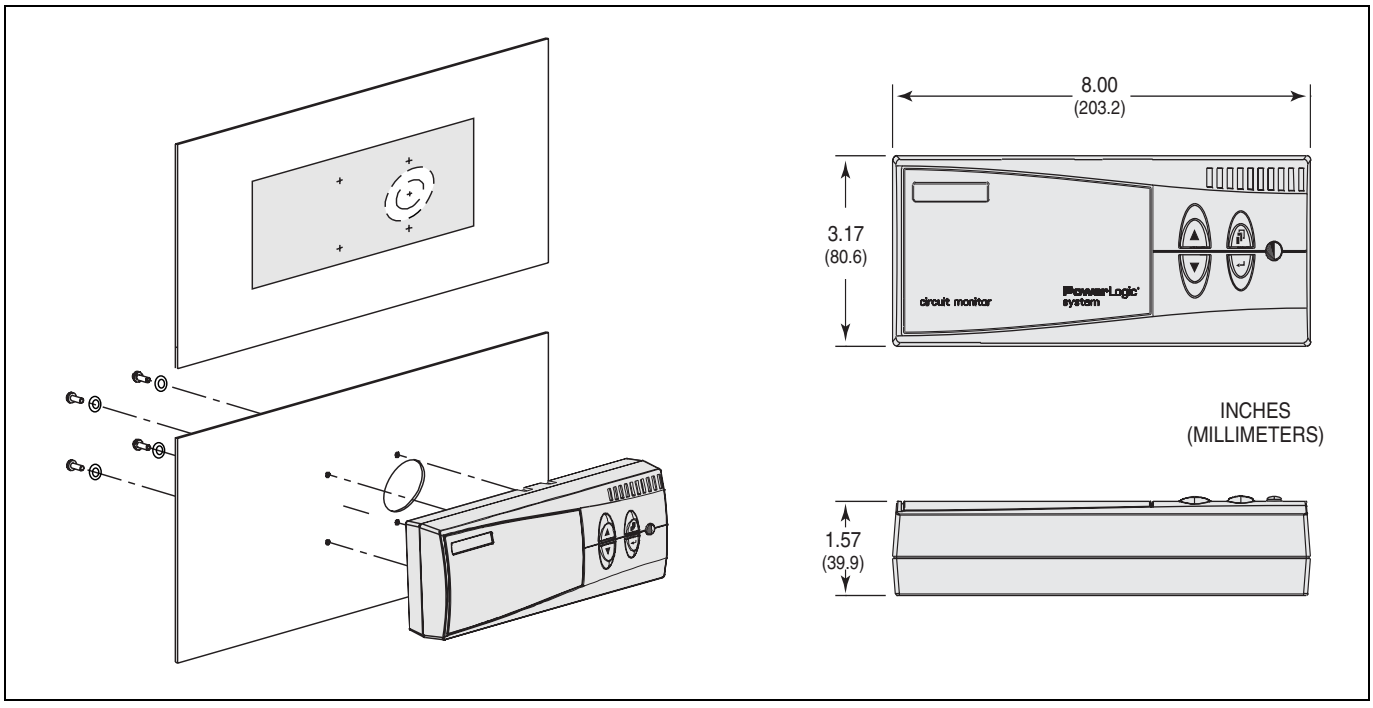
Failure to follow this instruction will result in death or serious injury.

1. Before drilling the holes, understand all mounting considerations and verify that the selected location has the required clearances.
2. Tape the template provided in the display hardware kit to the selected location on the front of the panelboard. Refer to Figure 4–9 on page 21.
3. Making sure wires or equipment on the inside of the enclosure will not be damaged, drill four 0.16 in. (4 mm) diameter mounting holes in location “A” marked on the template.
4. On the right end of the template, drill or punch one hole that is 0.75 in. minimum to 1.25 in. maximum (19–31.75 mm) diameter through the panel. Remove the template. Smooth the edges of the hole to remove any sharp edges.

If this is a NEMA 12 installation, position a gasket between the back of the display and the mounting surface.

Figure 4–9: Display mounting hole dimensions and locations





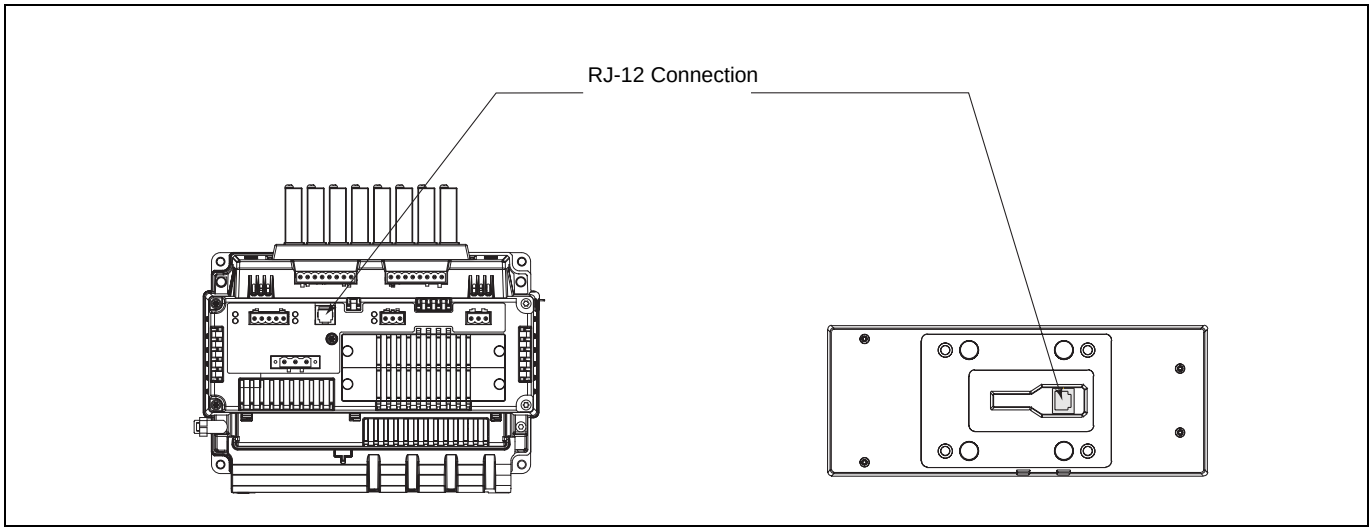
5. Position the display against the front of the panel and align the mounting holes in the panel with the mounting holes on the back of the display.

6. Secure the display. Insert the four M3.5 x 10mm screws through the back of the panel and screw into the mounting holes of the display. Torque the screws 6–9 lb.-in. (0.68–1 N•m).

Connecting the Display

The display connects to the RJ-12 port on the back of the display and the top of the circuit monitor. The display obtains its control power and communications through the cable. A 12-ft. (3.7 m) cable is provided, but 4-ft. (1.2 m) and 30-ft. (9.1 m) cables are also available (part no. CAB-4 or CAB-30). Plug one end of the cable into the back of the display and the other end into the port labeled with the display icon on the top of circuit monitor as shown in Figure 4–10.

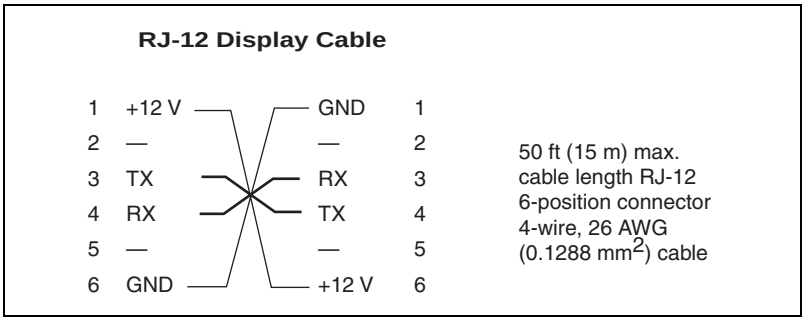
Figure 4–10: Display connection to the circuit monitor



RJ-12 Display Cable Pinout

The pinout for the display cable and cable requirements are shown in Figure 4–11.

Figure 4–11: RJ-12 display cable pinout



CURRENT/VOLTAGE MODULE

The current and voltage connections are housed in the separate current/voltage module that is attached by Allen-head screws and plugged into the circuit monitor at the factory. All metering data is acquired through the current/voltage module, which allows up to 690 V (600 V for CM4000) direct connection.

The circuit monitor is calibrated at the factory at the time of manufacture and does not normally need to be recalibrated. However, in special cases where annual calibration is specified by the user, the current/voltage module can be removed and sent to the factory for recalibration without removing the entire circuit monitor. If you need to do this, replace the current/voltage module with a spare while the other is being calibrated.

Replacing the Current/Voltage Module—CM4250, CM4000T

To remove and reinstall the current/voltage module, refer to Figure 4–12 on page 24 and follow these instructions:

⚠ DANGER

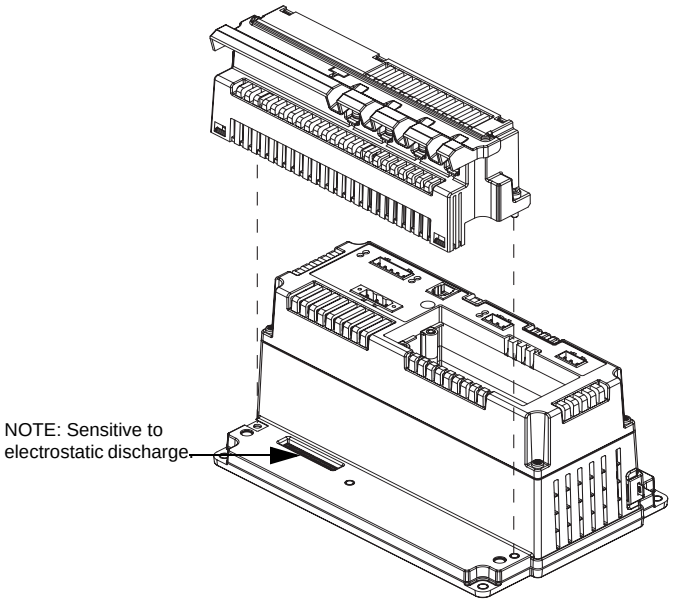
HAZARD OF ELECTRIC SHOCK, EXPLOSION OR ARC FLASH

- Turn off all power supplying the circuit monitor and the equipment in which it is installed before working on it.
- Always use a properly rated voltge sensing device to confirm that all power is off.

Failure to follow this instruction will result in death or serious injury.

1. Turn off all power supplying the circuit monitor and the equipment in which it is installed before working on it. Ensure CT blocks are shorted.
2. Lift or remove the terminal cover and ensure that the voltage and current input wiring is labeled accurately. See “Installing the Terminal Cover—CM4250, CM4000T” on page 49 for more information on terminal cover installation.
3. Remove the voltage and current input wires.
4. Loosen the two Allen-head screws (one on either side of the current/voltage module) until they disengage.
5. Pull the current/voltage module straight up until it disengages from the circuit monitor as shown in Figure 4–12.

Figure 4–12: Removal of Current/Voltage Module—CM4250, CM4000T



6. Align the replacement current/voltage module with the mounting holes on the circuit monitor.
7. Seat the current/voltage module and tighten the two Allen-head screws. Torque screws at 5-7 in.-lbs.(0.56–0.79 N•m). Do not overtighten.
8. Reconnect the voltage and current input wires. Replace or install the terminal cover. Restore power to the circuit monitor.

Replacing the Current/Voltage Module—CM4000

To remove and reinstall the current/voltage module (CM4000), refer to Figure 4–13 on page 25 and follow these instructions:

⚠ DANGER

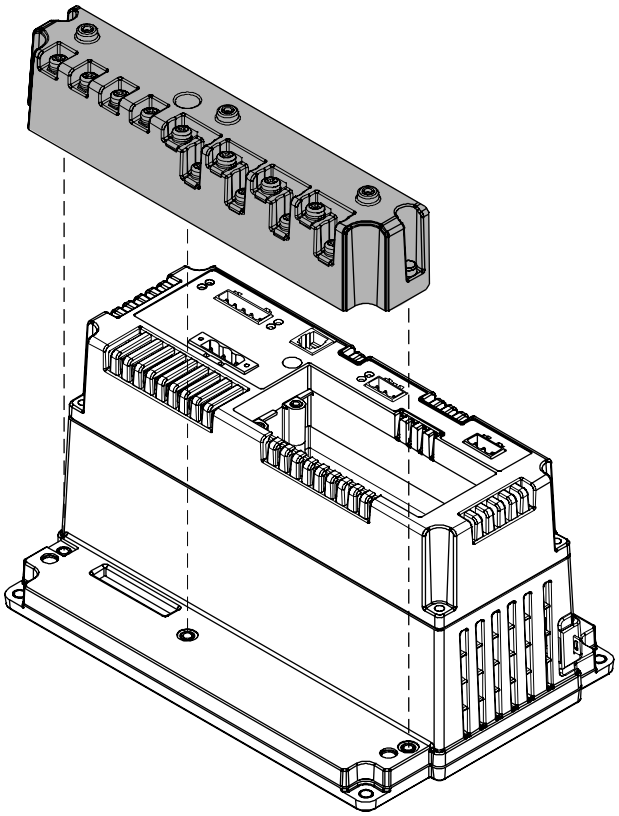
HAZARD OF ELECTRIC SHOCK, EXPLOSION OR ARC FLASH

- Turn off all power supplying the circuit monitor and the equipment in which it is installed before working on it.
- Always use a properly rated voltge sensing device to confirm that all power is off.

Failure to follow this instruction will result in death or serious injury.

1. Turn off all power supplying the circuit monitor and the equipment in which it is installed before working on it. Ensure CT blocks are shorted.
2. Remove the terminal cover and ensure that the voltage and current input wiring is labeled accurately. See “Installing the Terminal Cover—CM4000” on page 50 for more information on terminal cover installation.
3. Remove the voltage and current input wires.
4. Loosen the three Allen-head screws until they disengage.
5. Pull the current/voltage module straight up until it disengages from the circuit monitor as shown in Figure 4–13.

Figure 4–13: Removal of Current/Voltage Module—CM4000



6. Align the replacement current/voltage module with the mounting holes on the circuit monitor.
7. Seat the current/voltage module and tighten the three Allen-head screws. Torque screws at 5-7 in.-lbs. (0.56–0.79 N•m). Do not overtighten.
8. Reconnect the voltage and current input wires. Re-install the terminal cover. Restore power to the circuit monitor.

I/O EXTENDER MODULE

The I/O extender is an optional, external field-installable accessory that enables you to expand the I/O capabilities of the circuit monitor. The module plugs directly into the main housing of the circuit monitor (see Figure 4–15) and holds up to eight individual plug-on digital and analog I/O modules. You can configure many combinations of inputs and outputs. Standard modules are available as ac or dc inputs and outputs in a variety of voltage ranges, or you can select and field-install the pluggable I/O modules. For more information, see the installation instructions that ship with the I/O extender. Table 4–6 lists the options available with the I/O extender.

Figure 4–14: I/O Extender Module

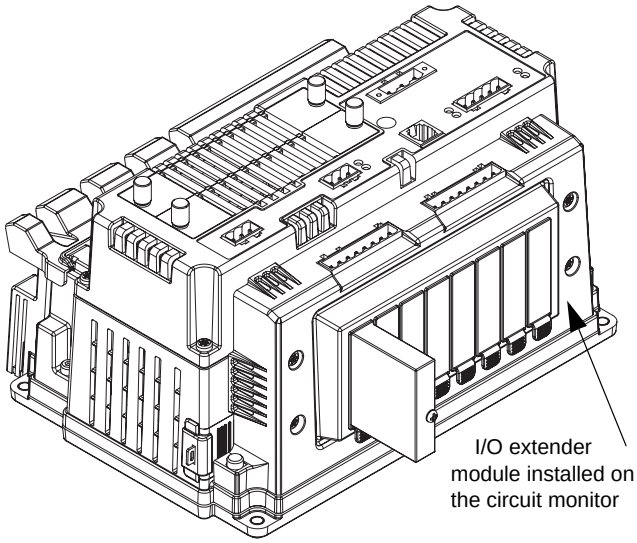


Table 4–6: I/O Extender Options

I/O Extender	Part Number
with no preinstalled I/Os, accepts up to 8 individual I/O modules including a maximum of 4 analog I/Os	IOX
with 4 digital inputs (32 Vdc), 2 digital outputs (60 Vdc), 1 analog output(4–20 mA), and 1 analog input (0–5 Vdc)	IOX2411
with 4 analog inputs (4–20 mA) and 4 digital inputs (120 Vac)	IOX0404
with 8 digital inputs (120 Vac)	IOX08
I/O Modules	
Digital I/Os	
120 Vac input	DI120AC
240 Vac input	DI240AC
32 Vdc input (0.2ms turn on) polarized	DI32DC
120 Vac output (3.5A maximum)	DO120AC
200 Vdc output (3.5A maximum)	DO200DC
240 Vac output (3.5A maximum)	DO240AC
60 Vdc output (3.5A maximum)	DO60DC

Table 4–6: I/O Extender Options *(continued)*

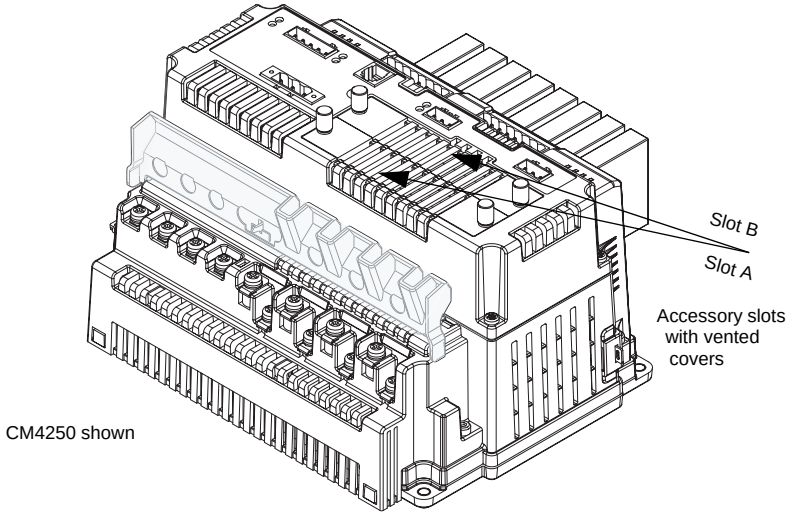
Analog I/Os	
0 to 5 Vdc analog input	AI05
4 to 20 mA analog input	AI420
4 to 20 mA analog output	AO420

OPTION CARDS

Option cards fit into the two accessory slots on the top of the circuit monitor. Two cards are available, a digital I/O card (with relay outputs rated up to 10 A) and an Ethernet communications card (ECC) for high-speed Ethernet communications. Figure 4–15 shows the location of the accessory slot in the circuit monitor.

The Ethernet communications card (ECC) must be installed in the outermost slot (A) and only one ECC can be used per circuit monitor. For more information, refer to ECC installation instructions. For information on the digital I/O card, see installation instructions included with the digital I/O card.

Figure 4–15: Location of vented slot for optional accessory cards



REVENUE SECURITY

The access door, shown in Figure 4–16 on page 30, lets you access the revenue metering security switch. When you press this button, the current settings for the the revenue-related parameters of the circuit monitor are locked and cannot be changed from the display or over the communications link. In addition, you can attach a standard meter security seal to secure the door closed and to visually detect any tampering with the meter (see Figure 4–17A). The following information is locked when revenue security is active:

- Metering configuration
  - — CT ratios (primary and secondary)
  - — PT ratios (primary and secondary)
  - — All scale factors
  - — Calibration constants

  - System type
  - Frequency
  - Power demand method and interval
  - Demand forgiveness
  - Incremental energy
  - VARh accumulation method
  - Energy accumulation mode
- Resets
  - Energy reset
  - Demand resets
  - Memory clear
  - Disk format
  - Meter Init
- Data Log 14

This door also provides access to the memory chip for upgrading memory.

Enabling the Security Button

By default, the security button is disabled. Until the security button is enabled, revenue security cannot be activated. SMS software or the display can be used to enable the security button. Follow the instructions below to enable the security button using the display.

1. From the Main Menu, select Diagnostics > Read/Write Regs.
   The password prompt displays.
2. Select your password.
   The Read/Write Regs menu displays.
3. Use the arrow buttons to scroll to register 8001, then press the enter button. The Hex and Dec columns begin to blink.
4. Use the arrow buttons to scroll through the values in the Dec column, selecting any value except 1, then press the enter button.
5. Use the arrow buttons to scroll to register 8000, then press the enter button.
6. Use the arrow buttons to scroll through the values in the Dec column, selecting the value 9021, then press the enter button.

Selecting this value exits the Setup session. This is important because revenue security commands will not function during setup. Exiting the Setup session allows you to activate or deactivate the revenue security button.

7. Register 8000 should still be selected. Press enter, then select the value 1411 to enable the security button.

To disable the security button, select the value 1410.

8. Press the menu button. You will be prompted to save your changes.
9. Select “No” so that changes are not saved to the register list.

Activating Revenue Security

Once the security button has been enabled (by writing the value 1411 to register 8000), it can then be used to activate and de-activate revenue security. When the security button is press to activitate revenue security, the security LED will illuminate.

To open the access door and activate security, follow the instructions below. Control power to the circuit monitor must be ON to use this feature, but de-energize the metering inputs, I/O extender, and all other I/O including the I/O card. Remove all power sources.

⚠ DANGER

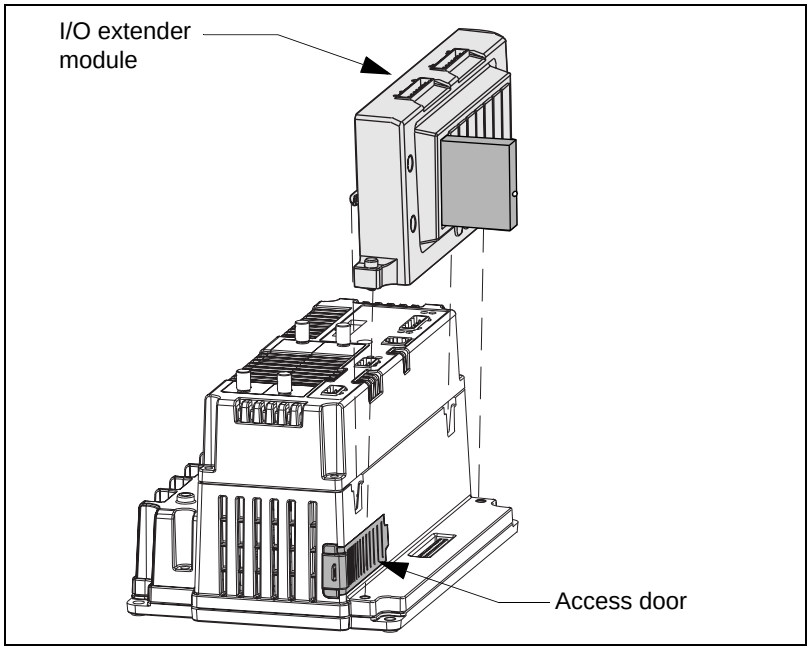
HAZARD OF ELECTRIC SHOCK, EXPLOSION OR ARC FLASH

- Turn off all power supplying the circuit monitor and the equipment in which it is installed before working on it. Be aware that the circuit monitor may be connected to a separate control power source derived from the equipment in which it is installed.
- Remove power to the individual I/O modules (if present).
- Always use a properly rated voltage sensing device to confirm that all power is off.
- Remove leads from all voltage inputs including neutral.

