Instruction Bulletin

63230-300-200
February 2000

POWERLOGIC® Circuit Monitor
Series 4000

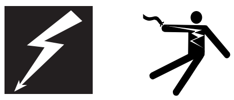
Retain for future use

Merlin Gerin
Modicon
Square D
Telemecanique

Schneider Electric

NOTICE

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. This document is not intended as an instruction manual for untrained persons. No responsibility is assumed by Square D for any consequences arising out of the use of this manual.

Class A FCC Statement

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 designated 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.

CONTENTS

LIST OF FIGURES

LIST OF TABLES

CHAPTER 1—INTRODUCTION

This chapter offers a general description of the Series 4000 Circuit Monitor, tells how to best use this bulletin, and lists related documents.

CHAPTER CONTENTS

WHAT IS THE CIRCUIT MONITOR?

The circuit monitor is a multifunction, digital instrumentation, data acquisition and control device. It can replace a variety of meters, relays, transducers and other components. The circuit monitor can be located at the service entrance to monitor the cost and quality of power, and can be used to evaluate the utility service. When located at equipment mains, the circuit monitor detects voltage-based disturbances that cause costly equipment downtime.

The circuit monitor is equipped with RS-485 and RS-232 communications for integration into any power monitoring and control system. However, System Manager™ software (SMS) from POWERLOGIC, which is 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. You can view over 50 metered values plus extensive minimum and maximum data from 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
Demand Readings	**Power Analysis Values**
• Demand Current (per-phase present, peak) • Demand Voltage (per-phase present, peak) • Average Power Factor (3-Phase total) • Demand Real Power (3-Phase total) • Demand Reactive Power (3-Phase total) • Demand Apparent Power (3-Phase total) • Coincident Readings • Predicted Demands	• Crest Factor (per phase) • K-Factor Demand (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 & Angles (per phase)

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 (CVM)**. A standard part of the circuit monitor is the current/voltage module where all metering data acquisition occurs.
- **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 and can be used to download firmware, which keeps the circuit monitor up to date with the latest system enhancements.
- **I/O Extender**. The I/O extender, located on the side of the circuit monitor, enables you to "plug in" up to 8 industry-standard inputs and outputs. Several preconfigured combinations are available, or you can create a custom configuration.
- **Digital I/O Card**. You can further expand the I/O capabilities of the circuit monitor by adding a digital I/O card (4 inputs and 4 outputs). This card fits into one of the option slots 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 outer option slot on the top of the circuit monitor.

Table 1–2 lists the circuit monitor parts and accessories and their associated instruction bulletins, which ship with the product and detail installation and use of the product.

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

Description	Part Number	Document Number
Circuit Monitor	CM4000	63230-300-200
Current/ Voltage Module	CVM	63230-301-200
VFD Display with infrared (IR) port and proximity sensor	CMDVF	63230-305-200
LCD Display	CMDLC	
Optical Communications Interface (for use with the VFD display only)	OCIVF	63230-306-200
I/O Extender Module ①		63230-302-200
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	IOX0404	
with 8 digital inputs (120 Vac)	IOX08	
Digital I/O Card Field installable with 4 digital inputs, 3 relay outputs, 1 pulse output (KYZ)	IOC44	63230-303-200
Ethernet Communications Card with 100 Mbps fiber or 10/100 Mbps UTP Ethernet port and 1 RS-485 master port	ECC21	63230-304-200
4-ft display cable	CAB-4	N/A
12-ft display cable	CAB-12	
30-ft display cable	CAB-30	

① For parts list of individual inputs and outputs, see Table 9–1 on page 122.

Features

Some of the circuit monitor's many features include:

- True rms metering to the 255th harmonic
- Accepts standard CT and PT inputs
- 600 volt direct connection on metering inputs
- Certified ANSI C12.20 revenue accuracy and IEC 687.2 class
- High accuracy—0.04% current and voltage
- Min/max readings of metered data
- Power quality readings—THD, K-factor, crest factor
- 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 where you can view metered values (password protected)
- Setpoint-controlled alarm and relay functions
- Onboard event 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 expanded, field-installable I/O and Ethernet capabilities
- Standard 8MB onboard memory (field upgradable to 16 MB, 32 MB, and higher
- CT and PT wiring diagnostics
- Revenue security with utility sealing capability

TOPICS NOT COVERED IN THIS BULLETIN

Some of the circuit monitor's advanced features, such as onboard data logs and event log files, can only be set up over the communications link using SMS. SMS versions 3.12 and higher support the CM4000 device type.This circuit monitor instruction bulletin describes these 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-3000 Setup Guide,* which is available in English (63220-060-200), French (63220-060-201), and Spanish (63220-060-202). For information about related instruction bulletins, see Table 1–2 on page 3.