Failure to follow this instruction will result in death, serious injury, or equipment damage.

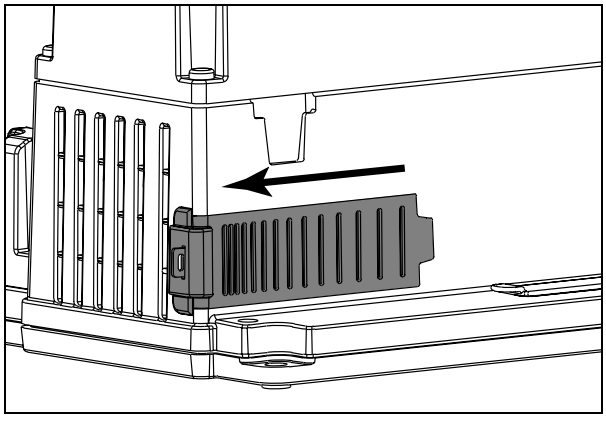
1. Refering to Figure 4–16 on page 30, remove the I/O extender module if present:
   a. Remove power to the circuit monitor and to the individual I/O modules in the I/O extender module. Use a properly rated voltage sensing device to confirm that all power is off.
   b. Loosen the two hex head mounting screws.
   c. Remove the I/O extender module. Pull up and then out until it disengages from the circuit monitor. Set the module aside.

Figure 4–16: Removal of the I/O extender module

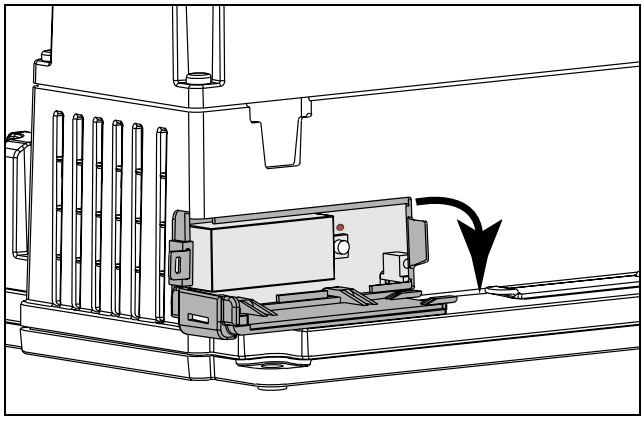


2. Restore control power to the circuit monitor. The circuit monitor must have power in order to activate revenue security.
3. To open the door, refer to Figure 4–17. Slide the door along the side of the circuit monitor (A), then gently pull the door down to open it (B).

Figure 4–17: Opening the access door



A



B

⚠ CAUTION

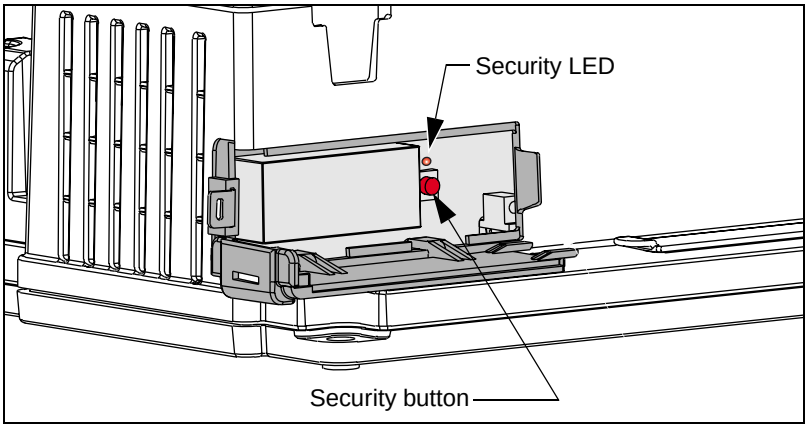
ESD-SENSITIVE COMPONENTS

You must ground yourself and discharge any static charge before pressing the security button.

Failure to follow this instruction can result in equipment damage.

4. To discharge static, place one hand momentarily on any grounded metal surface, then press and hold the security button a few seconds until the security LED is lit (see Figure 4–18).

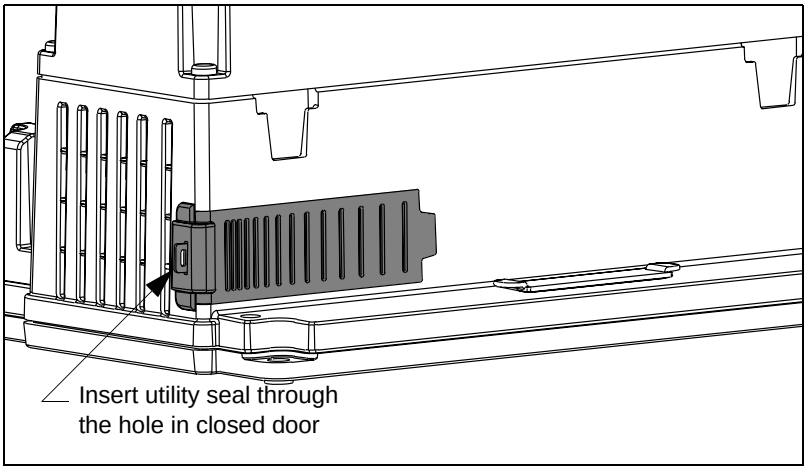
Figure 4–18: Security button location



5. Close the door.

6. If required, insert your utility seal through the hasp on the door (see Figure 4–19).

Figure 4–19: Securing the access door



7. If the I/O extender is present, perform the following:
   a. Turn off all power to the circuit monitor. Verify all power is off using an appropriate voltage sensing device.
   b. Reinstall the I/O extender if present.
8. Restore all power to the circuit monitor.

De-activating Revenue Security

To de-activate revenue security, complete the instructions in “Activating Revenue Security” on page 29, pressing the security button to turn it off.

To turn off the revenue security feature in the circuit monitor, you can disable the security button. Refer to the instructions in “Enabling the Security Button” on page 28, keeping in mind that the value 1410 should be used instead of 1411 for step 7.

CHAPTER 5—WIRING

REQUIREMENTS BEFORE YOU BEGIN WIRING

Before you begin wiring, make sure you understand the requirements discussed in this section.

⚠ DANGER

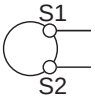
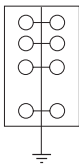
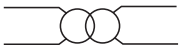
HAZARD OF ELECTRIC SHOCK, BURN, OR EXPLOSION

- Only qualified workers should install and wire the circuit monitor. Perform this work only after completely reading the installation and wiring chapters.
- Turn off all power supplying the circuit monitor and the equipment in which it is installed before working on it.
- Use a properly rated voltage testing device to verify that the power is off.

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

The following symbols are used in the wiring diagrams in this section:

Table 5–1: Wiring Diagram Symbols

Symbol	Description
	Voltage disconnect switch
	Fuse
	Earth Ground
	Protective conductor terminal symbol
	Current transformer
	Shorting block
	Potential transformer US equivalent: 

NOTE: The disconnect circuit breaker must be placed within reach of the circuit monitor and labeled: ***Disconnect Circuit Breaker for Circuit Monitor****.*

Control Power

An external power source, separate from the metered voltage, is recommended for control power to the circuit monitor. If control power is pulled from the metering inputs, you should use a 500 VA or larger potential transformer.

Control Power Transformers

If you are using control power transformers (CPTs), refer to Table 5–2 to see the correct CPT size to use for the number of circuit monitors.

Table 5–2: Control Power Transformer Sizing

Number of Circuit Monitors	Size of the CPT
1–10	500 VA
11–20	1000 VA
21–30	1500 VA
31–40	2000 VA

Control Power Fusing

The control power inputs of each circuit monitor should be individually fused under all circumstances. When deriving control power from either a control power transformer or a metering potential transformer where the secondary voltage is 250 Vac or less, use a standard 1A time-delay, 250 Vac fuse. An example of a suitable fuse is the Bussmann FNM. If the control power is derived directly from the line voltage (305 Vac or less), use a rejection type time-delay fuse rated for 600 V, 3A, such as the Bussman type FNQ-R.

Table 5–3 lists fuse requirements for the circuit monitor. For European safety compliance (EN61010 / LVD), see “Required Protection for CE Compliance” on page 38 for details on installation of protection devices in the control power circuit.

Table 5–3: Control Power Derivation–Fuses

Derivation of Control Power	Voltage (AC)	Fuse	Fuse Amperage
CPT	< or = 125 V	FNM-1	1A
CPT	> 125 V < 305 V	FNQ or FNQ-R1	1A
Direct from line voltage	< or = 305 V	FNQ-R1	1A

Potential (Voltage) Transformers

Potential transformers (PTs), sometimes referred to as voltage transformers (VTs), are not required on the voltage metering inputs with line-to-line voltages of 690 V or less. Connect the voltage metering inputs directly to the line voltages. However, for power systems with voltages higher than 690 V line-to-line, you **must** use potential transformers.

Control Power Wiring

Figure 5–1: Direct Connect Control Power (Phase to Phase)

NOTES:

- Phase to Phase only when voltage < 305 Vac maximum.
- Connect the ground terminal (terminal 26) to a true earth gound, using 14 AWG (2 mm^2) copper wire or larger.
- Do not use the mounting panel or equipment door as a true earth ground. Connect the ground terminal to a true earth ground bus.
- Improper grounding of the circuit monitor may induce noise on the metering inputs.
- Installation Category II.

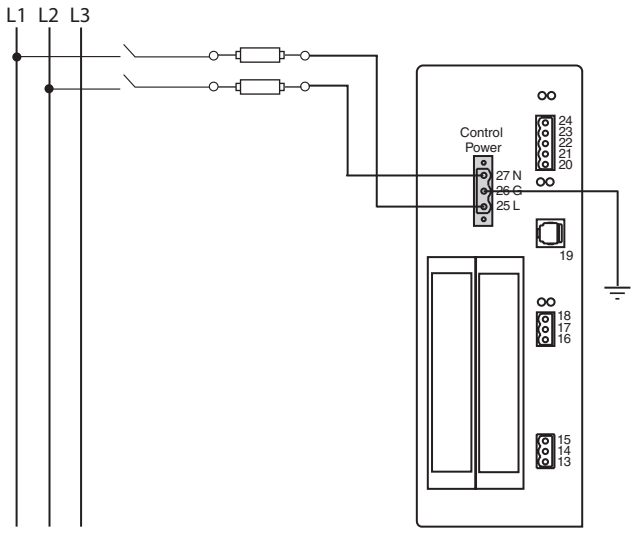


Figure 5–2: Direct Connect Control Power (Phase to Neutral)

NOTES:

- Phase to Neutral only when voltage < 305 Vac maximum.
- Connect the ground terminal (terminal 26) to a true earth gound, using 14 AWG (2 mm^2) copper wire or larger.
- Do not use the mounting panel or equipment door as a true earth ground. Connect the ground terminal to a true earth ground bus.
- Improper grounding of the circuit monitor may induce noise on the metering inputs.
- Installation Category II.

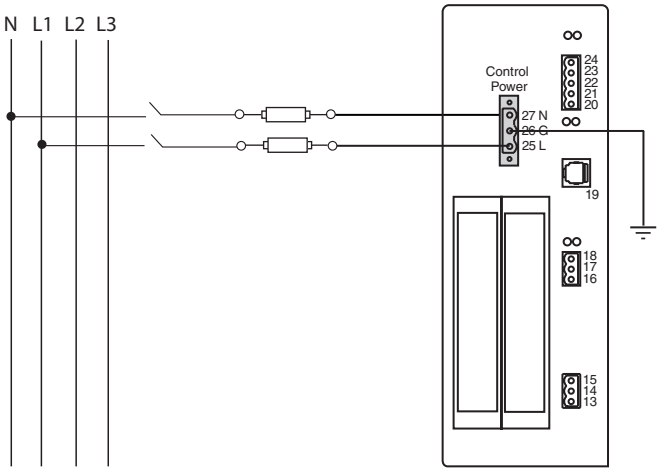
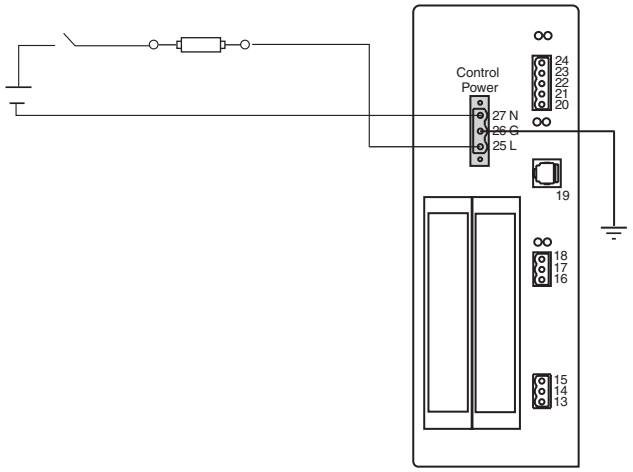


Figure 5–3: Direct Connect Control Power (DC Control Power)

NOTES:

- DC Control Power 100 Vdc < V < 300 Vdc.
- Connect the ground terminal (terminal 26) to a true earth gound, using 14 AWG (2 mm^2) copper wire or larger.
- Do not use the mounting panel or equipment door as a true earth ground. Connect the ground terminal to a true earth ground bus.
- Improper grounding of the circuit monitor may induce noise on the metering inputs.
- Installation Category II.



Deriving Control Power from Phase PT Inputs

Whenever possible, obtain control power for the circuit monitor from a stable voltage source separate from the metering inputs. If such a source is unavailable, the circuit monitor can derive control power from its active phase PT inputs. Because of the wide range of permissible control power inputs, the circuit monitor can accept either line-to-neutral (L–N) or line-to-line (L–L) control power inputs up to 240 V nominal. If you use the L–L control power option, the circuit monitor ride-through time increases.

⚠ CAUTION

OVERLOADED PT.

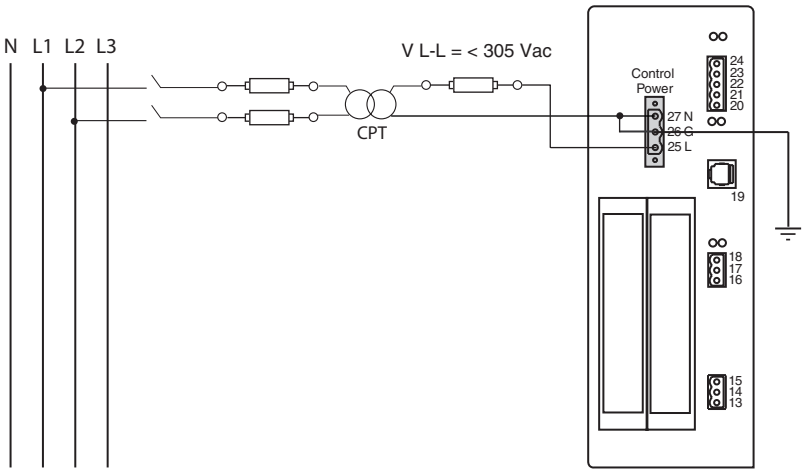
When deriving control power from the phase PT inputs, the phase PT used must have a VA rating sufficient for all connected burdens. If excessive burden is placed on the metering PT, it could reduce the voltage transformer's accuracy or damage the PT.

Failure to follow this instruction can reduce metering accuracy and can cause equipment damage.

Figure 5–4: Control Power Transformer Connection

NOTES:

- Control Power Transformer 120 or 240 Vac Secondary 50 Va maximum.
- Connect the ground terminal (terminal 26) to a true earth gound, using 14 AWG (2 mm^2) copper wire or larger.
- Do not use the mounting panel or equipment door as a true earth ground. Connect the ground terminal to a true earth ground bus.
- Improper grounding of the circuit monitor may induce noise on the metering inputs.
- Installation Category II.



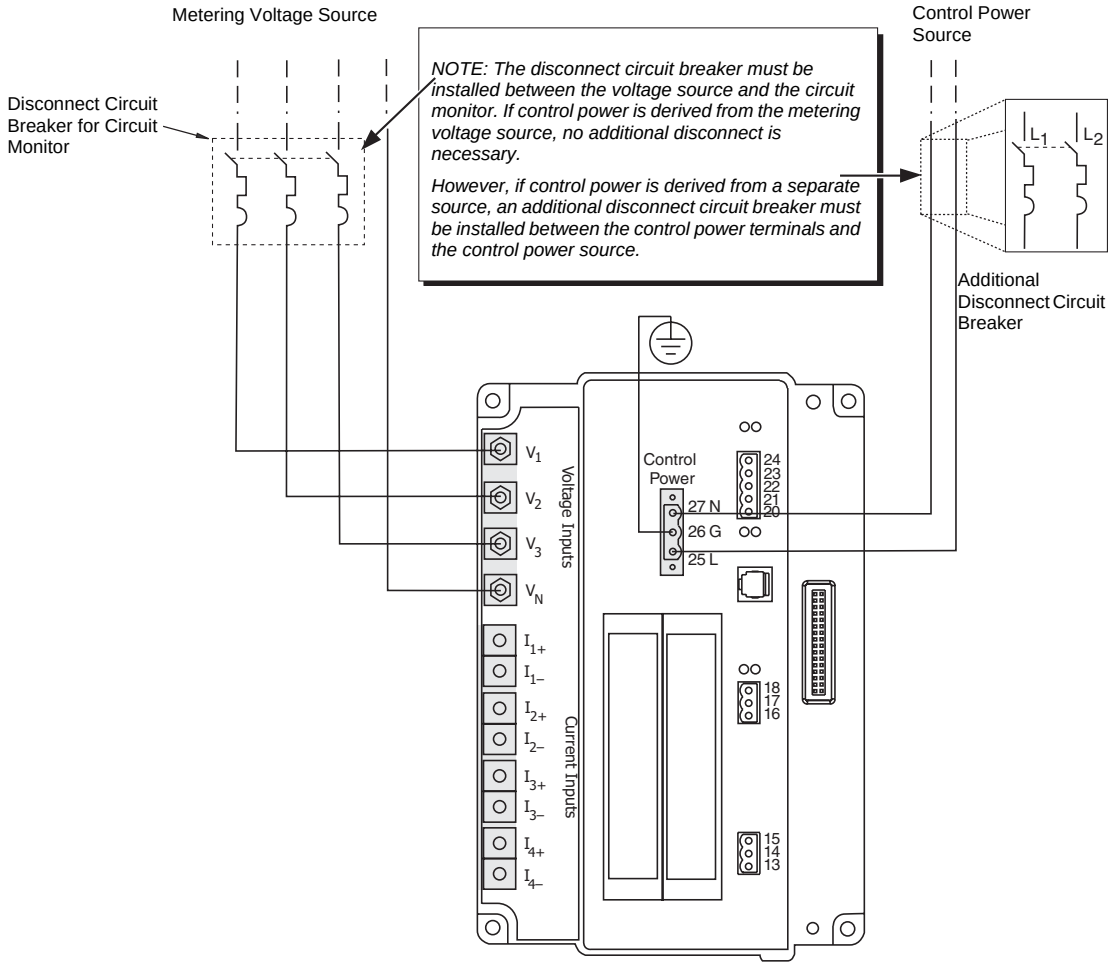
Required Protection for CE Compliance

For CE compliance, use a CE-compliant protection device. The protection device must be connected directly to the metering voltage and control power inputs (see Figure 5–5).

The disconnect circuit breaker must be placed within reach of the circuit monitor and labeled: **Disconnect Circuit Breaker for Circuit Monitor**.

The disconnect circuit breaker must be rated for the short circuit current at the connection points.

Figure 5–5: Example of a disconnect breaker connection for CE compliance



WIRING CTS, PTS, AND CONTROL POWER TO THE CIRCUIT MONITOR

The circuit monitor supports a variety of 3-phase power system wiring connections, including 3-wire delta and 4-wire wye. The metering voltage inputs support direct connection to 3-phase power systems as follows:

- CM4250—from 208 V L–L/120 V L–N through 690 V L-L/400 V L–N
- CM4000 and CM4000T—from 208 V L–L/120 V L–N through 600 V L-L/347 V L–N

In addition, the circuit monitor supports higher voltages through potential transformers (PTs). The circuit monitor can also be used with line-to-line rated PTs connected line to neutral, which results in a line-to-neutral voltage of:

- CM4250—400 V
- CM4000 and CM4000T—347 V

Table 5–4 lists the supported system connections as shown in the wiring diagrams beginning on page 42.

Table 5–4: Supported Types of System Connections*

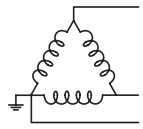
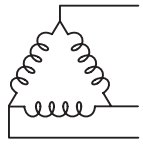
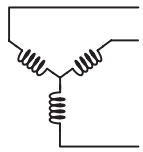
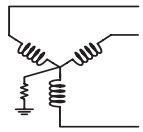
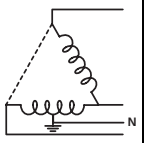
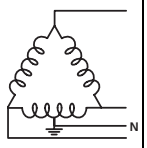
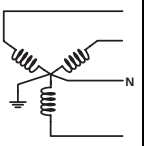
System Wiring Configuration		# of CTs	Auxillary CT	# of PTs	PT Connection	Currents	Voltage Connection ID	System Type①	Figure Number
	3Φ, 3-Wire Delta, Grounded or 3Φ, 3-Wire Delta, Ungrounded	2	None	No PTs	Direct Connection (<690 V_{l-l}, <400 V_{l-n})✦ (<600 V_{l-l}, <347 V_{l-n})✧	I_1, $I_2$②, I_3	V_{12}, V_{23}, V_{31}	3Φ3W2CT (30)	Figure 5–7 on page 42
		3	None	No PTs	Direct Connection (<690 V_{l-l}, <400 V_{l-n})✦ (<600 V_{l-l}, <347 V_{l-n})✧	I_1, I_2, I_3, I_g②	V_{12}, V_{23}, V_{31}	3Φ3W3CT (31)	Figure 5–8 on page 43
		2	None	2	Open-Delta	I_1, $I_2$②, I_3	V_{12}, V_{23}, V_{31}②	3Φ3W2CT (30)	Figure 5–9 on page 43
		3	None	2	Open-Delta	I_1, I_2, I_3, I_g②	V_{12}, V_{23}, V_{31}②	3Φ3W3CT (31)	Figure 5–10 on page 44
	3Φ, 3-Wire Wye, Ungrounded or 3Φ, 3-Wire Wye, Resistance Grounded	2	None	No PTs	Direct Connection (<690 V_{l-l}, <400 V_{l-n})✦ (<600 V_{l-l}, <347 V_{l-n})✧	I_1, $I_2$②, I_3	V_{12}, V_{23}, V_{31}	3Φ3W2CT (30)	Figure 5–7 on page 42
		3	None	No PTs	Direct Connection (<690 V_{l-l}, <400 V_{l-n})✦ (<600 V_{l-l}, <347 V_{l-n})✧	I_1, I_2, I_3, I_g②	V_{12}, V_{23}, V_{31}	3Φ3W3CT (31)	Figure 5–8 on page 43
		2	None	2	Open-Delta	I_1, $I_2$②, I_3	V_{12}, V_{23}, V_{31}②	3Φ3W2CT (30)	Figure 5–9 on page 43
		3	None	2	Open-Delta	I_1, I_2, I_3, I_g②	V_{12}, V_{23}, V_{31}②	3Φ3W3CT (31)	Figure 5–10 on page 44

Table 5–4: Supported Types of System Connections* *(continued)*

System Wiring Configuration		# of CTs	Auxillary CT	# of PTs	PT Connection	Currents	Voltage Connection ID	System Type①	Figure Number
	3Φ, 4-Wire Open-Delta, Center-Tapped⑤	3	None	No PTs	Direct Connection (<690 V_{l-l}, <400 V_{l-n})✦ (<600 V_{l-l}, <347 V_{l-n})✧	I_1, I_2, I_3, I_n②	V_{1n}, V_{2n}, V_{3n}, V_{ng}③	3Φ4W3CT (40)	Figure 5–11 on page 44
		3	None	3	Wye-Wye	I_1, I_2, I_3, I_n②	V_{1n}, V_{2n}, V_{3n}, V_{ng}③	3Φ4W3CT (40)	Figure 5–12 on page 45
	or								
	3Φ, 4-Wire Delta, Center-Tap Grounded⑤	4	Neutral	3	Wye-Wye	I_1, I_2, I_3, I_n, I_g②	V_{1n}, V_{2n}, V_{3n}, V_{ng}③	3Φ4W4CT (41)	Figure 5–13 on page 45
	3Φ, 4-Wire Wye, Grounded	2	None	No PTs	Direct Connection (<690 V_{l-l}, <400 V_{l-n})✦ (<600 V_{l-l}, <347 V_{l-n})✧	I_1, $I_2$④, I_3	V_{1n}, V_{2n}, V_{3n}, V_{ng}③	3Φ4W3CT (40) for balanced loads	Figure 5–14 on page 46
		3	None	No PTs	Direct Connection (<690 V_{l-l}, <400 V_{l-n})✦ (<600 V_{l-l}, <347 V_{l-n})✧	I_1, I_2, I_3, I_n②	V_{1n}, V_{2n}, V_{3n}, V_{ng}③	3Φ4W3CT (40)	Figure 5–15 on page 46
		4	Neutral	No PTs	Direct Connection (<690 V_{l-l}, <400 V_{l-n})✦ (<600 V_{l-l}, <347 V_{l-n})✧	I_1, I_2, I_3, I_n, I_g②	V_{1n}, V_{2n}, V_{3n}, V_{ng}③	3Φ4W4CT (41)	Figure 5–16 on page 47
		2	None	2	2 1/2 Element Wye	I_1, $I_2$④, I_3	V_{1n}, V_{2n}②③, V_{3n}, V_{ng}	3Φ4W3CT2PT (42) for balanced loads	Figure 5–17 on page 47
	or	3	None	2	2 1/2 Element Wye	I_1, I_2, I_3, I_n②	V_{1n}, V_{2n}②③, V_{3n}, V_{ng}	3Φ4W3CT2PT (42)	Figure 5–18 on page 48
	3Φ, 4-Wire Wye, Resistance Grounded	4	Neutral	2	2 1/2 Element Wye	I_1, I_2, I_3, I_n, I_g②	V_{1n}, V_{2n}②③, V_{3n}, V_{ng}	3Φ4W4CT2PT (43)	Figure 5–19 on page 48
		2	None	3	Wye-Wye	I_1, $I_2$④, I_3	V_{1n}, V_{2n}, V_{3n}, V_{ng}③	3Φ4W3CT (40) for balanced loads	Figure 5–20 on page 49
		3	None	3	Wye-Wye	I_1, I_2, I_3, I_n②	V_{1n}, V_{2n}, V_{3n}, V_{ng}③	3Φ4W3CT (40)	Figure 5–12 on page 45
		4	Neutral	3	Wye-Wye	I_1, I_2, I_3, I_n, I_g②	V_{1n}, V_{2n}, V_{3n}, V_{ng}③	3Φ4W4CT (41)	Figure 5–13 on page 45

*Neutral to ground voltage ≤ 100 Volts

✦CM4250 only

✧CM4000T and CM4000

①The “system type” is a code assigned to each type of system connection.

②Indicates a value that is calculated rather than measured directly.

③Vng is measured from the metered neutral and control power ground.

④Current is determined from residual

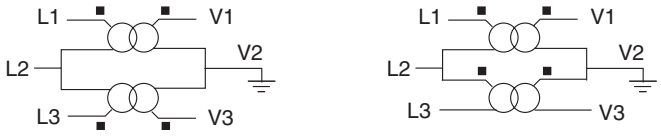
⑤PTs for Delta, center-tap grounded configurations should be rated for high-leg value. L-L rated PTs required. All PTs should be the same. Single phase power factor is invalid.

When wiring the circuit monitor, do not route wires over unused option card slots or over the I/O extender module (may be installed in the future). Do not block the circuit monitor vents with the wires. See “Mounting Considerations” on page 13 for clearances.

For CE wiring requirements, see “Required Protection for CE Compliance” on page 38.

If the current/voltage module is not installed, you must mount it onto the circuit monitor first. See “Replacing the Current/Voltage Module—CM4250, CM4000T” on page 23 for more information.

In 2 PT systems, these connections are equivalent.



WIRING PROCEDURE

To wire the circuit monitor, refer to the appropriate wiring diagram (see “Wiring Diagrams” on page 42) and complete the following steps:

1. Strip .25 in. (6 mm) of insulation from the wire ends. Using a suitable crimping tool, crimp the yellow spade lugs onto the wires for the voltage, current, and control power inputs on the control/voltage module.
2. Loosen the terminal screws for each terminal on the control/voltage module and insert the spade lug under the washer. Torque the screws 6–9 lb.-in. (0.68–1 N•m).
3. Ground the circuit monitor.
4. Install the plastic terminal cover over the terminals. See “Installing the Terminal Cover—CM4250, CM4000T” on page 49 or “Installing the Terminal Cover—CM4000” on page 50.

WIRING DIAGRAMS

Figure 5–6: Circuit Monitor Connections

NOTES:

- Connect the ground terminal (terminal 26) to a true earth gound, using 14 AWG (2 mm^2) copper wire or larger.
- Do not use the mounting panel or equipment door as a true earth ground. Connect the ground terminal to a true earth ground bus.
- Improper grounding of the circuit monitor may induce noise on the metering inputs.

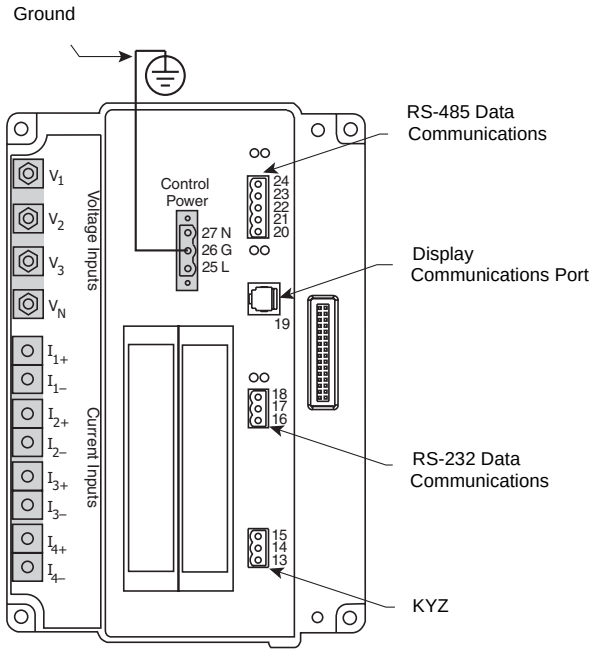


Figure 5–7: 3-Phase 3-Wire 2 CT No PT (Direct Voltage Input Connection)

NOTES:

- Use system type 3Φ3W2CT (30) No PT.
- Installation Category IV.

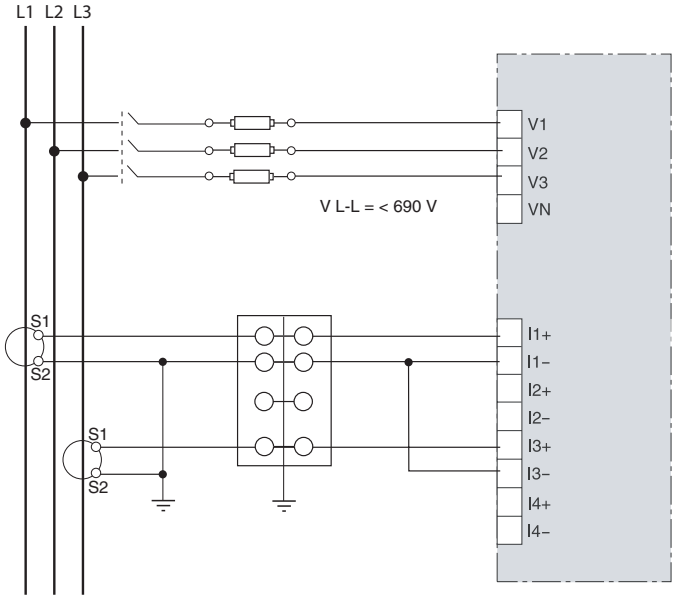


Figure 5–8: 3-Phase 3-Wire 3 CT No PT (Direct Voltage Input Connection)

NOTES:

- Use system type 3Φ3W3CT (31) No PT.
- Installation Category IV.

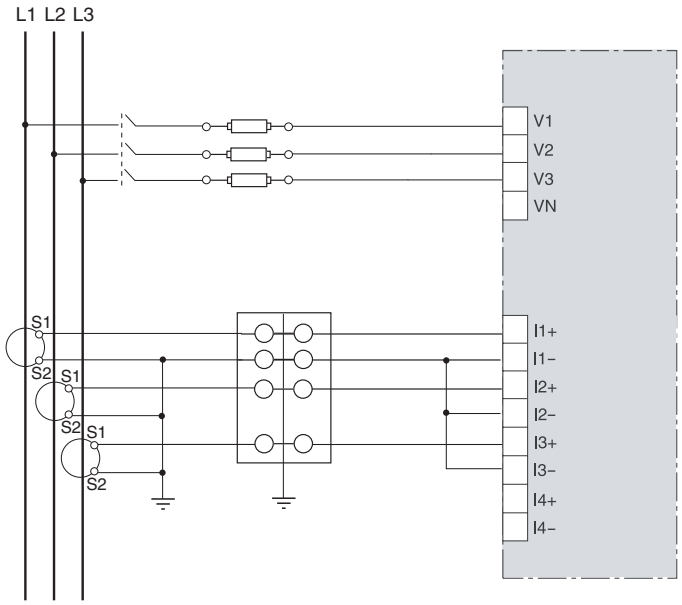


Figure 5–9: 3-Phase 3-Wire Delta Connection 2 CT 2 PT

NOTES:

- For an open delta PT connection with 120 V L-L secondaries, use system type 3Φ3W2CT (30).
- Pay close attention to polarity marks when connecting CTs (S1, S2) and PTs (■ =X_1).
- Installation Category IV.

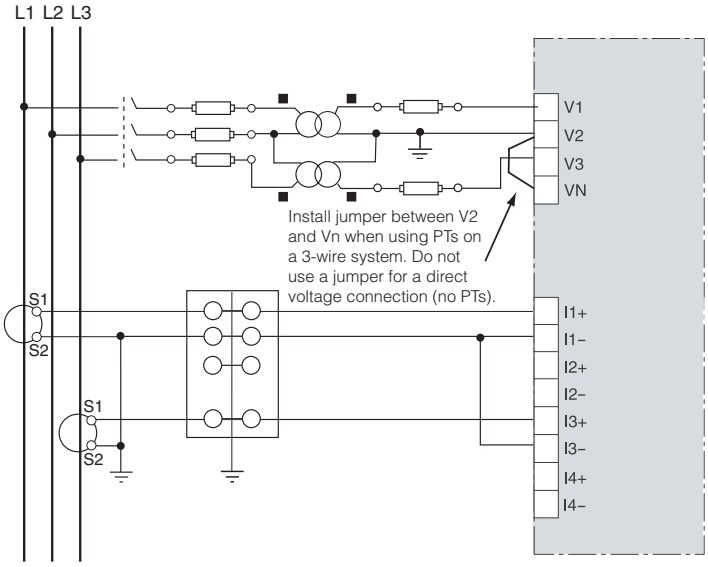


Figure 5–10: 3-Phase 3-Wire Delta Connection 3 CT 2 PT

NOTES:

- For an open delta PT connection with 120 V L-L secondaries, use system type 3Φ3W3CT (31).
- Pay close attention to polarity marks when connecting CTs (S1, S2) and PTs (■ =X_1).
- Installation Category IV.

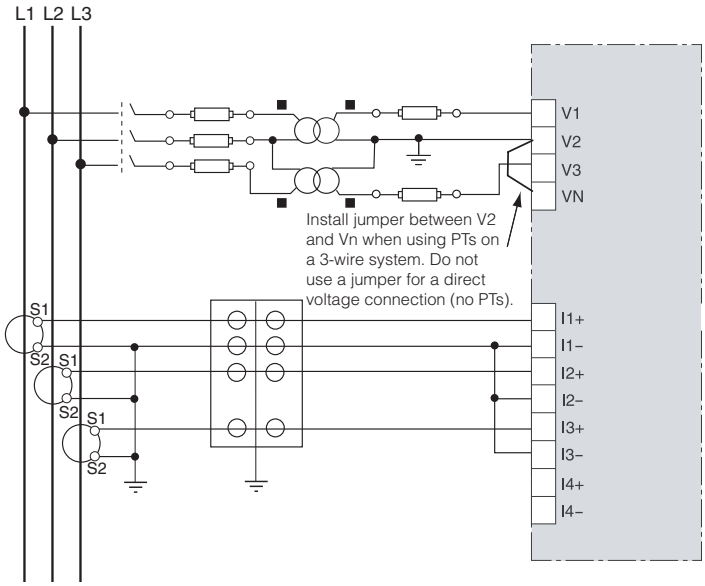


Figure 5–11: 3-Phase 4-Wire Wye Connection 3 CT No PT (Direct Voltage Input Connection)

NOTES:

- Use system type 3Φ4W3CT (40).
- Pay close attention to polarity marks when connecting CTs (S1, S2) and PTs (■ =X_1).
- Installation Category IV.

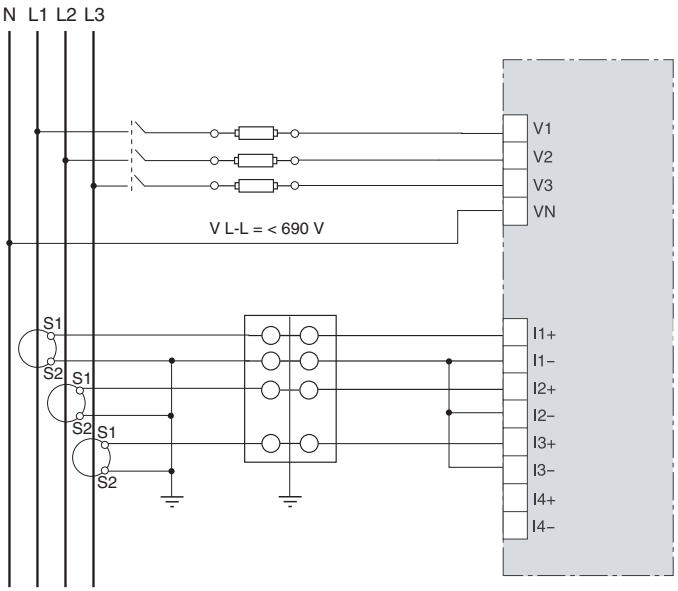


Figure 5–12: 3-Phase 4-Wire Wye Connection 3 CT 3 PT

NOTES:

- Use system type 3Φ4W3CT (40).
- Pay close attention to polarity marks when connecting CTs (S1, S2) and PTs (■ =X_1).
- Installation Category IV.

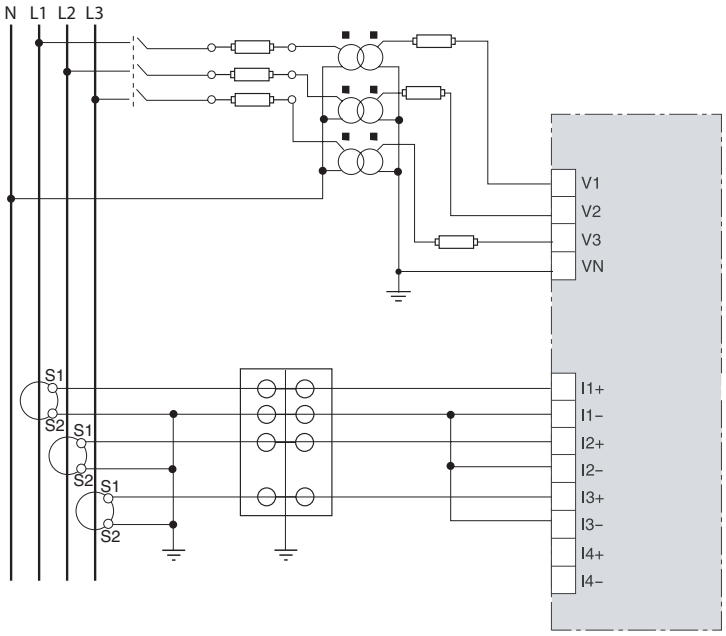


Figure 5–13: 3-Phase 4-Wire Wye 4 CT 3 PT

NOTES:

- Use system type 3Φ4W4CT (41).
- Pay close attention to polarity marks when connecting CTs (S1, S2) and PTs (■ =X_1).
- Installation Category IV.

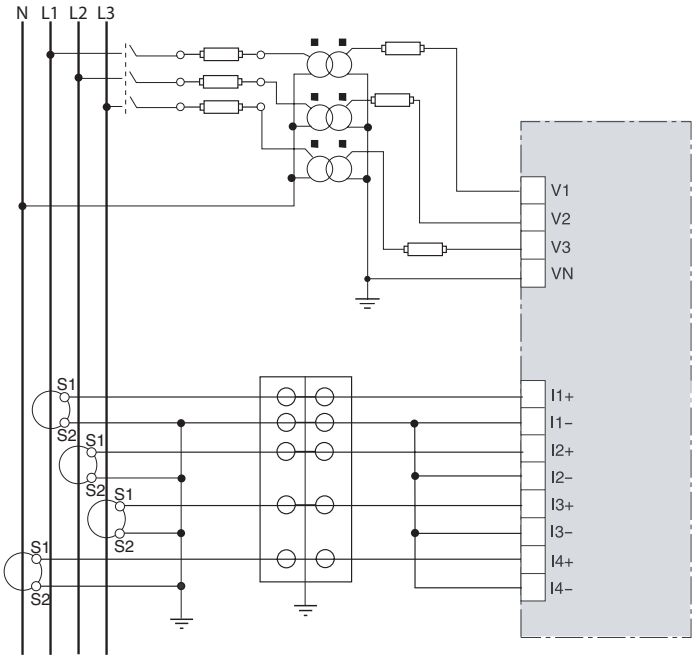


Figure 5–14: 3-Phase 4-Wire Wye 2 CT No PT (Direct Voltage Input Connection) (for balanced loads)

NOTES:

- Use system type 3Φ4W3CT (40) No PT.
- Pay close attention to polarity marks when connecting CTs (S1, S2) and PTs (■ =X_1).
- Installation Category IV.

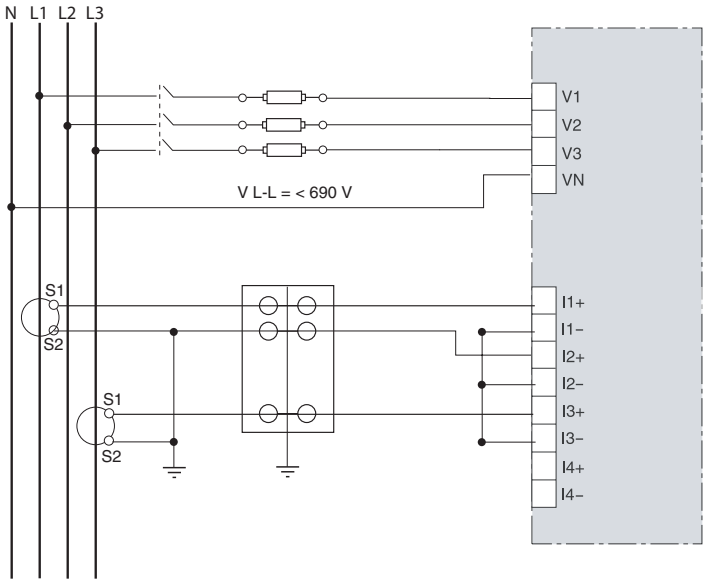


Figure 5–15: 3-Phase 4-Wire Wye 3 CT No PT (Direct Voltage Input Connection)

NOTES:

- Use system type 3Φ4W3CT (40) No PT.
- Pay close attention to polarity marks when connecting CTs (S1, S2) and PTs (■ =X_1).
- Installation Category IV.

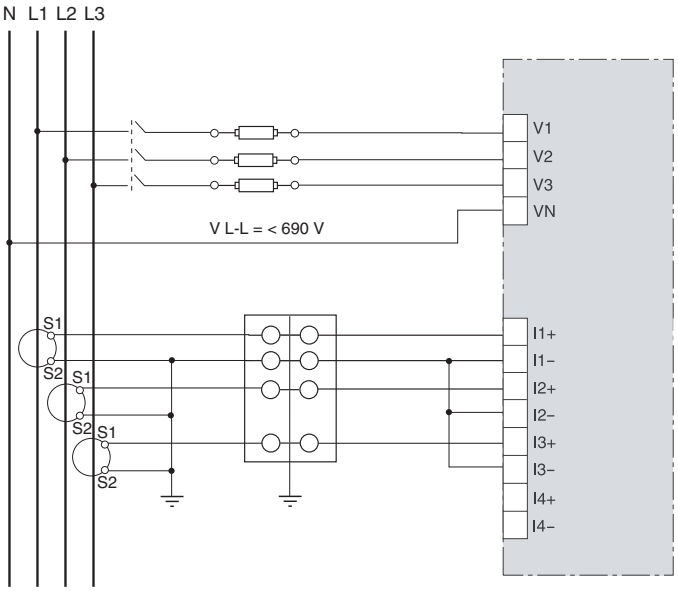


Figure 5–16: 3-Phase 4-Wire Wye 4 CT No PT (Direct Voltage Input Connection)

NOTES:

- Use system type 3Φ4W4CT (41) No PT.
- Pay close attention to polarity marks when connecting CTs (S1, S2) and PTs (■ =X_1).
- Installation Category IV.

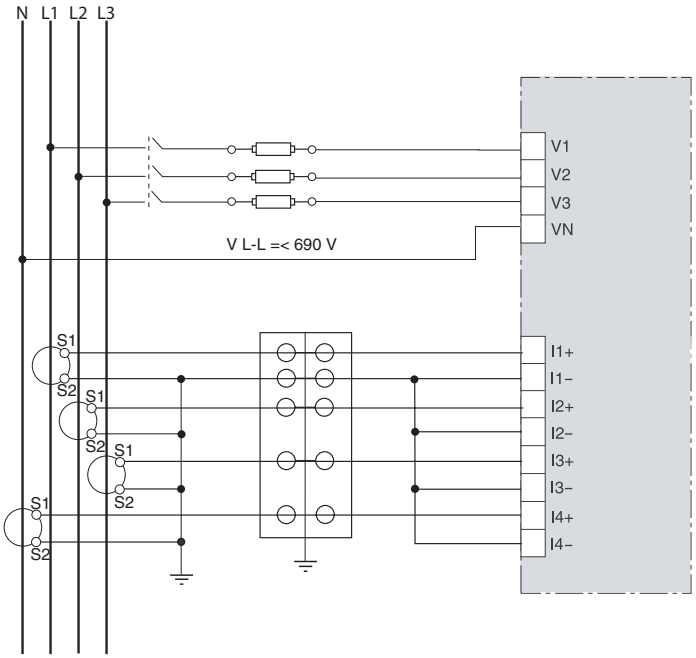


Figure 5–17: 3-Phase 4-Wire Wye 2 CT 2 PT (for balanced loads)

NOTES:

- Use system type 3Φ4W3CT2PT (42).
- Pay close attention to polarity marks when connecting CTs (S1, S2) and PTs (■ =X_1).
- Installation Category IV.