CHAPTER 2—SAFETY PRECAUTIONS

This chapter 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, BURN, OR EXPLOSION

- Only qualified workers should install this equipment. Such work should be performed only after reading this entire set of instructions.
- NEVER work alone.
- 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, grounded, and tagged. Pay particular attention to the design of the power system. Consider all sources of power, including the possibility of backfeeding.
- 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.
- Beware of potential hazards, wear personal protective equipment, 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

Read this chapter to get a quick overview about what it takes to get your circuit monitor installed and operating.

CHAPTER CONTENTS

SETTING UP THE CIRCUIT MONITOR: QUICK START

The circuit monitor is shipped with factory default settings that give you the option to use the circuit monitor “right out of the box,” or you can customize it to suit your needs. At minimum, you must to do the following installation and setup steps to get the circuit monitor to meter properly:

⚠ DANGER

HAZARD OF ELECTRIC SHOCK, BURN, OR EXPLOSION

- 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.

1. **Mount the hardware.**
   See **Chapter 4—Installation** 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.**
   See **Chapter 4—Wiring** on page 29.
   a. Wire the circuit monitor.
   b. Wire the communications.
   c. Wire any inputs and outputs. (See the instructions that ship with the I/Os for wiring instructions.)

3. **Set up communications and the meter.**
   At minimum, you must set up these parameters:
   - Address, baud rate, and parity for the selected communications port
   - CT primary and secondary
   - PT primary and secondary
   - System type
   - Frequency

   If you are using SMS, do the following:

   a. From the display, set up the address, baud rate, and parity. See “Setting Up the Communications” on page 77 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 79 for details.

4. **Initiate a wiring error test from the circuit monitor display.**
   See “Wiring Error Detection” on page 51 for instructions.

FACTORY DEFAULTS

The circuit monitor is preconfigured with the following features enabled:

- On-board event log will record 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 will record 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	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
Demand Current	A, B, C, N, Average
Power Demand	kWd, kVARd, kVAd
THD Current	A, B, C, N, G
THD Voltage L–N	A, B, C
THD Voltage L–L	A-B, B-C, C-A

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

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 will automatically perform 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.
- 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.

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
THD Voltage L-N	A, B, C
THD Voltage L-L	A-B, B-C, C-A

- The on-board alarms listed in Table 3–4 have also been enabled.

Table 3–4: Enabled on-board alarms

Alarm	Alarm No.	Pickup	Pickup delay	Dropout	Dropout Delay	Priority	Action
Voltage Sag	Disturbance 4 to 6	13% (%relative)	2 cycles	10% (% relative)	4 cycles	Low	Disturbance WFC, Adaptive WFC, 100 ms Event
Over THD Voltage	Standard 37 to 42	5%	300 seconds	5%	300 seconds	Low	Disturbance WFC
Voltage Unbalance	Standard 22 to 23	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.

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 monitors are installed:

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

For more information, see the SMS online help file.

CHAPTER 4—INSTALLATION

This chapter describes the parts of the circuit monitor and its accessories and explains how to install the circuit monitor and display. It also describes how to replace the current/voltage module (CVM) and how to activate revenue security.

NOTE: For wiring instructions, see **Chapter 5—Wiring** *on page 31. To make the communications connections, see* **Chapter 6—Communications Connections** *on page 57.*

CHAPTER CONTENTS

CIRCUIT MONITOR INSTALLATION

This section describes the circuit monitor hardware, provides dimensional drawings, and explains how to mount the circuit monitor.

Description

Figure 4–1 shows the parts of the circuit monitor. A brief description of each part follows in Table 4–1 on page 13.