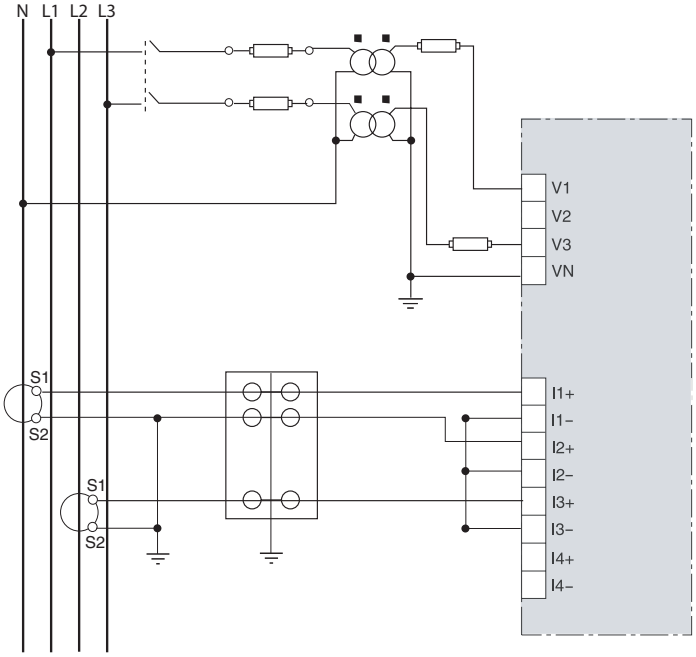


Figure 5–18: 3-Phase 4-Wire Wye 3 CT 2 PT

NOTES:

- Use system type 3Φ4W3CT2PT (42).
- Pay close attention to polarity marks when connecting CTs (S1, S2) and PTs (■ =X_1).
- Installation Category IV.

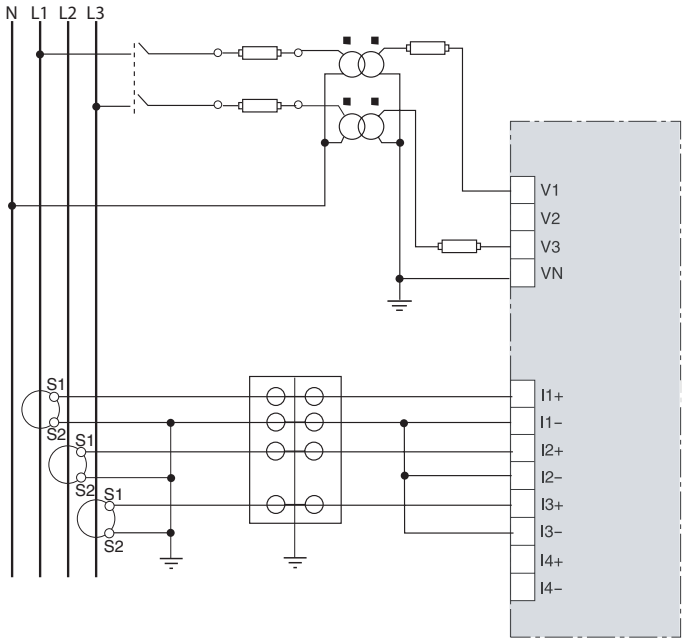


Figure 5–19: 3-Phase 4-Wire Wye 4 CT 2 PT

NOTES:

- Use system type 3Φ4W4CT2PT (43).
- Pay close attention to polarity marks when connecting CTs (S1, S2) and PTs (■ =X_1).
- Installation Category IV.

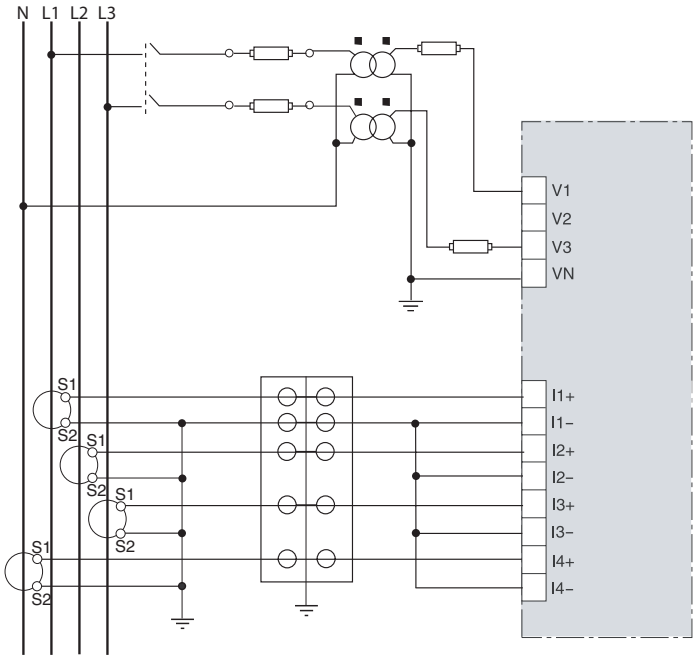
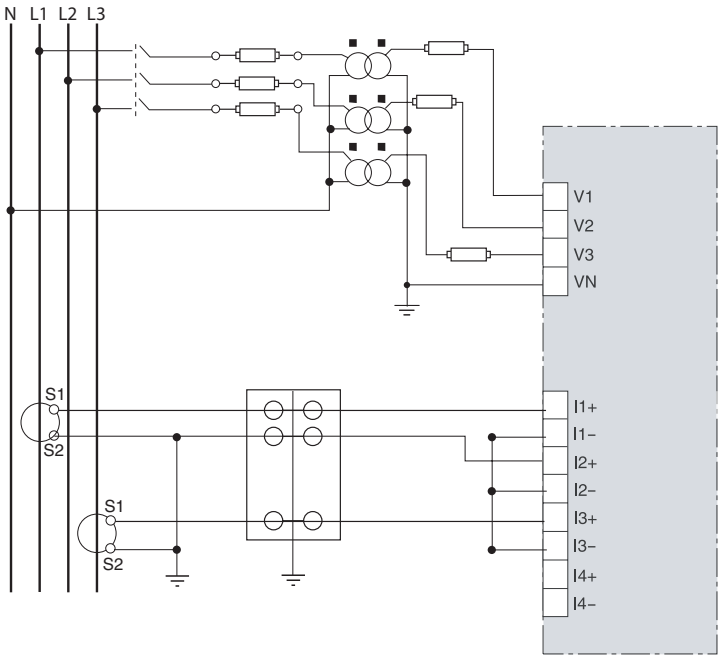


Figure 5–20: 3-Phase 4-Wire Wye 2 CT 3 PT (for balanced loads)

NOTES:

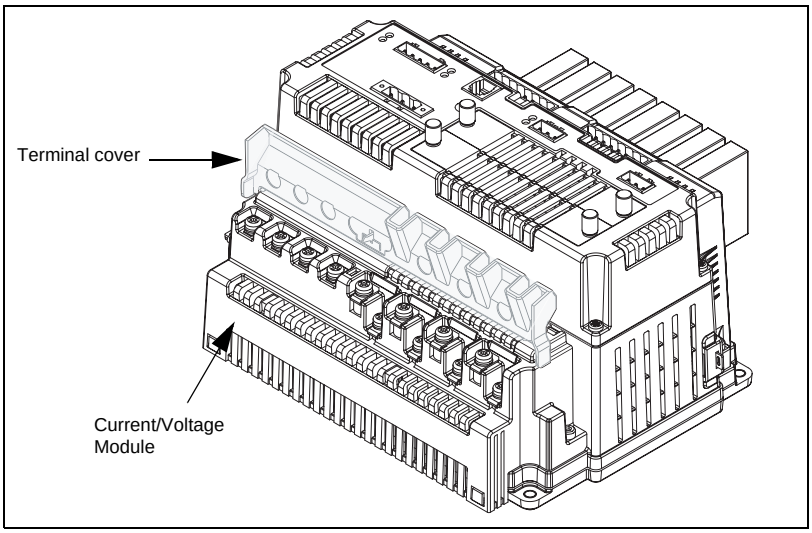
- Use system type 3Φ4W3CT (40).
- Neutral current readings will be reported as zero.
- Pay close attention to polarity marks when connecting CTs (S1, S2) and PTs (■ =X_1).
- Installation Category IV.



Installing the Terminal Cover—CM4250, CM4000T

The plastic terminal cover snaps into guide holes on either side of the current/voltage module and flips forward and backward to cover or uncover the terminals. After wiring the control monitor, install the terminal cover as shown in Figure 5–21.

Figure 5–21: Installing terminal cover—CM4250, CM4000T

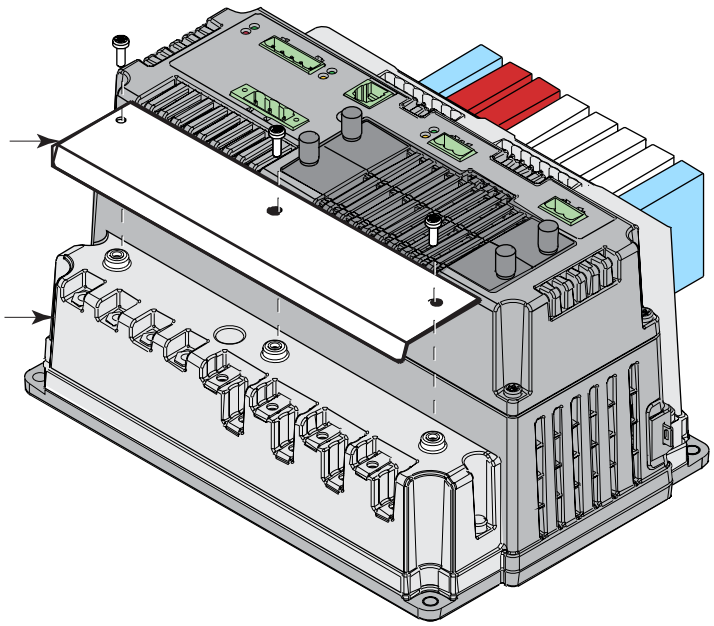


Installing the Terminal Cover—CM4000

Install the terminal cover for the CM4000 as illustrated in Figure 5–22. Follow these steps:

1. Place the terminal cover over the terminals of the current/voltage module.
2. Insert the three M3 screws and torque 5–7 in.-lbs. (0.56–0.79 N•m). Do not overtighten.

Figure 5–22: Installing terminal cover—CM4000



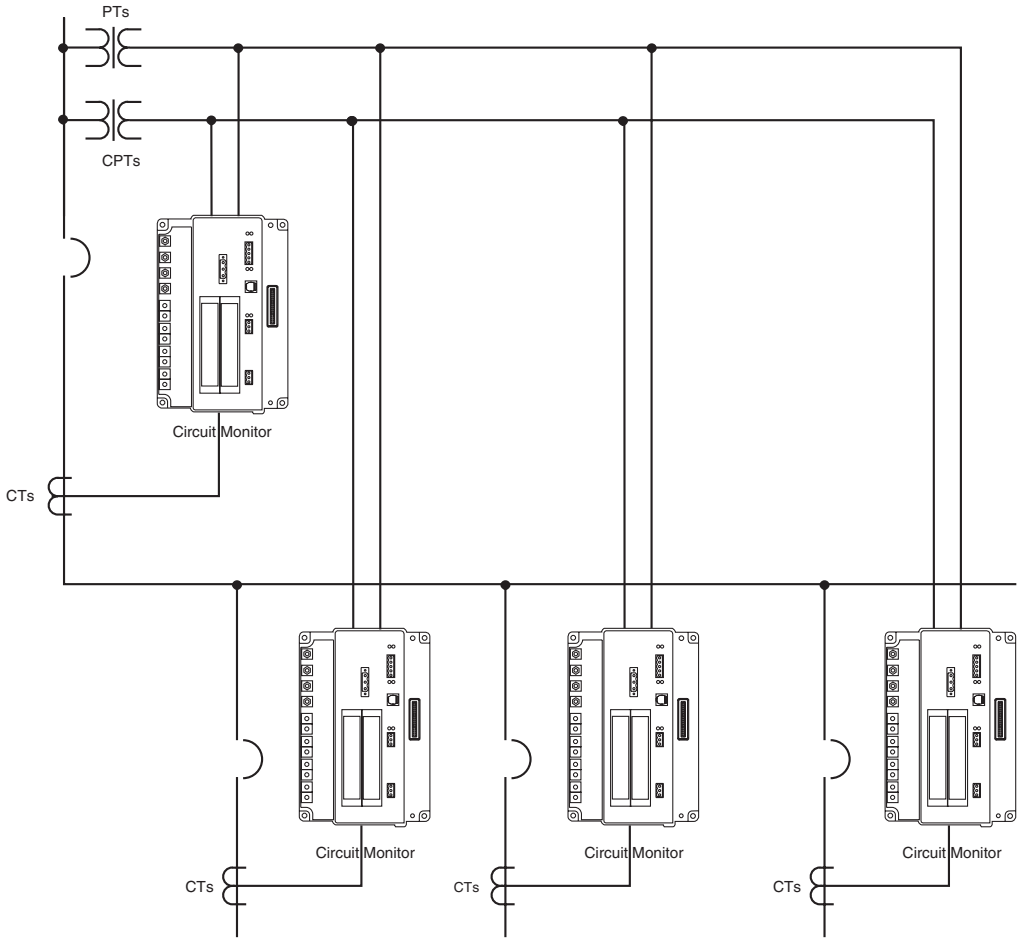
Wiring Multiple Circuit Monitors to a Single Set of PTs and CPTs

Multiple circuit monitors can share one set of 3-phase PTs. Also, multiple circuit monitors can share a single control power transformer (CPT). In all cases, each circuit monitor must use a separate set of CTs. Figure 5–23 shows how to connect multiple circuit monitors to a single set of PTs and one CPT.

When using multiple devices on CPTs and PTs, it is important to calculate the CPT burden and PT burden to maintain accuracy.

When using this wiring method, ground the PT secondaries in only one location.

Figure 5–23: Wiring multiple circuit monitors



WIRING THE SOLID-STATE KYZ OUTPUT

You can wire the KYZ output to a 2-wire or 3-wire pulse receiver.

⚠ DANGER

HAZARD OF ELECTRIC SHOCK, EXPLOSION OR ARC FLASH

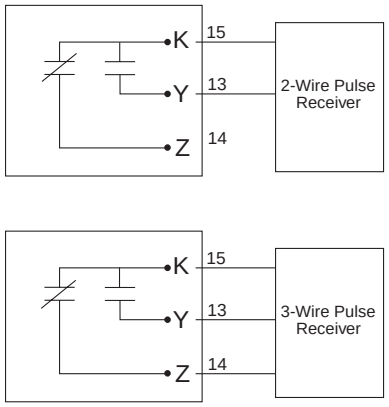
- Turn off all power supplying the circuit monitor and the equipment in which it is installed before working on it.
- Use a properly rated voltage testing device to verify that the power is off.

Failure to follow this instruction will result in death or serious injury.

To wire to a 2-wire pulse receiver, use the K and Y terminals only (see Figure 5–24). When wiring the KYZ pulse output, use 14 to 18 AWG wire. Strip 0.25 in. (6 mm) of insulation from the end of each wire being connected to the KYZ connector. Insert the wires into the KYZ output terminal block. Torque the terminal block screws to 5–7 lb-in (0.56–0.79 N-m).

Use SMS or the display to set up the KYZ output. See the SMS online help for instructions.

Figure 5–24: KYZ pulse output wiring.



WIRING ERROR DETECTION

The circuit monitor can diagnose possible wiring errors when you initiate the wiring test on the Diagnostics menu. Running the test is not required, but may help you to pinpoint a potentially miswired connection. Before running the wiring test, you must first wire the circuit monitor and perform the minimum set up of the circuit monitor, which includes setting up these parameters:

- CT primary and secondary
- PT primary and secondary
- System type
- Frequency

After you have wired and completed the minimum set up, run the wiring test to verify proper wiring of your circuit monitor. The wiring test assumes that the following is true about your system:

- Voltage connection V_{an} (4-wire) or V_{ab} (3-wire) is correct. This connection must be properly wired for the wiring check program to work.
- 3-phase system. The system must be a 3-phase system. You cannot perform a wiring check on a single-phase system.
- System type. The wiring check can be performed only on supported system types (see Table 5–4 for a description of system types).
- Expected displacement power factor is between .60 lagging and .99 leading.
- The load must be at least 1% of the CT Primary setting.

This wiring error program is based on the assumptions above and based on a typical wiring system. Results may vary depending on your system, and some errors may not apply to your system. When the wiring test is run, the program performs the following checks in this order:

1. Verifies that the system type is one of those listed above.
2. Verifies that the frequency is within ±5% of the frequency that you selected in circuit monitor set up.
3. Verifies that the voltage phase angles are 120° apart. If the voltage connections are correct, the phase angles will be 120° apart.

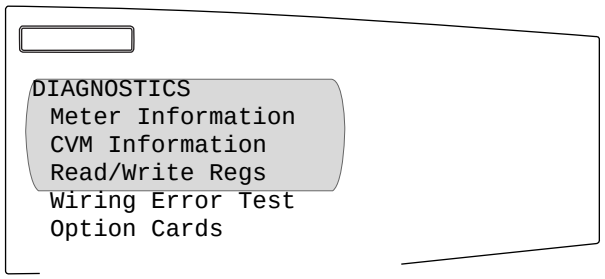
   If the voltage connections are correct, the test continues.
4. Verifies that the measured phase rotation is the same as the phase rotation set up in the circuit monitor.
5. Verifies the magnitude of the currents to see if there is enough load on each phase input to perform the check.
6. Indicates if the 3-phase real power (kW) total is negative, which could indicate a wiring error.
7. Compares each current angle to its respective voltage.

Running the Diagnostics Wiring Error Test

When the circuit monitor detects a possible error, find and correct the problem and then run the test again. Repeat the procedure until no error messages are displayed. To perform a wiring diagnostic test, follow these steps:

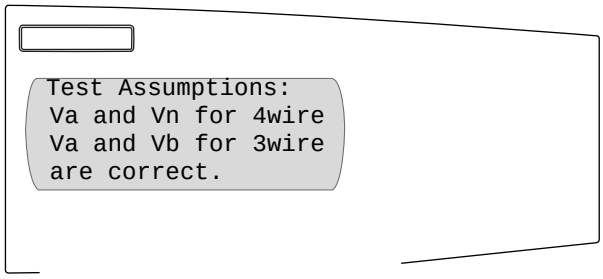
1. From the Main Menu, select Diagnostics.

   The Diagnostics menu displays.



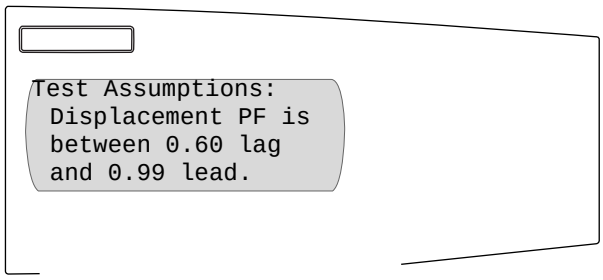
2. Select Wiring Error Test from the menu.

   The test assumptions for the wiring matches are displayed.



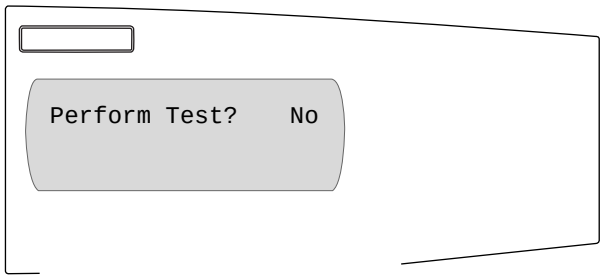
3. Press the down arrow button.

   The test assumptions for the expected displacement power factor are displayed.



4. Press the down arrow button, again.

   This screen allows you to initiate the wiring diagnostic test.



5. Select “Yes” to perform the test by pressing the up arrow button and then pressing the enter button.

   The circuit monitor performs the wiring test.

   If no errors are found, the message “Wire test complete. No errors found!” is displayed. If possible errors are found, the message “Error detected. See following screens for details.” is displayed.

6. Press the arrow buttons to scroll through the wiring error messages.

   Table 5–5 explains the possible wiring error messages.

7. Turn off all power supplying the circuit monitor. Verify that the power is off using a properly rated voltage testing device.

⚠ DANGER

HAZARD OF ELECTRIC SHOCK, EXPLOSION OR ARC FLASH

- Turn off all power supplying the circuit monitor and the equipment in which it is installed before working on it.
- Use a properly rated voltage testing device to verify that the power is off.
- Never short the secondary of a PT.
- Never open circuit a CT; use the shorting block to short circuit the leads of the CT before removing the connection from the circuit monitor.

Failure to follow this instruction will result in death or serious injury.

8. Correct the wiring errors.
9. Repeat these steps until all errors are corrected.

Table 5–5: Wiring Error Message

Message	Description
Invalid system type	The circuit monitor is set up for a system type that the wiring test does not support.
Frequency out of range	Actual frequency of the system is not the same as the selected frequency configured for the circuit monitor.
Voltage not present on all phases	No voltage metered on one or more phases.
Severe voltage unbalance present	Voltage unbalance on any phase greater than 70%.
Not enough load to check wiring	Metered current below deadband on one or more phases.
Suspected error: Check meter configuration for direct connection	Set up for voltage input should be “No PT.”
Suspected error: Reverse polarity on all current inputs	Check polarities. Polarities on all CTs could be reversed.
Phase rotation does not match meter setup	Metered phase rotation is different than phase rotation selected in the circuit monitor set up.
Negative kW, check CT & VT polarities	Metered kW is negative, which could indicate swapped polarities on any CT or VT.
No voltage metered on V1–n	No voltage metered on V1–n on 4-wire system only.
No voltage metered on V2–n	No voltage metered on V2–n on 4-wire system only.
No voltage metered on V3–n	No voltage metered on V3–n on 4-wire system only.
No voltage metered on V1–2	No voltage metered on V1–2.
No voltage metered on V2–3	No voltage metered on V2–3.
No voltage metered on V3-1	No voltage metered on V3-1.
V2–n phase angle out of range	V2–n phase angle out of expected range.
V3–n phase angle out of range	V3–n phase angle out of expected range.
V2–3 phase angle out of range	V2–3 phase angle out of expected range.
V3–1 phase angle out of range	V3–1 phase angle out of expected range.
Suspected error: Reverse polarity on V2–n VT	Polarity of V2–n VT could be reversed. Check polarity.
Suspected error: Reverse polarity on V3–n VT	Polarity of V3–n VT could be reversed. Check polarity.
Suspected error: Reverse polarity on V2–3 VT	Polarity of V2–3 VT could be reversed. Check polarity.
Suspected error: Polarity on V3–1 VT	Polarity of V3–1 VT could be reversed. Check polarity.
Suspected error: Check V1 input, may be V2 VT	Phase 2 VT may actually be connected to input V1.
Suspected error: Check V2 input, may be V3 VT	Phase 3 VT may actually be connected to input V12
Suspected error: Check V3 input, may be V1 VT	Phase 1 VT may actually be connected to input V3.

Table 5–5: Wiring Error Message *(continued)*

Message	Description
Suspected error: Check V1 input, may be V3 VT	Phase 3 VT may actually be connected to input V1.
Suspected error: Check V2 input, may be V1 VT	Phase 1 VT may actually be connected to input V2.
Suspected error: Check V3 input, may be V2 VT	Phase 2 VT may actually be connected to input V3.
I1 load current less than 1% CT	Metered current on I1 less than 1% of CT. Test could not continue.
I2 load current less than 1% CT	Metered current on I2 less than 1% of CT. Test could not continue.
I3 load current less than 1% CT	Metered current on I3 less than 1% of CT. Test could not continue.
I1 phase angle out of range. Cause of error unknown.	I1 phase angle is out of expected range. Cause of error unable to be determined.
I2 phase angle out of range. Cause of error unknown	I2 phase angle is out of expected range. Cause of error unable to be determined.
I3 phase angle out of range. Cause of error unknown.	I3 phase angle is out of expected range. Cause of error unable to be determined.
Suspected error: Reverse polarity on I1 CT.	Polarity of I1 CT could be reversed. Check polarity.
Suspected error: Reverse polarity on I2 CT	Polarity of I2 CT could be reversed. Check polarity.
Suspected error: Reverse polarity on I3 CT	Polarity of I3 CT could be reversed. Check polarity.
Suspected error: Check I1 input, may be I2 CT	Phase 2 CT may actually be connected to input I1.
Suspected error: Check I2 input, may be I3 CT	Phase 3 CT may actually be connected to input I2.
Suspected error: Check I3 input, may be I1 CT	Phase 1 CT may actually be connected to input I3.
Suspected error: Check I1 input, may be I3 CT	Phase 3 CT may actually be connected to input I1.
Suspected error: Check I2 input, may be I1 CT	Phase 1 CT may actually be connected to input I2.
Suspected error: Check I3 input, may be I2 CT	Phase 2 CT may actually be connected to input I3.
Suspected error: Check I1 input, may be I2 CT with reverse polarity	Phase 2 CT may actually be connected to input I1, and the CT polarity may also be reversed.
Suspected error: Check I2 input, may be I3 CT with reverse polarity	Phase 3 CT may actually be connected to input I21, and the CT polarity may also be reversed.
Suspected error: Check I3 input, may be I1 CT with reverse polarity	Phase 1 CT may actually be connected to input I3, and the CT polarity may also be reversed.
Suspected error: Check I1 input, may be I3 CT with reverse polarity	Phase 3 CT may actually be connected to input I1, and the CT polarity may also be reversed.
Suspected error: Check I2 input, may be I1 CT with reverse polarity	Phase 1 CT may actually be connected to input I2, and the CT polarity may also be reversed.
Suspected error. Check I3 input, may be I2 CT with reverse polarity	Phase 2 CT may actually be connected to input I3, and the CT polarity may also be reversed.

CHAPTER 6—COMMUNICATIONS

COMMUNICATIONS CAPABILITIES

The circuit monitor comes equipped with two communication ports, an RS-485 and an RS-232. You can expand the communications capabilities by adding an Ethernet communications card (ECC), a VFD display, or both. The ECC has two Ethernet ports and one RS-485 serial port. When the circuit monitor is equipped with the ECC, a VFD display, and both of its standard ports are used, the circuit monitor can communicate simultaneously from up to five communication ports.

Protocols

The circuit monitor can use either MODBUS or JBUS protocols. Selecting which protocol to use is done during setup. Descriptions of the connections that can be used with each protocol are described in the sections that follow.

POINT-TO-POINT COMMUNICATIONS USING THE RS-232 PORT

For point-to-point communications, such as connecting the circuit monitor to a personal computer (PC) or modem, use the circuit monitor's RS-232 port. If you have a VFD display, you can also use the infrared communications interface (OCIVF) to communicate directly with the circuit monitor. For more information about using this accessory, see the instruction bulletin provided with the OCIVF.

⚠ DANGER

HAZARD OF ELECTRIC SHOCK, EXPLOSION OR ARC FLASH

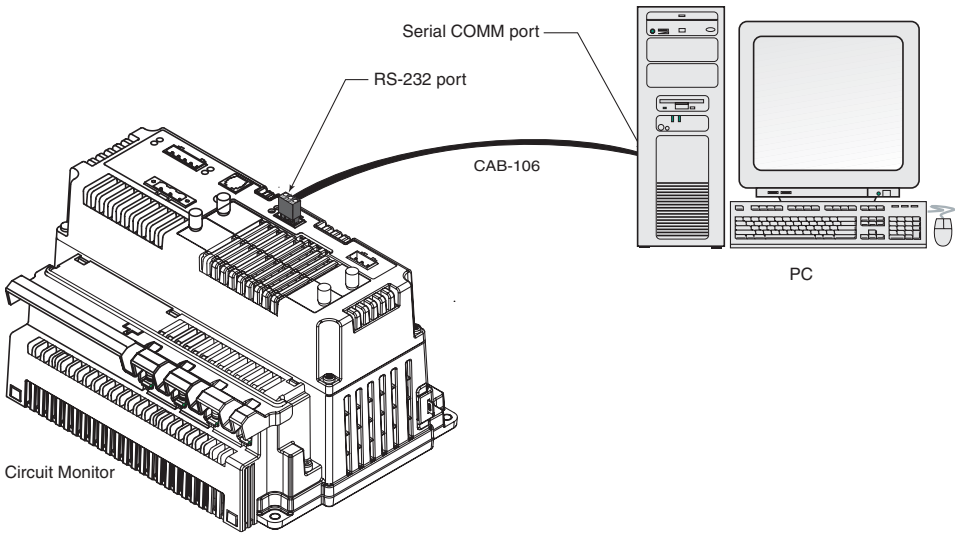
- Turn off all power supplying the circuit monitor and the equipment in which it is installed before working on it.
- Use a properly rated voltage testing device to verify that the power is off.

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

Connecting to a PC

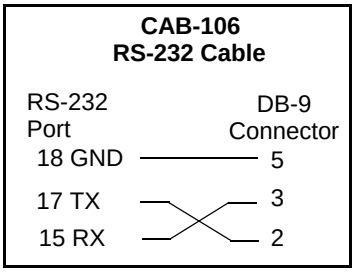
To directly connect the circuit monitor to a PC, connect the serial COMM port on the PC to the RS-232 port on the circuit monitor as shown in Figure 6–1.

Figure 6–1: Circuit monitor connected directly to a PC



The pinout for the CAB-106 (RS-232) cable is shown in Figure 6–2.

Figure 6–2: CAB-106 cable pinout



DAISY-CHAINING DEVICES TO THE CIRCUIT MONITOR

The RS-485 slave port allows the circuit monitor to be connected in a daisy chain with up to 31, 4-wire devices. In this bulletin, communications link refers to a chain of devices that are connected by a communications cable.

To daisy-chain devices to the circuit monitor, use communications cable containing two twisted-shielded pairs (Belden 8723, Belden 9842, or equivalent) and the five-terminal connector of the RS-485 port on the circuit monitor. The terminals are labeled:

24 ⏚ (shield)

23 TX- , 22 TX+ (transmit)

21 RX-, 20 RX+ (receive)

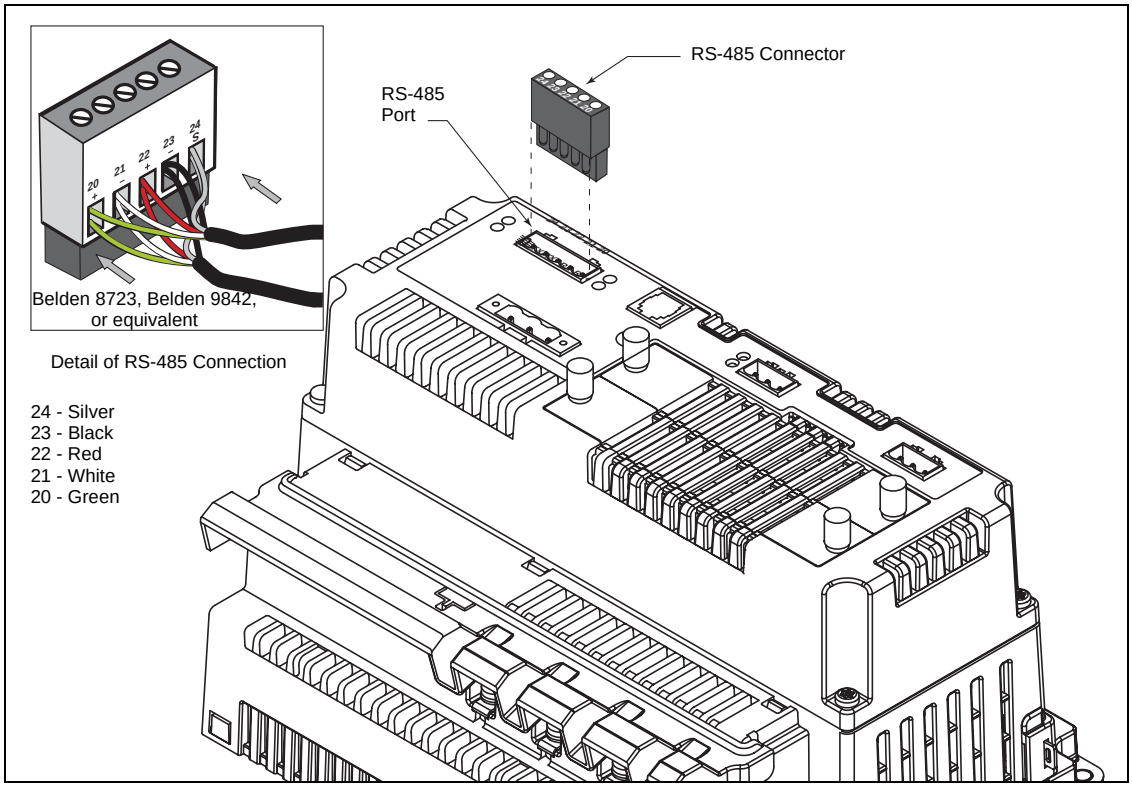
Figure 6–3 shows the labels. When making connections to other PowerLogic devices, such as PowerLogic power meters and CM2000 circuit monitors, the terminal labels correspond to the circuit monitor in this way:

IN → RX, OUT→ TX, and SHLD→⏚

To connect to the circuit monitor, follow these steps:

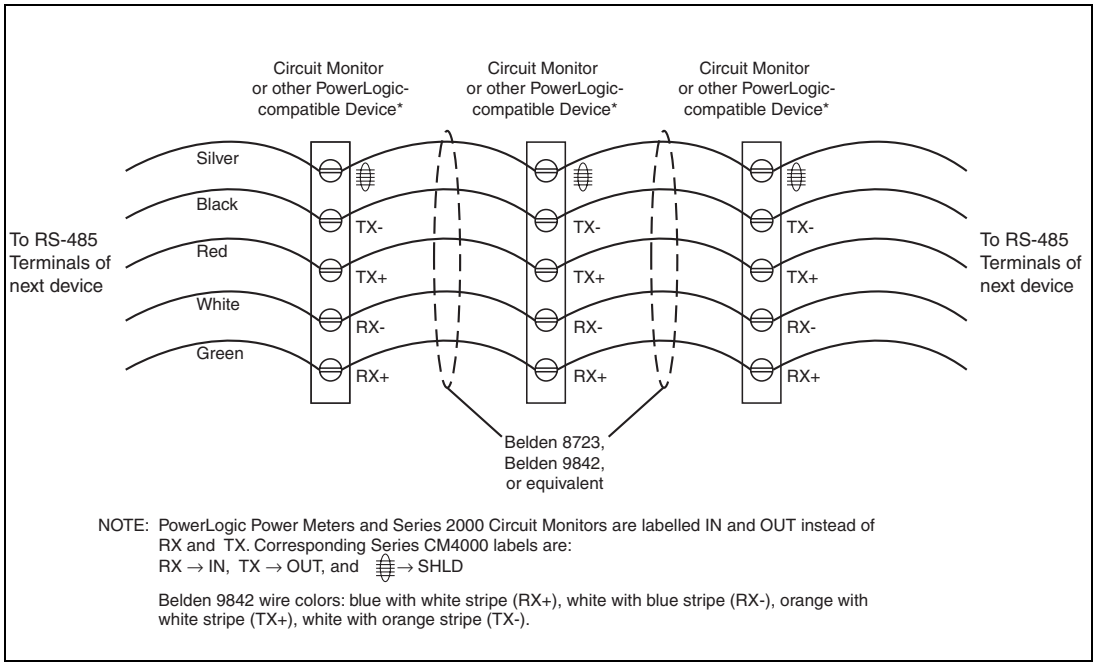
1. Strip the cable wires and insert them into the holes in the connector.
2. On the top of the connector, torque the wire binding screws 5–7 lb.-in. (0.56–0.79 N•m)

Figure 6–3: RS-485 connection



To daisy-chain the circuit monitor to another PowerLogic device, wire the circuit monitor's RS-485 communications terminals to the matching communications terminals of the next device. In other words, wire the RX+ terminal of the circuit monitor to the RX+ (or IN+) terminal of the next device, wire RX- to RX- (or IN-), TX+ to TX+ (or OUT+), TX- to TX- (or OUT-), and shield to shield (to SHLD) as shown in Figure 6–4.

Figure 6–4: Daisy-chaining devices



NOTE: PowerLogic Power Meters and Series 2000 Circuit Monitors are labelled IN and OUT instead of RX and TX. Corresponding Series CM4000 labels are:
RX → IN, TX → OUT, and → SHLD

Belden 9842 wire colors: blue with white stripe (RX+), white with blue stripe (RX-), orange with white stripe (TX+), white with orange stripe (TX-).

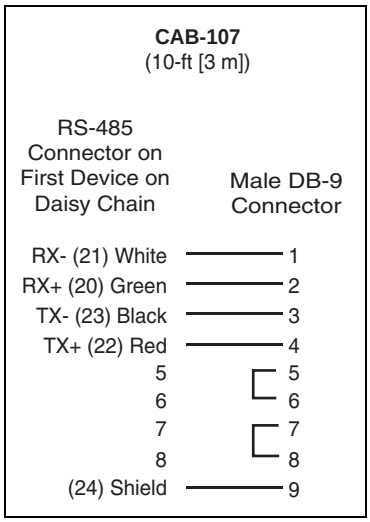
- If the circuit monitor is the first device on the daisy chain, connect it to the personal computer or programmable controller using the CAB-107 cable (or equivalent cable). See "Connecting the First Device on the Daisy Chain" on page 61 for instructions.
- If the circuit monitor is the last device on the daisy chain, terminate it. See "Terminating the Communications Link" on page 62 for instructions.

Connecting the First Device on the Daisy Chain

If the circuit monitor is the first device on the daisy chain, refer to Figure 6–6 and follow these instructions to make the connections:

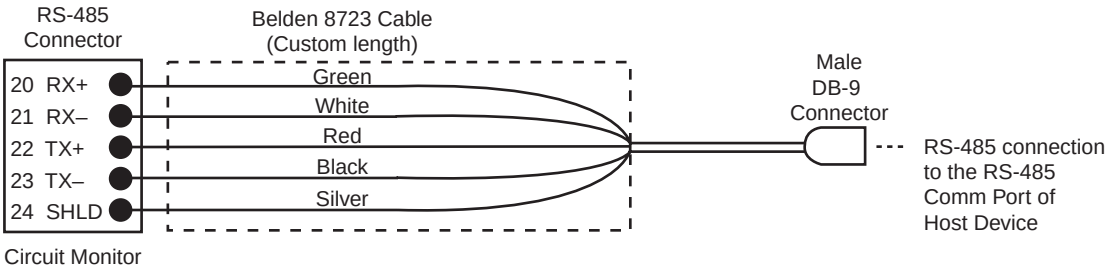
The CAB-107 cable is 10 ft. (3 m) long with a male DB-9 connector attached at one end. If the circuit monitor must be located farther than 10 ft. (3 m) from the host device, build a custom cable using Belden 8723 cable, Belden 9842, or equivalent and a male DB-9 connector. Refer to Figure 6–5 for the CAB-107 pinout.

Figure 6–5: CAB-107 Cable Pinout



1. Connect the host master device to the first circuit monitor. Plug the DB-9 connector into the RS-485 Comm Port of the host device.
2. If the distance between the host device and the circuit monitor is longer than the 10-ft. (3 m) CAB-107 cable, you will need to make your own cable.
   a. Cut a length of Belden cable long enough to reach from the host device to the circuit monitor. Strip 1-1/4 in. (32 mm) of cable sheath from both ends.
   b. On one end of the Belden cable, carefully strip .25 in. (6 mm) of insulation from the end of each wire to be connected.
   c. Insert the wire ends of the Belden cable into the DB-9 connector using Figure 6–5 as a reference. Torque the DB-9 terminal screws to 5–7 lb.-in. (0.56–0.79 N•m).
   d. On the other end of the Belden cable, carefully strip .4 in.–.45 in. (10–11 mm) of insulation from the end of each wire to be connected.
   e. Insert the wire ends of the Belden cable into the RS-485 terminal connector of the circuit monitor, making sure to connect RX+ to RX+, and so forth. Torque the RS-485 terminal screws to 5–7 lb.-in. (0.56–0.79 N•m).

Figure 6–6: Typical procedure for connecting the first device on the daisy chain



Length of the Communications Link

The length of the communications link cannot exceed 10,000 feet (3,050 m).This means that the total length of the communications cable from the host device to the last device in the daisy chain, cannot exceed 10,000 feet. When 17 or more devices are on a communications link, the maximum distance may be shorter, depending on the baud rate. Table 6–1 shows the maximum distances at different baud rates.

Table 6–1: Maximum distances of 4-wire communications link at different baud rates

Baud Rate	Maximum Distances	
	1–16 Devices	17–32 Devices
1200	10,000 ft (3,048 m)	10,000 ft (3,048 m)
2400	10,000 ft (3,048 m)	5,000 ft (1,524 m)
4800	10,000 ft (3,048 m)	5,000 ft (1,524 m)
9600	10,000 ft (3,048 m)	4,000 ft (1,219 m)
19200	5,000 ft (1,548 m)	2,500 ft (762 m)
38400	5,000 ft (1,524 m)	2,500 ft (762 m)

Terminating the Communications Link

For proper RS-485 communications performance, you must terminate the last device on the communications link using one of these methods:

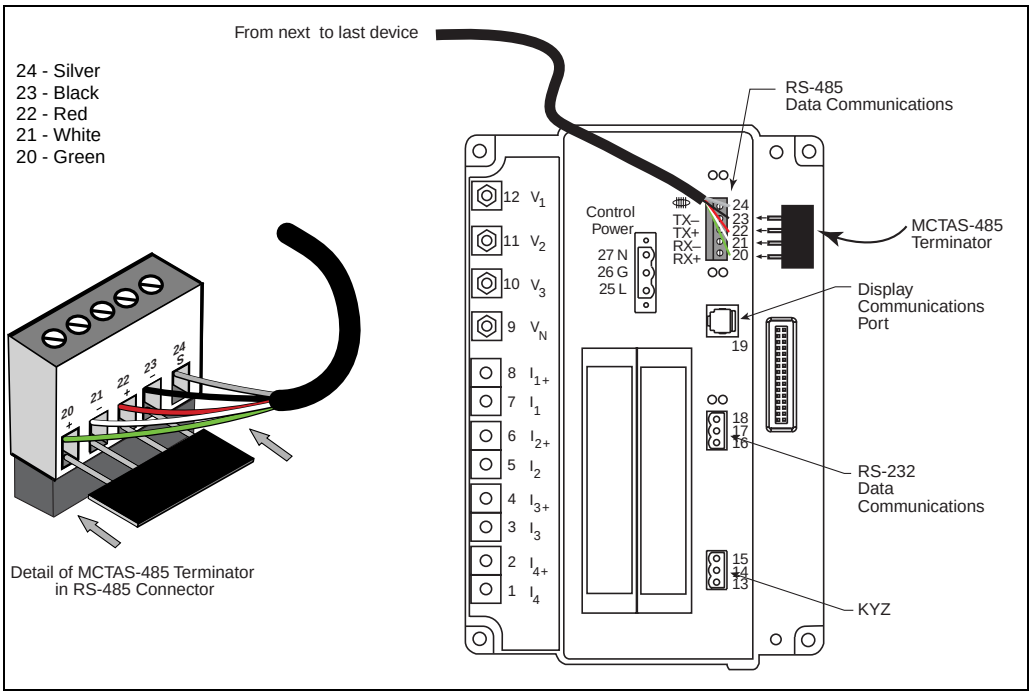
- Use the MCTAS-485 terminator, which inserts directly into the connector in the RS-485 port of the circuit monitor as illustrated in Figure 6–7.
- Use a terminal block and the MCT-485 terminator. In this method, communications wires route from the last device on a daisy chain to a 5-position terminal block. The terminator attaches to the terminal block. See Figure 6–8.

- Terminate **only the last device** on the link. If a link has only one device, terminate that device.
- Some PowerLogic devices use a removable communications connector. If the last device on the communications link is not a circuit monitor, refer to the instruction bulletin for that device for termination instructions.

Using the MCTAS-485 Terminator

To terminate the circuit monitor using the MCTAS-485 terminator, insert the wires of the terminator directly into terminals 20, 21, 22, and 23 of the RS-485 communications connector on the circuit monitor as shown in Figure 6–7.

Figure 6–7: Terminating the circuit monitor using the MCTAS-485 terminator

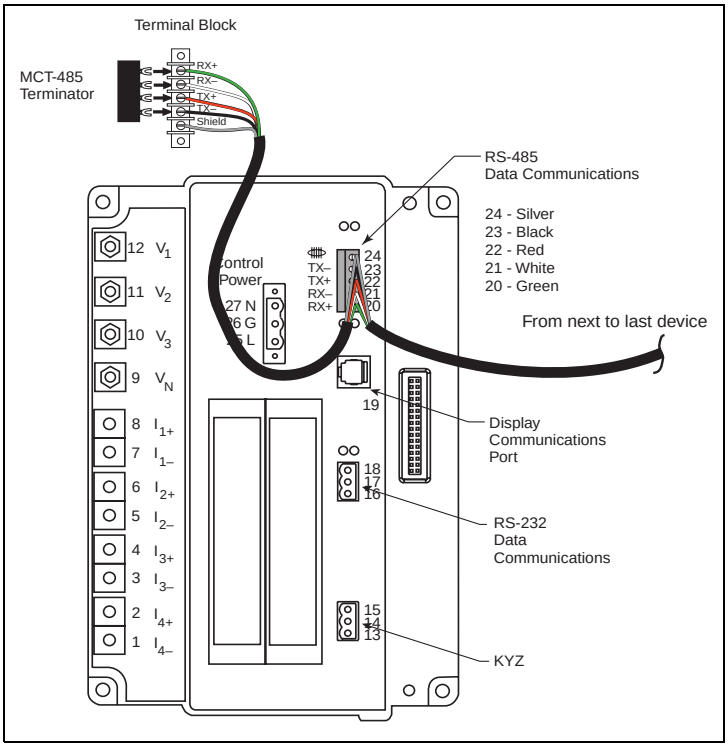


Using the MCT-485 Terminator

If the circuit monitor is the last device on the communication link, follow these instructions to terminate it using the MCT-485 terminator:

1. Route the communications wires from the last circuit monitor on a daisy chain to a 5-position terminal block.
2. Attach the terminator to the terminal block as shown in Figure 6–8.

Figure 6–8: Terminating the circuit monitor using the MCT-485 terminator and a terminal block



CONNECTING TO A HOST USING THE RS-485 PORT

The RS-485 slave port allows the circuit monitor to be connected to a daisy-chain of up to 32 devices to the serial communications port on a host device (see Figure 6–9). Refer to “Length of the Communications Link” on page 62 for cable distance limitations at varying baud rates. To make this type of connection, you must use a RS-232-to-RS-422/RS-485 converter. PowerLogic offers a converter kit for this purpose (part number MCI-101). For connection instructions, refer to the instruction bulletin included with the MCI-101 kit.

Figure 6–9: Circuit monitors connected to a PC serial port through the RS-485 port on the circuit monitor

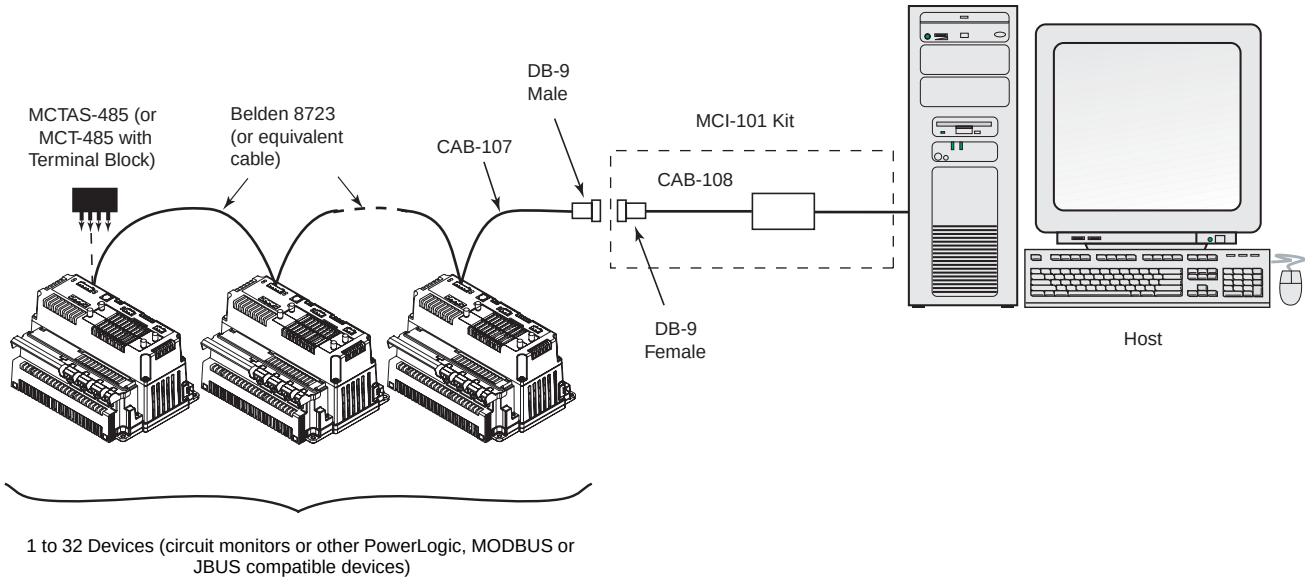
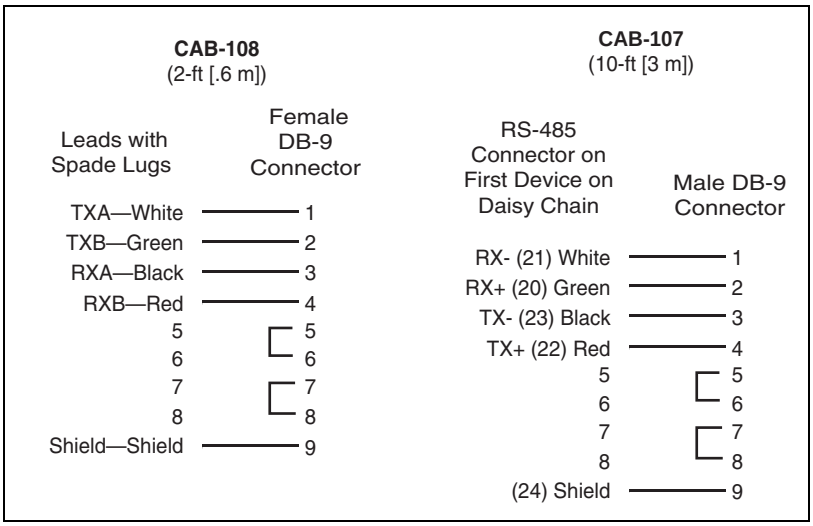


Figure 6–10: Cable Pinouts for RS-485 Connection



WIRING FOR 2-WIRE MODBUS OR JBUS COMMUNICATION

When wiring the communications terminals for 2-wire MODBUS or JBUS, jumper connections are made from RX+ to TX+ and from RX– to TX– as shown in Figure 6–11.

Figure 6–11: 2-wire MODBUS or JBUS wiring

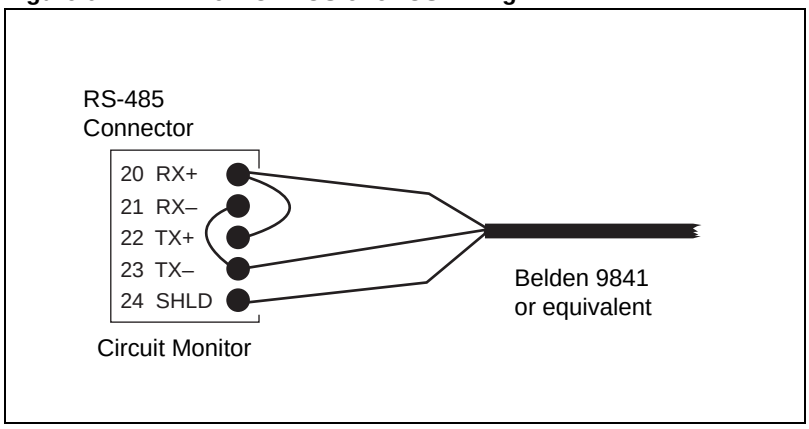


Table 6–2 shows the maximum daisy chain distance that includes circuit monitors communicating using 2-wire MODBUS or JBUS. Consider baud rate and the number of devices on the daisy chain when calculating the maximum distance.

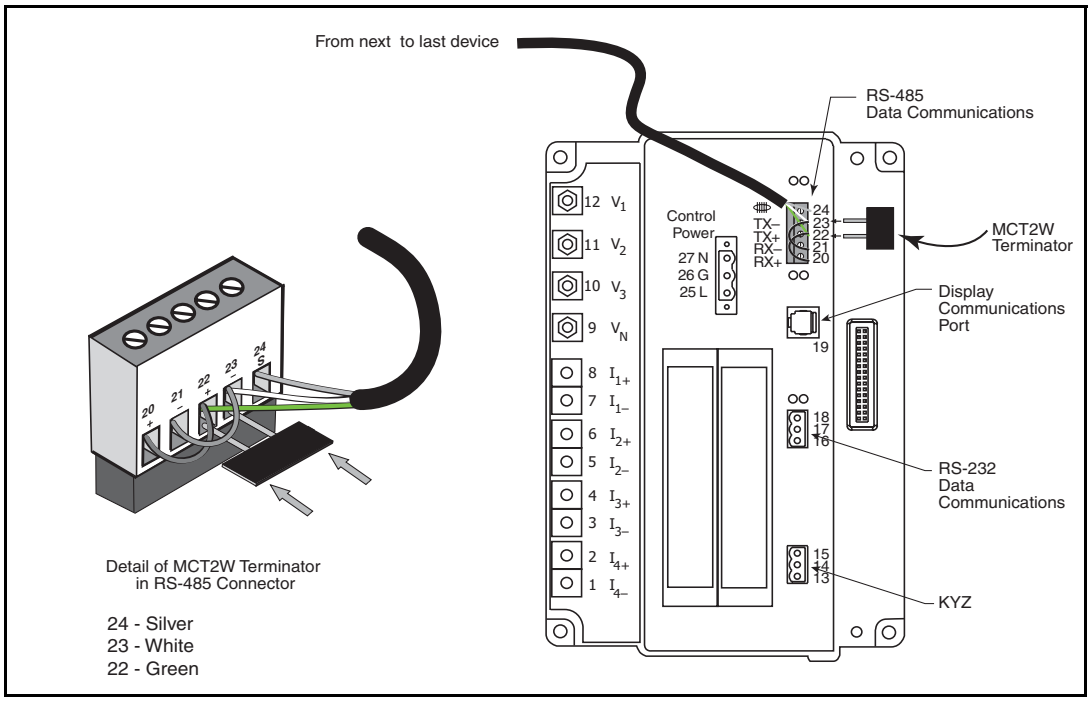
Table 6–2: Maximum distances of 2-wire MODBUS or JBUS comms link at different baud rates

BaudRate	Maximum Distances	
	1–8 Devices	9–16 Devices
1200	5,000 ft (1,524 m)	5,000 ft (1,524 m)
2400	5,000 ft (1,524 m)	2,500 ft (762 m)
4800	5,000 ft (1,524 m)	2,500 ft (762 m)
9600	5,000 ft (1,524 m)	2,000 ft (609 m)
19200	2,500 ft (762 m)	1,250 ft (381 m)
38400	1,500 ft (457 m)	1,250 ft (381 m)

Terminating 2-Wire MODBUS or JBUS Communications

To terminate a circuit monitor wired for 2-wire MODBUS or JBUS, you can use the MCT2W terminator as shown in Figure 6–12.

Figure 6–12: Terminating a circuit monitor wired for 2-wire MODBUS or JBUS communications

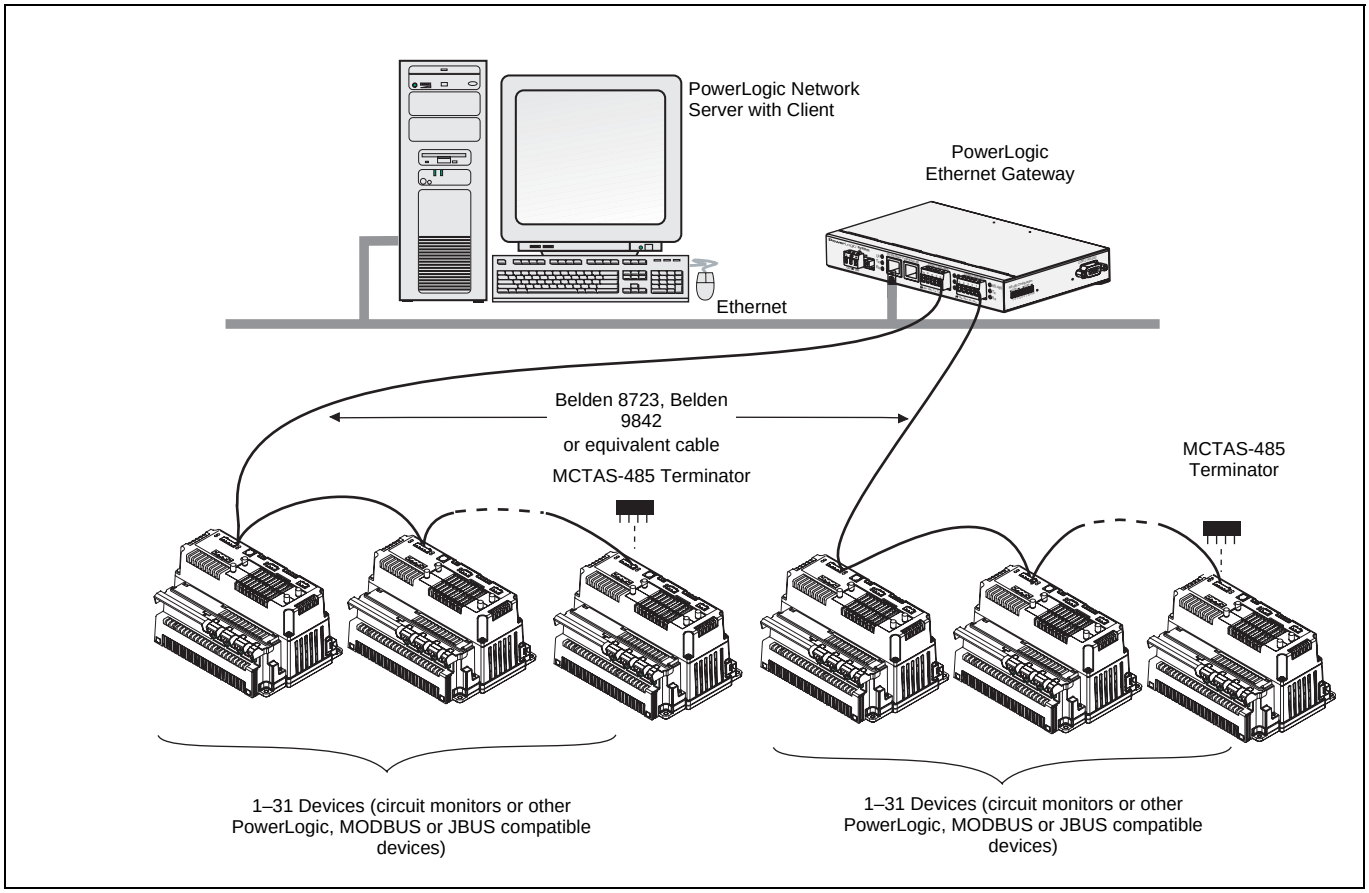


CONNECTING TO A POWERLOGIC ETHERNET GATEWAY (EGX)

The PowerLogic Ethernet Gateway is a network communications interface that performs protocol conversion between PowerLogic-compatible devices and standard Ethernet network protocols.

An Ethernet Gateway has serial ports that support from 8 to 31 PowerLogic devices, depending on the Ethernet Gateway model. More devices can be daisy-chained when a signal repeater is used. Refer to the instruction bulletin that ships with your Ethernet Gateway for more information and installation procedures.

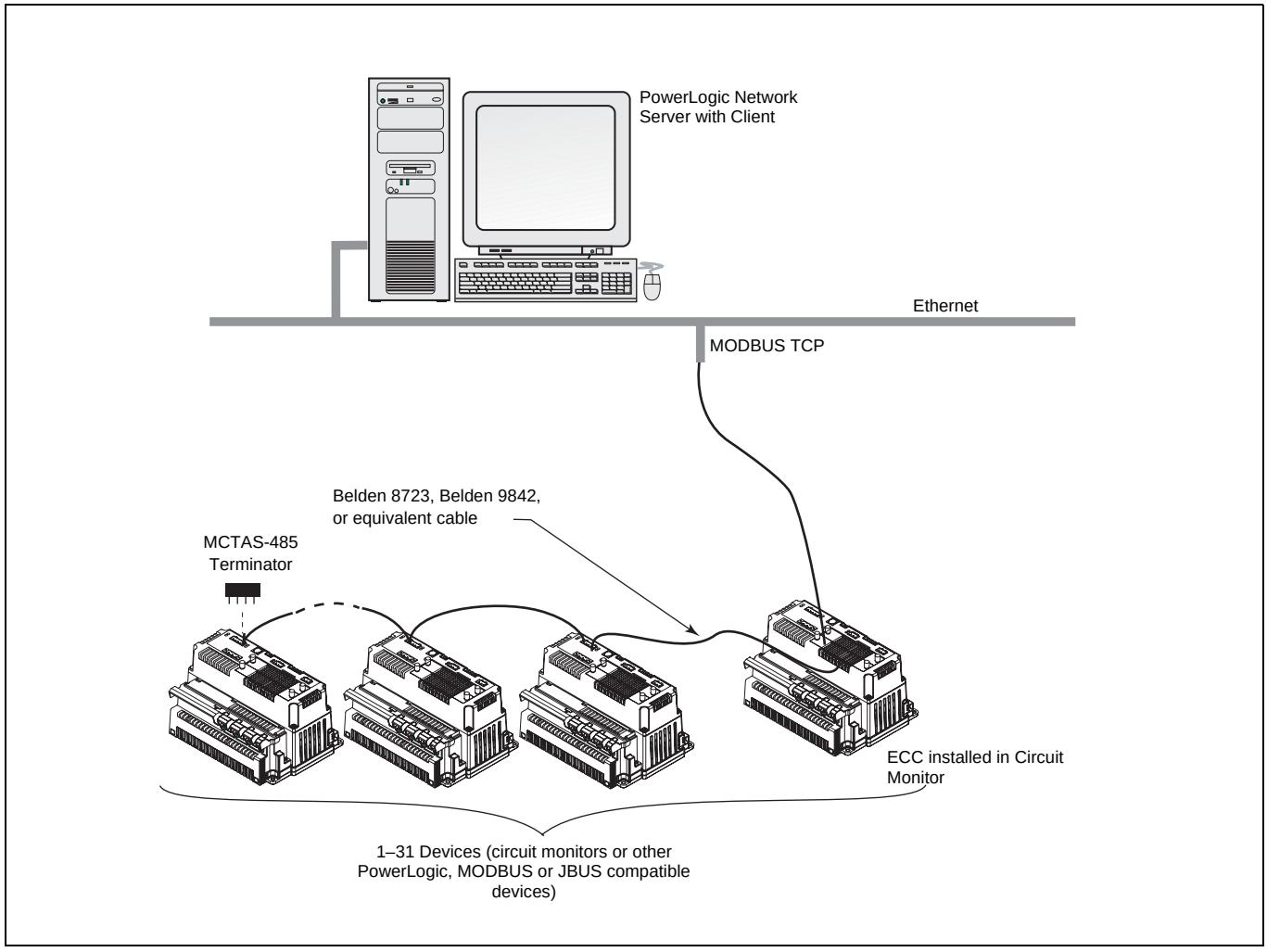
Figure 6–13: Circuit monitors connected to Ethernet using a PowerLogic Ethernet Gateway



CONNECTING TO A POWERLOGIC ETHERNET COMMUNICATION CARD (ECC)

The RS-485 port of the ECC supports up to 31 devices. The daisy chain can be mixed mode enabling PowerLogic, MODBUS, and JBUS devices to be daisy-chained together. Use either the 100 Mbps fiber optic port or the 10/100 Mbps UTP port to connect to Ethernet. Using the embedded web page feature of the ECC21, you can use your internet browser to view data from the circuit monitor. For detailed instructions on how to use ECC, see the instruction bulletin that ships with this accessory.

Figure 6–14: Circuit monitors connected to an Ethernet Communication Card (ECC)



CHAPTER 7—OPERATION

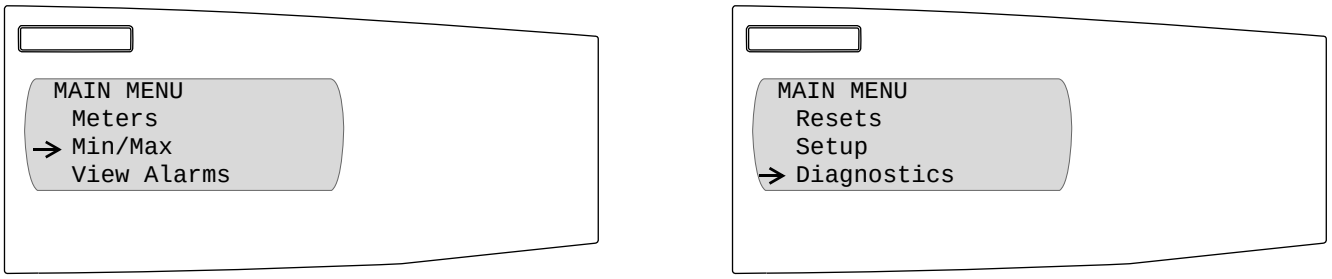
MINIMUM SETUP

This section tells how to set up the minimum requirements for the circuit monitor from the display. Some advanced features, such as configuring the onboard logs of the circuit monitor, must be set up over the communications link using SMS. Refer to the SMS instruction bulletin and online help file for instructions on setting up advanced features not accessible from the display. Other advanced features using the display are explained in the circuit monitor reference manual.

OPERATING THE DISPLAY

The display shows four lines of information at a time. Notice the arrow on the left of the display screen. This arrow indicates that you can scroll up or down to view more information. For example, on the Main Menu you can view the Resets, Setup, and Diagnostics menu options only if you scroll down to display them. When at the top of a list, the arrow moves to the top line. When the last line of information is displayed, the arrow moves to the bottom as illustrated in Figure 7–1.

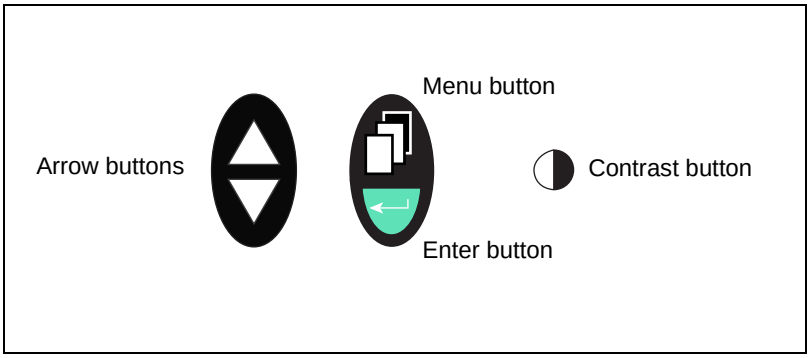
Figure 7–1: Arrow on the display screen



How the Buttons Work

The buttons on the display let you scroll through and select information, move from menu to menu, and adjust the contrast. Figure 7–2 shows the buttons.

Figure 7–2: Display buttons



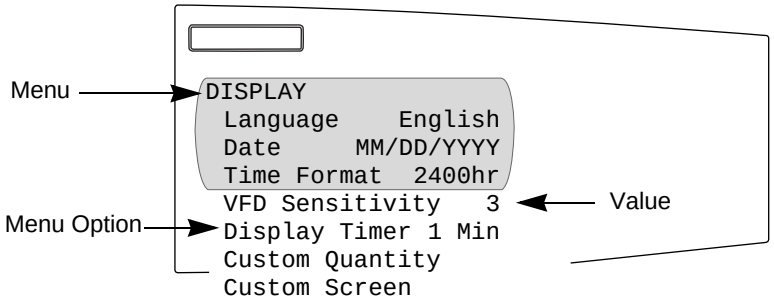
The buttons are used in the following way:

- **Arrow buttons**. Use the arrow buttons to scroll up and down the options on a menu. Also, when a value can be changed, use the arrow buttons to scroll through the values that are available. If the value is a number, holding the arrow button down increases the speed in which the numbers increase or decrease.
- **Menu button**. Each time you press the menu button, you move back one menu level. The menu button also prompts you to save if you've made changes to any options within that menu structure.
- **Enter button**. Use the enter button to select an option on a menu or select a value to be edited.
- **Contrast button**. Press the contrast button to darken or lighten the display. On the LCD model, press any button once to activate the back light.

Display Menu Conventions

The menu conventions described below are applicable to all display instructions in this section. Figure 7–3 shows the parts of a menu.

Figure 7–3: Parts of a menu



Selecting a Menu Option

Each time you read "select" in this manual, choose the option from the menu by doing this:

1. Press the arrows to highlight the menu option.
2. Press the enter button to select that option.

Changing a Value

To change a value, the procedure is the same on every menu:

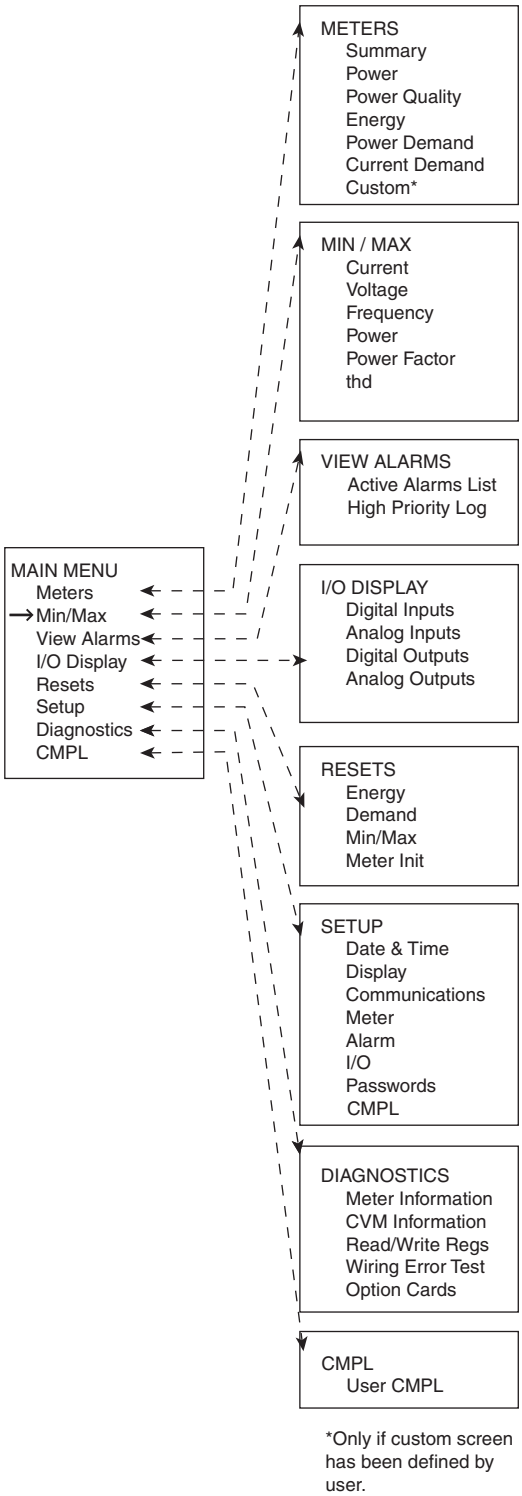
1. Use the arrow buttons to scroll to the menu option you want to change.
2. Press the enter button to select the value. The value begins to blink.
3. Press the arrow buttons to scroll through the possible values. To select the new value, press the enter button.
4. Press the arrow buttons to move up and down the menu options. You can change one value or all of the values on a menu. To save the changes, press the menu button until the circuit monitor displays: "Save changes? No"

Pressing the menu button while a value is blinking will return that value to its most current setting.

5. Press the arrow to change to "Yes," then press the enter button to save the changes.

MAIN MENU OVERVIEW

Figure 7–4: Menu options on the Main Menu



The Main Menu on the display contains the menu options that you use to set up and control the circuit monitor and its accessories and view metered data and alarms. Figure 7–4, on the left, shows the Main Menu options with additional selections under each option. Main Menu options include the following:

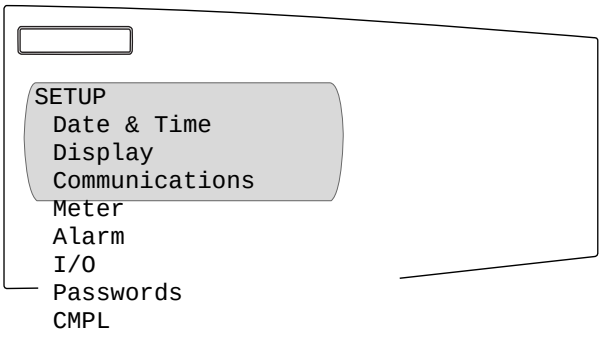
- **Meters**. This menu lets you view metered values that provide information about power usage and power quality.
- **Min/Max**. This menu lets you view the minimum and maximum metered values since the last reset of the min/max values with their associated dates and times.
- **View Alarms**. This menu lets you view a list of all active alarms, regardless of the priority. In addition, you can view a log of high priority alarms, which contains the ten most recent high priority alarms.
- **I/O Display**. From this menu, you can view the designation and status of each input or output. This menu will only display the I/Os present, so you might not see all of the available menu items if you do not have a particular I/O installed.
- **Resets**. This menu lets you reset energy, peak demand, and minimum/maximum values.
- **Setup**. From this menu, you define the settings for the display such as selecting the date format to be displayed. Creating custom quantities and custom screens are also options on this menu. In addition, use this menu to set up the circuit monitor parameters such as the CT and PT ratios. The Setup menu is also where you define the communications, alarms, I/Os and passwords.
- **Diagnostics**. From this menu, you can initiate the wiring error test. Also, use this menu to read and write registers and view information about the circuit monitor such as its firmware version and serial number.
- **CMPL**. CMPL is the custom programming language for the circuit monitor. If a custom program is installed, you can view the name, version, date, and status of the program.

CONFIGURING THE CIRCUIT MONITOR USING THE SETUP MENU

Before you can access the Setup menu from the Main Menu, you must enter the Setup password.

To enter the Setup password, follow these instructions:

1. From the Main Menu, select Setup.
   The password prompt displays.
2. Select 0, the default password.
   The Setup menu displays.



To change the password, see “Setting Up Passwords” in the reference manual.

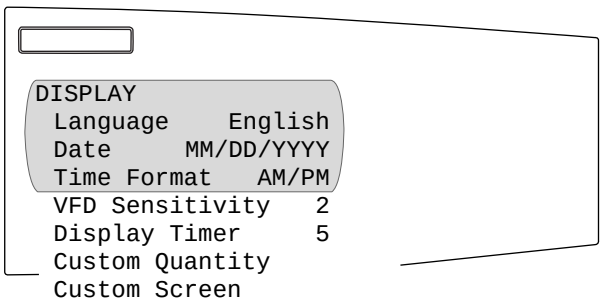
The Setup menu has the following options:

- Date & Time
- Display
- Communications
- Meter
- Alarm
- I/O
- Passwords
- CMPL

Setting Up the Display

Setting up the display involves, for example, choosing a date and time format that you want to be displayed. To set up the display, follow these steps:

1. From the Main Menu, select Setup > Display.
   The Display Setup menu displays. Table 7–1 describes the options on this menu and includes default values.



2. Use the arrow buttons to scroll to the menu option you want to change.
3. Press the enter button to select the value.The value begins to blink. Use the arrow buttons to scroll through the available values. Then, press the enter button to select the new value.
4. Use the arrow buttons to scroll through the other options on the menu, or if you are finished, press the menu button to save.

Table 7–1: Factory Defaults for the Display Settings

Option	Available Values	Selection Description	Default
Language	English Francais Espanol Italiano Polski	Language used by the display.	English
Date	MM/DD/YYYY YYYY/MM/DD DD/MM/YYYY	Data format for all date-related values of the circuit monitor.	MM/DD/YYYY
Time Format	2400hr AM/PM	Time format can be 24-hour military time or 12-hour clock with AM and PM.	2400hr
VFD Sensitivity	Off 1 = 0–6 ft (0–15 m) 2 = 0–12 ft (0–31 m) 3 = 0–20 ft (0–51 m)	Sensitivity value for the proximity sensor (for the VFD display only).	2
Display Timer	1, 5, 10, or 15 minutes	Number of minutes the display remains illuminated after inactivity.	5
Custom Quantity	Creating custom quantities is an advanced feature that is not required for basic setup. To learn more about this feature, see “Creating Custom Quantities to be Displayed” in the reference manual.		
Custom Screen	Creating custom screens is an advanced feature that is not required for basic setup. To learn more about this feature, see “Creating Custom Screens” in the reference manual.		

Setting Up the Communications

The Communications menu lets you set up the following communications:

- *RS-485* communications for daisy-chain communication of the circuit monitor and other RS-485 devices.
- *RS-232* communications for point-to-point communication between the the circuit monitor and a host device, such as a PC or modem.
- *Infrared Port* communications between the circuit monitor and a laptop computer (available only on the VFD display).
- *Ethernet Options* for Ethernet communications between the circuit monitor and your Ethernet network when an Ethernet Communications Card (ECC) is present.

Each of these options is described in the sections that follow.

Setting the Device Address

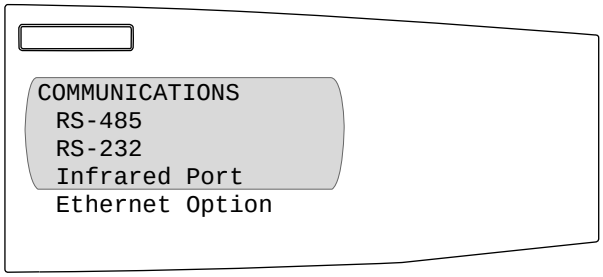
Each PowerLogic device on a communications link must have a unique device address. The term communications link refers to 1–32 PowerLogic-compatible devices daisy-chained to a single communications port. If the communications link has only a single device, assign it address 1. By networking groups of devices, PowerLogic systems can support a virtually unlimited number of devices.

RS-485, RS-232, and Infrared Port Communications Setup

To set up RS-485, RS-232, or the infrared port communications, set the address, baud rate, and parity. Follow these steps:

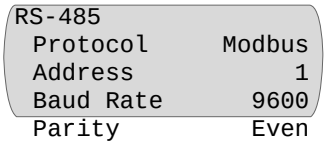
1. From the Main Menu, select Setup > Communications.

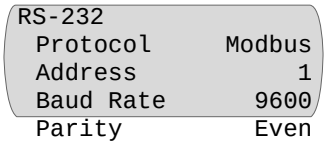
   The Communications Setup screen displays.

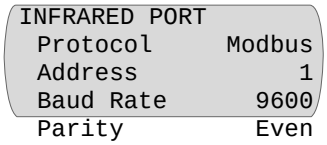


You can set up infrared communications only if the circuit monitor is equipped with a VFD display. Also, you can set up Ethernet communications only if the circuit monitor is equipped with an ECC card.

2. From the Communications Setup menu, select the type of communications that you are using. Depending on what you select, the screen for that communications setup displays, as shown below. Table 7–2 describes the options on this menu.







3. Use the arrow buttons to scroll to the menu option you want to change.
4. Press the enter button to select the value. The value begins to blink. Use the arrow buttons to scroll through the available values. Then, press the enter button to select the new value.
5. Use the arrow buttons to scroll through the other options on the menu, or if you are finished, press the menu button to save.

Table 7–2: Options for Communications Setup

Option	Available Values	Selection Description	Default
Protocol	Modbus Jbus	Select MODBUS or JBUS protocol.	MODBUS
Address	1–255	Device address of the circuit monitor. See “Setting the Device Address” on page 76 for requirements of device addressing.	1

Table 7–2: Options for Communications Setup *(continued)*

Option	Available Values	Selection Description	Default
Baud Rate	1200 2400 4800 9600 19200 38400	Speed at which the devices will communicate. The baud rate must match all devices on the communications link.	9600
Parity	Even, Odd, or None	Parity at which the circuit monitor will communicate.	Even

Ethernet Communications Card (ECC) Setup

Ethernet communications is available only if you have an optional Ethernet Communications Card (ECC) that fits into slot A on the top of the circuit monitor. See “Option Cards” on page 27 for more information. To set up the Ethernet communications between the circuit monitor and the network, refer to the instruction bulletin provided with the ECC.

Setting Up the Metering Functions of the Circuit Monitor

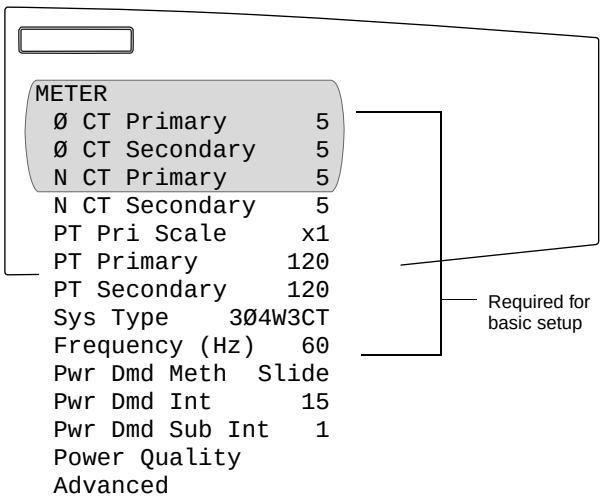
To set up the metering within the circuit monitor, you must configure the following items on the Meter setup screen for basic setup:

- CT and PT ratios
- System type
- Frequency

The power demand method, interval and subinterval, and advanced setup options are also accessible from the Meter Setup menu but are not required for basic setup when you accept the factory defaults. To set up the circuit monitor, follow these steps:

1. From the Main Menu, select Setup > Meter.

   The Meter setup screen displays. Table 7–3 on page 79 describes the options on this menu.



2. Use the arrow buttons to scroll to the menu option you want to change.

3. Press the enter button to select the value. The value begins to blink. Use the arrow buttons to scroll through the available values. Then, press the enter button to select the new value.
4. Use the arrow buttons to scroll through the other options on the menu, or if you are finished, press the menu button to save.

Table 7–3: Options for Meter Setup

Option	Available Values	Selection Description	Default
CT Primary	1–32,767	Set the rating for the CT primary. The circuit monitor supports two primary CT ratings: one for the phase CTs and the other for the neutral CT.	5
CT Secondary	1 or 5	Set the rating for the CT secondaries.	5
PT Pri Scale	x1 x10 x100 No PT	Set the value to which the PT Primary is to be scaled if the PT Primary is larger than 32,767. For example, setting the scale to x10 multiplies the PT Primary number by 10. For a direct-voltage installation, select “No PT.”	x1
PT Primary	1–32,767	Set the rating for the PT primary.	120
PT Secondary	100 110 115 120	Set the rating for the PT secondaries.	120
Sys Type	3Φ3W2CT 3Φ3W3CT 3Φ4W3CT 3Φ4W4CT 3Φ4W3CT2PT 3Φ4W4CT2PT	3Φ3W2CT is system type 30 3Φ3W3CT is system type 31 3Φ4W3CT is system type 40 3Φ4W4CT is system type 41 3Φ4W3CT2PT is system type 42 3Φ4W4CT2PT is system type 43 Set the system type. A system type code is assigned to each type of system connection. See Table 5–4 on page 39 for a description of system connection types.	3Φ4W3CT (40)
Frequency (Hz)	50, 60, or 400 Hz	Frequency of the system.	60
Pwr Dmd Meth	Select the power demand calculation method. The circuit monitor supports several methods to calculate average demand of real power. See “Demand Power Calculation Methods” in the reference manual for a detailed description. Slide—Sliding Block Demand Slave—Slave Block Demand Therm—Thermal Demand RComms—Command-Synchronized Rolling Block Demand Comms—Command-Synchronized Block Demand RInput—Input-Synchronized Rolling Block Demand Input—Input-Synchronized Block Demand RClock—Clock-Synchronized Rolling Block Demand Clock—Clock-Synchronized Block Demand RBlock—Rolling Block Demand Block—Fixed Block Demand IncEngy—Synch to Incremental Energy Interval		Slide
Pwr Dmd Int	1–60	Power demand interval—set the time in minutes in which the circuit monitor calculates the demand.	15
Pwr Dmd Sub Interval	1–60	Power demand subinterval—period of time within the demand interval in which the demand calculation is updated. Set the subinterval only for methods that will accept a subinterval. The subinterval must be evenly divisible into the interval.	N/A
Advanced	See “Advanced Meter Setup” in the reference manual for more information.		

CHAPTER 8—MAINTENANCE

CIRCUIT MONITOR MAINTENANCE

The circuit monitor does not require regular maintenance, nor does it contain any user-serviceable parts. If the circuit monitor requires service, contact your local sales representative. Do not open the circuit monitor. Opening the circuit monitor voids the warranty.

⚠ DANGER

HAZARD OF ELECTRIC SHOCK, EXPLOSION OR ARC FLASH

Do not attempt to service the circuit monitor. CT and PT inputs may contain hazardous currents and voltages. Only authorized service personnel from the manufacturer should service the circuit monitor.

Failure to follow this instruction will result in death or serious injury.

⚠ CAUTION

HAZARD OF EQUIPMENT DAMAGE

Do not perform a Dielectric (Hi-Pot) or Megger test on the circuit monitor. High voltage testing of the circuit monitor may damage the unit. Before performing Hi-Pot or Megger testing on any equipment in which the circuit monitor is installed, disconnect all input and output wires to the circuit monitor.

Failure to follow this instruction can result in injury or equipment damage.

GETTING TECHNICAL SUPPORT

Contact your local Schneider Electric sales representative for assistance or go to the www.powerlogic.com website.

TROUBLESHOOTING

The information in Table 8–1 on page 83 describes potential problems and their possible causes. It also describes checks you can perform or possible solutions for each. After referring to this table, if you cannot resolve the problem, contact your local Square D/Schneider Electric sales representative for assistance.

⚠ DANGER

HAZARD OF ELECTRIC SHOCK, EXPLOSION OR ARC FLASH

- This equipment must be installed and serviced only by qualified personnel.
- Qualified persons performing diagnostics or troubleshooting that require electrical conductors to be energized must comply with NFPA 70 E - Standard for Electrical Safety Requirements for Employee Workplaces and OSHA Standards - 29 CFR Part 1910 Subpart S - Electrical.
- Carefully inspect the work area for tools and objects that may have been left inside the equipment.
- Use caution while removing or installing panels so that they do not extend into the energized bus; avoid handling the panels, which could cause personal injury.

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

Table 8–1: Troubleshooting

Potential Problem	Possible Cause	Possible Solution
The red maintenance LED is illuminated on the circuit monitor.	When the red maintenance LED is illuminated, it indicates a potential hardware or firmware problem in the circuit monitor.	Contact your local sales representative for assistance.
The green control power LED is not illuminated on the circuit monitor.	The circuit monitor is not receiving the necessary power.	Verify that the circuit monitor line (L) and neutral (N) terminals (terminals 25 and 27) are receiving the necessary power.
The display is blank after applying control power to the circuit monitor.	The display is not receiving the necessary power or communications signal from the circuit monitor.	Verify that the display cable is properly inserted into the connectors on the display and the circuit monitor.
The data being displayed is inaccurate or not what you expect.	Circuit monitor is grounded incorrectly.	Verify that the circuit monitor is grounded as described in Figure 5–6 on page 42**.**
	Incorrect setup values.	Check that the correct values have been entered for circuit monitor setup parameters (CT and PT ratings, System Type, Nominal Frequency, and so on). See “Setting Up the Metering Functions of the Circuit Monitor” on page 78 for setup instructions.
	Incorrect voltage inputs.	Check circuit monitor voltage input terminals (9, 10, 11,12) to verify that adequate voltage is present.
	Circuit monitor is wired improperly.	Check that all CTs and PTs are connected correctly (proper polarity is observed) and that they are energized. Check shorting terminals. See “Wiring CTs, PTs, and Control Power to the Circuit Monitor” on page 39 for wiring diagrams. Initiate a wiring check from the circuit monitor display.
Cannot communicate with circuit monitor from a remote personal computer.	Circuit monitor address is incorrect.	Check to see that the circuit monitor is correctly addressed. See “RS-485, RS-232, and Infrared Port Communications Setup” on page 77 for instructions.
	Circuit monitor baud rate is incorrect.	Verify that the baud rate of the circuit monitor matches the baud rate of all other devices on its communications link. See “RS-485, RS-232, and Infrared Port Communications Setup” on page 77 for instructions.
	Communications lines are improperly connected.	Verify the circuit monitor communications connections. Refer to “Communications” on page 57 for instructions.
	Communications lines are improperly terminated.	Check to see that a multipoint communications terminator is properly installed. See “Terminating the Communications Link” on page 62 for instructions.
	Incorrect route statement to circuit monitor.	Check the route statement. Refer to the SMS online help for instructions on defining route statements.

APPENDIX A—SPECIFICATIONS

This appendix contains specifications for the circuit monitor and display.

CM4250 SPECIFICATIONS

NOTE: Specifications given for the CM4250 are valid at 25 degrees centigrade.

Table A–1: Specifications for CM4250

METERING SPECIFICATIONS	
Current Inputs (Each Channel)	
Current Range	0–10 A①
Nominal Current CT sec	5 , 1 A
Voltage Inputs (Each Channel)	
Voltage Range	1–690 Line to Line, 400 Line to Neutral
Nominal Voltage PT sec	100, 110, 115, 120 V
Frequency Range	45–67 Hz, 350–450 Hz
Harmonic Response—Phase Voltages and Currents	
Frequency 45–67 Hz	Up to 255th Harmonic
Frequency 350–450 Hz	Up to 31st Harmonic
Data Update Rate	Approximately 1-second update of all real-time readings for demand and energy calculations (100 ms update for some real-time readings).
Accuracy ②	
Current (measured) ③	
Phase Amperes and Neutral Amperes	±(0.04% of reading + 0.025% full scale) (full scale = 10 A)
Voltage	±(0.04% of reading + 0.025% full scale) (full scale = 690 V)
Total Power	
Real, Reactive, and Apparent Power	0.075% of reading + 0.025% of full scale
True Power Factor	±0.002 from 0.500 leading to 0.500 lagging
Energy and Demand	ANSI C12.20 0.2 Class, IEC 62053-22 0.2 Class
Frequency	
50/60Hz	±0.01 Hz at 45–67 Hz
400 Hz	±0.10 Hz at 350–450 Hz
Time of Day Clock/Calendar (at 25°C) ④	Less than ±1.5 seconds in 24 hours (1 ms resolution)
METERING INPUT ELECTRICAL SPECIFICATIONS	
Current Inputs	
Nominal	5.0 A rms
Metering Over-range	400% (20 A maximum)
Overcurrent Withstand	40 A rms Continuous 100 A rms 10 seconds in 1 hour 500 A rms 1 second in 1 hour
Input Impedance	Less than 0.1 Ohm
Burden	Less than 0.15 VA
Analog-to-Digital Converter Resolution	16 bits
Anti-aliasing Filters	50 dB attenuation at 1/2 sample rate

Table A–1: Specifications for CM4250 *(continued)*

Voltage Inputs ⑤	
Nominal Full Scale	400 Vac Line to Neutral, 690 Line to Line
Metering Over-range	50%
Input Impedance	Greater than 5 MegaOhm
Measurement overvoltage category	CATIV - up to 2000 m
	CATIII - from 2000-3000 m
CONTROL POWER INPUT SPECIFICATIONS	
AC Control Power	
Operating Input Range	90–305 Vac
Burden, maximum	50 VA
Frequency Range	45–67 Hz, 350–450 Hz
Isolation	2400 V, 1 minute
Ride-through on Power Loss	0.1 second at 120 Vac
DC Control Power	
Operating Input Range	100–300 Vdc
Burden	30 W maximum
Isolation	3400 Vdc, 1 minute
Ride-through on Power Loss	0.1 second at 120 Vdc
Overvoltage Category	II per IEC 1010-1, second edition
ENVIRONMENTAL SPECIFICATIONS	
Operating Temperature	
Meter and Optional Modules	–25° to +70°C maximum (See information about operating temperature of the circuit monitor in “Display Mounting” on page 19.)
Remote Display	VFD model is –20 to +70°C LCD model is –20 to +60°C
Storage Temperature	
Meter and Optional Modules	–40 to +85°C (ADD Standard)
Remote Display	VFD model is –40 to +85°C LCD model is –30 to +80°C
Humidity Rating	5–95% Relative Humidity (non-condensing) at 40°C
Pollution Degree	II per IEC 1010-1
Altitude Range	0 to 3,000 m (10,000 ft)
Physical Specifications	
Weight (approximate, without add-on modules)	4.2 lb (1.90 kg)
Dimensions	See “Circuit Monitor Dimensions” on page 12.
REGULATORY/STANDARDS COMPLIANCE	
Electromagnetic Interference	
Radiated Emissions	FCC Part 15 Class A/EN550 II Class A
Conducted Emissions	FCC Part 15 Class A/EN550 II Class A
Electrostatic Discharge (Air Discharge)	IEC 1000-4-2 level 3
Immunity to Electrical Fast Transient	IEC 1000-4-4 level 3
Immunity to Surge (Impulse Wave)	IEC 1000-4-5 level 4 (up to 6 kv) on voltage inputs
Voltage dips and interrupts	IEC 1000-4-11
Conducted immunity	IEC 1000-4-6
Dielectric Withstand	UL 508, CSA C22.2-14-M1987, EN 61010
Immunity to Radiated Fields	IEC 61000-4-3

Table A–1: Specifications for CM4250 *(continued)*

Accuracy	ANSI C12.20, IEC 687 Class 0.2, IEC62053-22 Class 0.2
IEC 61000-4-8	Magnetic fields 30 A/m
Product Standards	
USA	UL 508, IEC61000-4-7
Canada	CSA C22.2-2-4-M1987
Europe	CE per low voltage directive EN 61010, IEC61000-4-30
Listings	CUL and UL Listed 18X5 Ind Cont. Eq.
KYZ SPECIFICATIONS	
Load voltage	240 Vac, 300 Vdc maximum
Load current	100 mA maximum at 25°C ⑥
ON resistance	35 ohms maximum
Leakage current	0.03 µA (typical)
Turn ON/OFF time	3 ms
Input or output isolation	3750 V rms

①All values are in rms unless otherwise noted.

②Based on 1-second update rate. Does not apply to 100ms readings.

③Any CT secondary currents less than 5 mA fundamental are reported as zero.

④If higher precision is required, a GPS option is available. See “Digital Inputs” in the reference manual for more information.

⑤Any voltage input to the meter that is below 1.0 V fundamental is reported as zero.

⑥Derate load current 0.56 mA/°C above 25°C.

CM4000T SPECIFICATIONS

Table A–2: Specifications for CM4000T

METERING SPECIFICATIONS	
Current Inputs (Each Channel)	
Current Range	0–10 A ac
Nominal Current	5 A ac
Voltage Inputs (Each Channel)	
Voltage Range	0–600 Vac Line to Line, 347 Line to Neutral
Nominal Voltage (typical)	120 Vac
Impulsive Voltage	
Impulse Sampling Frequency	15 MHz, 5 MHz per channel (3 voltage channels)
Impulse Range	0 to 5,000 volts (peak) L-N
	0 to 10,000 volts (peak) L-L
Impulse Resolution	12 bits, 2.0 volts
Impulse Accuracy	±5% of reading
Frequency Range	45–67 Hz, 350–450 Hz
Harmonic Response—Phase Voltages and Currents	
Frequency 45–67 Hz	255th Harmonic
Frequency 350–450 Hz	31st Harmonic
Data Update Rate	Approximately 1-second update of all real-time readings for demand and energy calculations (100 ms update for some real-time readings).
Accuracy ①	
Current (measured) ②	
• Phase Amperes and Neutral Amperes	Current = 0.04% of reading + 0.025% full scale
Voltage	0.04% of reading + 0.025% full scale
Power	
• Real, Reactive, and Apparent Power	0.075% of reading + 0.025% of full scale
True Power Factor	±0.002 from 0.500 leading to 0.500 lagging
Energy and Demand	ANSI C12.20 0.2 Class, IEC 687 0.2 Class
Frequency	
• 50/60Hz	±0.01 Hz at 45–67 Hz
• 400 Hz	±0.10 Hz at 350–450 Hz
Time of Day Clock/Calendar (at 25°C)	Less than ±1.5 seconds in 24 hours (1 ms resolution)
METERING INPUT ELECTRICAL SPECIFICATIONS	
Current Inputs	
Nominal	5.0 A rms
Metering Over-range	100% (10 A maximum)
Overcurrent Withstand	15 A rms Continuous
	50 A rms 10 seconds in 1 hour
	500 A rms 1 second in 1 hour
Input Impedance	Less than 0.1 Ohm
Burden	Less than 0.15 VA
Voltage Inputs④	
Nominal Full Scale	347 Vac Line to Neutral, 600 Line to Line
Metering Over-range	50%
Input Impedance	Greater than 2 Megohm (L-L), 1 Megohm (L-N)

Table A–2: Specifications for CM4000T *(continued)*

CONTROL POWER INPUT SPECIFICATIONS	
120/240 Vac Nominal	
Operating Input Range	90–305 Vac
Burden, maximum	50 VA
Frequency Range	45–67 Hz, 350–450 Hz
Isolation	2300 V, 1 minute
Ride-through on Power Loss	0.1 second at 120 Vac
125/250 Vdc Nominal	
Operating Input Range	100–300 Vdc
Burden	30 W maximum
Isolation	3250 Vdc, 1 minute
Ride-through on Power Loss	0.1 second at 120 Vdc
Mains Supply Voltage Fluctuations	not to exceed ±10%
ENVIRONMENTAL SPECIFICATIONS	
Operating Temperature	
Meter and Optional Modules	–25° to +65°C maximum (See information about operating temperature of the circuit monitor in "Mounting Considerations" on page 13.)
Remote Display	VFD model is –20 to +70°C LCD model is –20 to +60°C
Storage Temperature	
Meter and Optional Modules	–40 to +85°C
Remote Display	VFD model is –40 to +85°C LCD model is –30 to +80°C
Humidity Rating	5–95% Relative Humidity (non-condensing) at 40°C
Pollution Degree	UL840, IEC 1010-1 (Class 2)
Installation Category	UL508, IEC 1010-1 (Class 2)
Altitude Range	0 to 2,000 m (6,561.68 ft)
Physical Specifications	
Weight (approximate, without add-on modules)	4.2 lb (1.90 kg)
Dimensions	See "Circuit Monitor Dimensions" on page 12.
REGULATORY/STANDARDS COMPLIANCE	
Electromagnetic Interference	
Radiated Emissions	FCC Part 15 Class A/CE heavy industrial
Conducted Emissions	FCC Part 15 Class A/CE heavy industrial
Electrostatic Discharge (Air Discharge)	IEC pub 1,000-4-2 level 3
Immunity to Electrical Fast Transient	IEC pub 1,000-4-4 level 3
Immunity to Surge (Impulse Wave)	IEC pub 1,000-4-5 level 4
Dielectric Withstand	UL 508, CSA C22.2-14-M1987, EN 61010
Immunity to Radiated Fields	IEC pub 61000-6-2
Accuracy	ANSI C12.20 and IEC 687 Class 0.2
Safety	
USA	UL 508
Canada	CSA C22.2-2-4-M1987
Europe	CE per low voltage directive EN 61010, IEC61000-4-15
Listings	cUL and UL Listed 18X5 Ind Cont. Eq.

Table A–2: Specifications for CM4000T *(continued)*

KYZ SPECIFICATIONS	
Load voltage	240 Vac, 300 Vdc maximum
Load current	96 mA maximum
ON resistance	50 ohms maximum
Leakage current	0.03 μA (typical)
Turn ON/OFF time	3 ms
Input or output isolation	3750 V rms

① Based on 1-second update rate. Does not apply to 100ms readings.
② Any CT secondary currents less than 5 mA are reported as zero.
③ If higher precision is required, see “Digital Inputs” in the reference manual for more information.
④ Any voltage input to the meter that is below 1.0 V is reported as zero.

CM4000 SPECIFICATIONS

Table A–3: Specifications for CM4000

METERING SPECIFICATIONS	
Current Inputs (Each Channel)	
Current Range	0–10 A ac
Nominal Current	5 A ac
Voltage Inputs (Each Channel)	
Voltage Range	0–600 Vac Line to Line, 347 Line to Neutral
Nominal Voltage (typical)	120 Vac
Frequency Range	45–67 Hz, 350–450 Hz
Harmonic Response—Phase Voltages and Currents	
Frequency 45–67 Hz	255th Harmonic
Frequency 350–450 Hz	31st Harmonic
Data Update Rate	Approximately 1-second update of all real-time readings for demand and energy calculations (100 ms update for some real-time readings).
Accuracy ①	
Current (measured) ②	
Phase Amperes and Neutral Amperes	±(0.04% of reading + 0.025% full scale)
Voltage	±(0.04% of reading + 0.025% full scale)
Power	
Real, Reactive, and Apparent Power	0.075% of reading + 0.025% of full scale
True Power Factor	±0.002 from 0.500 leading to 0.500 lagging
Energy and Demand	ANSI C12.20 0.2 Class, IEC 687 0.2 Class
Frequency	
50/60Hz	±0.01 Hz at 45–67 Hz
400 Hz	±0.10 Hz at 350–450 Hz
Time of Day Clock/Calendar (at 25°C) ③	Less than ±1.5 seconds in 24 hours (1 ms resolution)
METERING INPUT ELECTRICAL SPECIFICATIONS	
Current Inputs	
Nominal	5.0 A rms
Metering Over-range	100% (10 A maximum)
Overcurrent Withstand	15 A rms Continuous 50 A rms 10 seconds in 1 hour 500 A rms 1 second in 1 hour
Input Impedance	Less than 0.1 Ohm
Burden	Less than 0.15 VA
Voltage Inputs ④	
Nominal Full Scale	347 Vac Line to Neutral, 600 Line to Line
Metering Over-range	50%
Input Impedance	Greater than 2 MegaOhm

Table A–3: Specifications for CM4000 *(continued)*

CONTROL POWER INPUT SPECIFICATIONS	
120/240 Vac Nominal	
Operating Input Range	90–305 Vac
Burden, maximum	50 VA
Frequency Range	45–67 Hz, 350–450 Hz
Isolation	2300 V, 1 minute
Ride-through on Power Loss	0.1 second at 120 Vac
125/250 Vdc Nominal	
Operating Input Range	100–300 Vdc
Burden	30 W maximum
Isolation	3250 Vdc, 1 minute
Ride-through on Power Loss	0.1 second at 120 Vdc
Mains Supply Voltage Fluctuations	not to exceed ±10%
ENVIRONMENTAL SPECIFICATIONS	
Operating Temperature	
Meter and Optional Modules	–25° to +70°C maximum (See information about operating temperature of the circuit monitor in “Mounting Considerations” on page 13.)
Remote Display	VFD model is –20 to +70°C LCD model is –20 to +60°C
Storage Temperature	
Meter and Optional Modules	–40 to +85°C
Remote Display	VFD model is –40 to +85°C LCD model is –30 to +80°C
Humidity Rating	5–95% Relative Humidity (non-condensing) at 40°C
Pollution Degree	II per IEC 1010-1
Installation Category	II per IEC 1010-1
Altitude Range	0 to 3,048 m (10,000 ft)
Physical Specifications	
Weight (approximate, without add-on modules)	4.2 lb (1.90 kg)
Dimensions	See “Circuit Monitor Dimensions” on page 12.
REGULATORY/STANDARDS COMPLIANCE	
Electromagnetic Interference	
Radiated Emissions	FCC Part 15 Class A/EN550 II Class A
Conducted Emissions	FCC Part 15 Class A/EN550 II Class A
Electrostatic Discharge (Air Discharge)	IEC 1000-4-2 level 3
Immunity to Electrical Fast Transient	IEC 1000-4-4 level 3
Immunity to Surge (Impulse Wave)	IEC 1000-4-5 level 4
Voltage dips and interrupts	IEC 1000-4-11
Conducted immunity	IEC 1000-4-6
Dielectric Withstand	UL 508, CSA C22.2-14-M1987, EN 61010
Immunity to Radiated Fields	IEC 61000-4-3
Accuracy	ANSI C12.20 and IEC 687 Class 0.2
Product Standards	
USA	UL 508
Canada	CSA C22.2-2-4-M1987
Europe	CE per low voltage directive EN 61010
Listings	cUL and UL Listed 18X5 Ind Cont. Eq.

Table A–3: Specifications for CM4000 *(continued)*

KYZ SPECIFICATIONS	
Load voltage	240 Vac, 300 Vdc maximum
Load current	100 mA maximum at 25°C ⑤
ON resistance	35 ohms maximum
Leakage current	0.03 µA (typical)
Turn ON/OFF time	3 ms
Input or output isolation	3750 V rms

①Based on 1-second update rate. Does not apply to 100ms readings.

②Any CT secondary currents less than 5 mA are reported as zero.

③If higher precision is required, see “Digital Inputs” in the reference manual for more information.

④Any voltage input to the meter that is below 1.0 V is reported as zero.

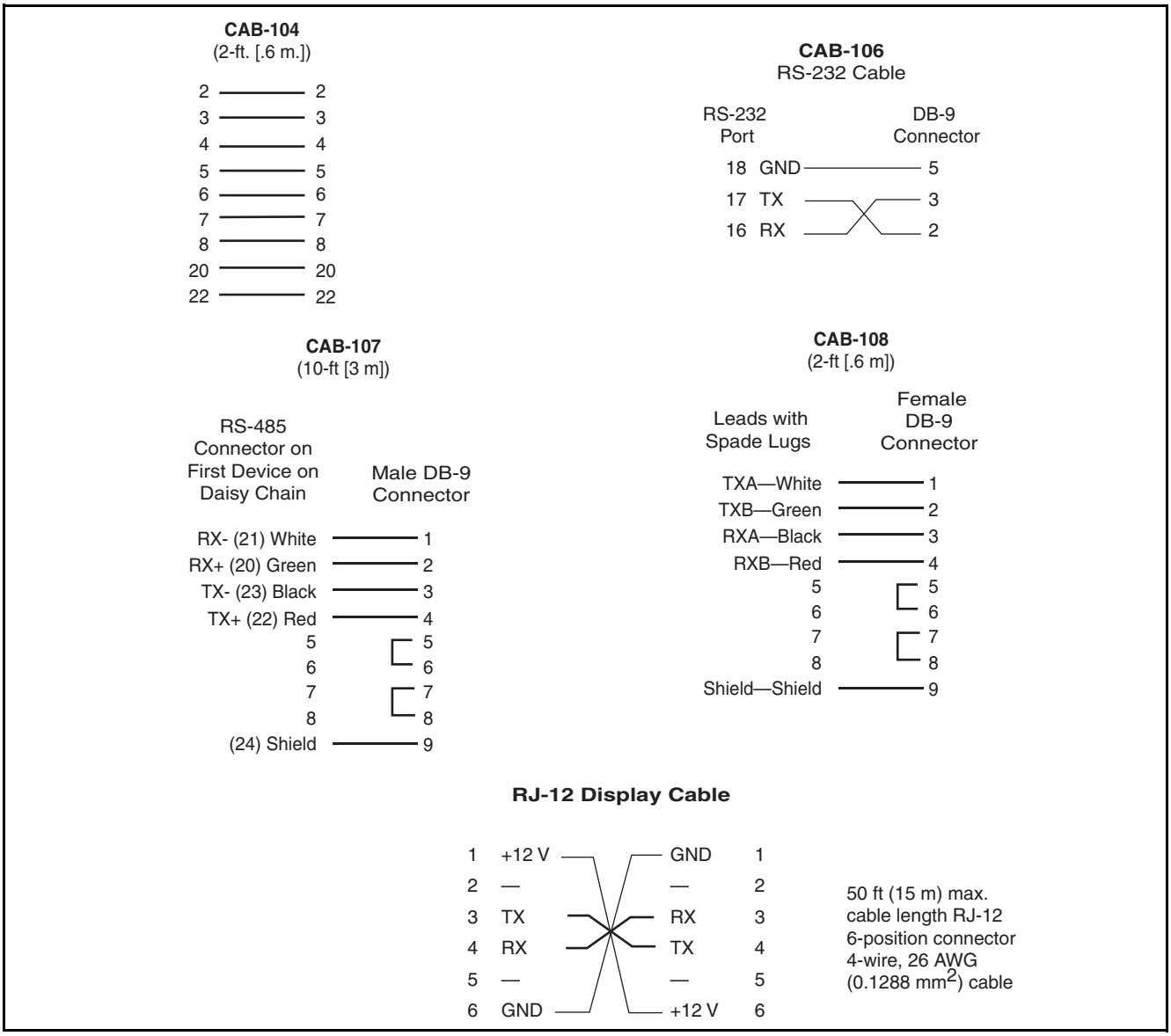
⑤Derate load current 0.56 mA/°C above 25°C.

APPENDIX B—PINOUTS

CABLE PINOUTS

This appendix contains pinouts for circuit monitor and display connections.

Figure B–1: Cable Pinouts



GLOSSARY

accumulated energy—energy can accumulate in either signed or unsigned (absolute) mode. In signed mode, the direction of power flow is considered and the accumulated energy magnitude may increase and decrease. In absolute mode, energy accumulates as a positive regardless of the power flow direction.

address—see *device address*. See also *Ethernet address*.

ANSI—American National Standards Institute.

baud rate—specifies how fast data is transmitted across a network port.

block interval demand—power demand calculation method for a block of time and includes three ways to apply calculating to that block of time using the sliding block, fixed block, or rolling block method.

coincident readings—two readings that are recorded at the same time.

command interface—used to issue commands, such as reset commands, and to manually operate relays contained in registers 8000–8149.

communications link—a chain of devices, such as circuit monitors and power meters, that are connected by a communications cable to a communications port.

conditional energy—energy accumulates only when a certain condition occurs.

control power—provides power to the circuit monitor.

control power transformer (CPT)—transformer to reduce control power voltage to the meter.

crest factor (CF)—crest factor of voltage or current is the ratio of peak values to rms values.

current transformer (CT)—current transformer for current inputs.

current unbalance—percentage difference between each phase voltage with respect to the average of all phase currents.

current/voltage module—an interchangeable part of the circuit monitor where all metering data acquisition occurs.

default—a value loaded into the circuit monitor at the factory that you can configure.

demand—average value of a quantity, such as power, over a specified interval of time.

device address—defines where the circuit monitor (or other devices) reside in the power monitoring system.

displacement power factor (dPF)—cosine of the angle between the fundamental components of current and voltage, which represents the time lag between fundamental voltage and current.

Ethernet address—a unique number that identifies the device in the Ethernet network and is always written as combination of eleven numbers such as 199.186.195.23.

event—the occurrence of an alarm condition, such as *Undervoltage Phase A*, configured in the circuit monitor.

firmware—operating system within the circuit monitor.

frequency—number of cycles in one second.

fundamental—value of voltage or current corresponding to the portion of the signal at the power frequency (50, 60, or 400 Hz).

generic demand profile—up to 10 quantities on which any of the demand calculations can be performed (thermal demand, block interval demand, or synchronized demand). Two generic demand profiles can be set up in the circuit monitor.

harmonic power—difference between total power and fundamental power. A negative value indicates harmonic power flow out of the load. A positive value indicates harmonic power flow into the load.

harmonics—the circuit monitor stores in registers the magnitude and angle of individual harmonics up to the 63rd harmonic. Distorted voltages and currents can be represented by a series of sinusoidal signals whose frequencies are multipliers of some fundamental frequency, such as 60 Hz.

holding register—register that holds the next value to be transmitted.

IEC—International Electrotechnical Commission

incremental energy—accumulates energy during a user-defined timed interval.

IOX—input/output extender that is an optional part of the circuit monitor. Up to eight analog or digital I/O modules can be added to expand the I/O capabilities of the circuit monitor.

K-factor—a numerical rating used to specify power transformers for nonlinear loads. It describes a transformer's ability to serve nonlinear loads without exceeding rated temperature rise limits.

KYZ output—pulse output from a metering device where each pulse has a weight assigned to it which represents an amount of energy or other value.

LCD—liquid crystal display.

line-to-line voltages—measurement of the rms line-to-line voltages of the circuit.

line-to-neutral voltages—measurement of the rms line-to-neutral voltages of the circuit.

logging—recording data at user-defined intervals in the circuit monitor's nonvolatile memory.

maximum value—highest value recorded of the instantaneous quantity such as Phase A Current, Phase A Voltage, etc., since the last reset of the minimums and maximums.

minimum value—lowest value recorded of the instantaneous quantity such as Phase A Current, Phase A Voltage, etc., since the last reset of the minimums and maximums.

nominal—typical or average.

onboard—refers to data stored in the circuit monitor.

option cards—optional, field-installable accessories for the circuit monitor that expand the I/O and Ethernet communications capabilities.

overvoltage—increase in effective voltage to greater than 110 percent for longer than one minute.

parity—refers to binary numbers sent over the communications link. An extra bit is added so that the number of ones in the binary number is either even or odd, depending on configuration). Used to detect errors in the transmission of data.

partial interval demand—calculation of energy thus far in a present interval. Equal to energy accumulated thus far in the interval divided by the length of the complete interval.

peak demand current—highest demand current measured in amperes since the last reset of demand. See also *peak value*.

peak demand real power—highest demand real power measured since the last rest of demand.

peak demand voltage—highest demand voltage measured since the last reset of demand voltage. See also *peak value*.

peak demand—highest demand measured since the last reset of peak demand.

peak value—of voltage or current is the maximum or minimum crest value of a waveform.

phase currents (rms)—measurement in amperes of the rms current for each of the three phases of the circuit. See also *peak value*.

phase rotation—phase rotations refers to the order in which the instantaneous values of the voltages or currents of the system reach their maximum positive values. Two phase rotations are possible: A-B-C or A-C-B.

potential transformer (PT)—also known as a voltage transformer.

power factor (PF)—true power factor is the ratio of real power to apparent power using the complete harmonic content of real and apparent power. It is calculated by dividing watts by volt amperes. Power factor is the difference between the total power the utility delivers and the portion of total power that does useful work. Power factor is the degree to which voltage and current to a load are out of phase. See also *displacement power factor*.

predicted demand—the circuit monitor takes into account the energy consumption thus far in the present interval and the present rate of consumption to predict demand power at the end of the present interval.

quantity—a parameter that the circuit monitor can measure or calculate such as current, voltage, power factor, etc.

real power—calculation of the real power (3-phase total and per-phase real power calculated) to obtain kilowatts.

recloser sequence—a series of voltage sags caused by a utility breaker opening a number of consecutive times in an effort to clear a fault. See also *sag*/*swell*.

rms—root mean square. Circuit monitors are true rms sensing devices. See also *harmonics (rms*).

sag/swell—fluctuation (decreasing or increasing) in voltage or current in the electrical system being monitored. See also, *voltage sag* and *voltage swell*.

scale factor—multipliers that the circuit monitor uses to make values fit into the register where information is stored.

SMS—see System Manager Software.

synchronized demand—demand intervals in the circuit monitor that can be synchronized with another device using an external pulse, a command sent over communications, or the circuit monitor's internal real-time clock.

System Manager Software (SMS)—software designed by PowerLogic for use in evaluating power monitoring and control data.

system type—a unique code assigned to each type of system wiring configuration of the circuit monitor.

thermal demand—demand calculation based on thermal response.

TIF/IT—telephone influence factor used to assess the interference of power distribution circuits with audio communications circuits.

Total Harmonic Distortion (THD or thd)—indicates the degree to which the voltage or current signal is distorted in a circuit.

total power factor—*see power factor*.

transient—sudden change in the steady-state condition of voltage or current.

troubleshooting—evaluating and attempting to correct problems with the circuit monitor's operation.

true power factor—see *power factor*.

undervoltage—decrease in effective voltage to less than 90% for longer than one minute.

VAR—volt ampere reactive.

VFD—vacuum fluorescent display.

voltage interruption—complete loss of power where no voltage remains in the circuit.

voltage sag—a brief decrease in effective voltage lasting more than one minute.

voltage swell—increase in effective voltage for up to one minute in duration.

voltage transformer (VT)—see *potential transformer*.

voltage unbalance—percentage difference between each phase voltage with respect to the average of all phase voltages.

waveform capture—can be done for all current and voltage channels in the circuit monitor.

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63230-300-209B1 12/2005