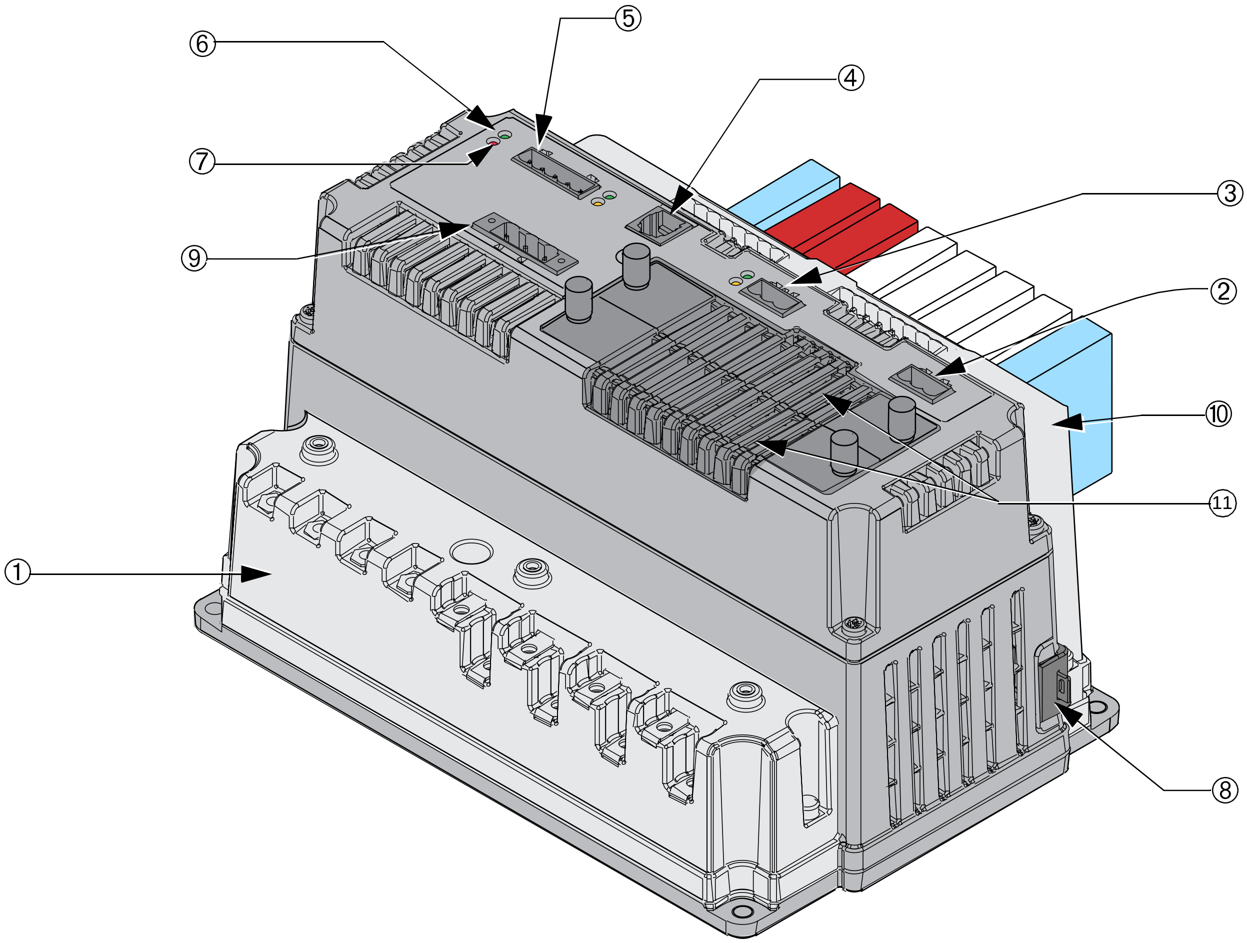


Figure 4–1 Parts of the Series 4000 Circuit Monitor

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 (CVM), which plugs directly into the main housing of the circuit monitor. All metering data is acquired through the CVM. Because the CVM is removable, it can be easily interchanged with enhanced current/voltage modules as they become available without removing the entire circuit monitor.
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-45 display comms port	The RJ-45 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 to 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).
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 27 for details. This door also lets you access the memory chip for upgrading the circuit monitor’s memory. See “Upgrading Memory in the Circuit Monitor” on page 177 for details.
⑨ Control power supply connector	Connection for control power to the circuit monitor.
⑩ I/O Extender ▲	Optional, external field-installable I/O accessory that lets you expand the input and output capabilities of the circuit monitor. The I/O extender plugs directly into the main housing of the circuit monitor and holds up to 8 individual plug-on digital or analog I/O points. Many combinations of inputs and outputs can be configured. Standard modules are available, or you can select other combinations of inputs and outputs and field-install the pluggable I/Os.
⑪ Option card slots ▲	Optional cards fit in the two slots provided on the top of the circuit monitor, a digital I/O card (outputs rated up to 10 A) and an Ethernet communications card.

✦ See Table 14–1 on page 179 in the maintenance chapter for more about the LEDs on the circuit monitor.
▲ See “I/O Position Numbers” on page 240 for a description of the labels on the inputs and outpus.

Dimensions

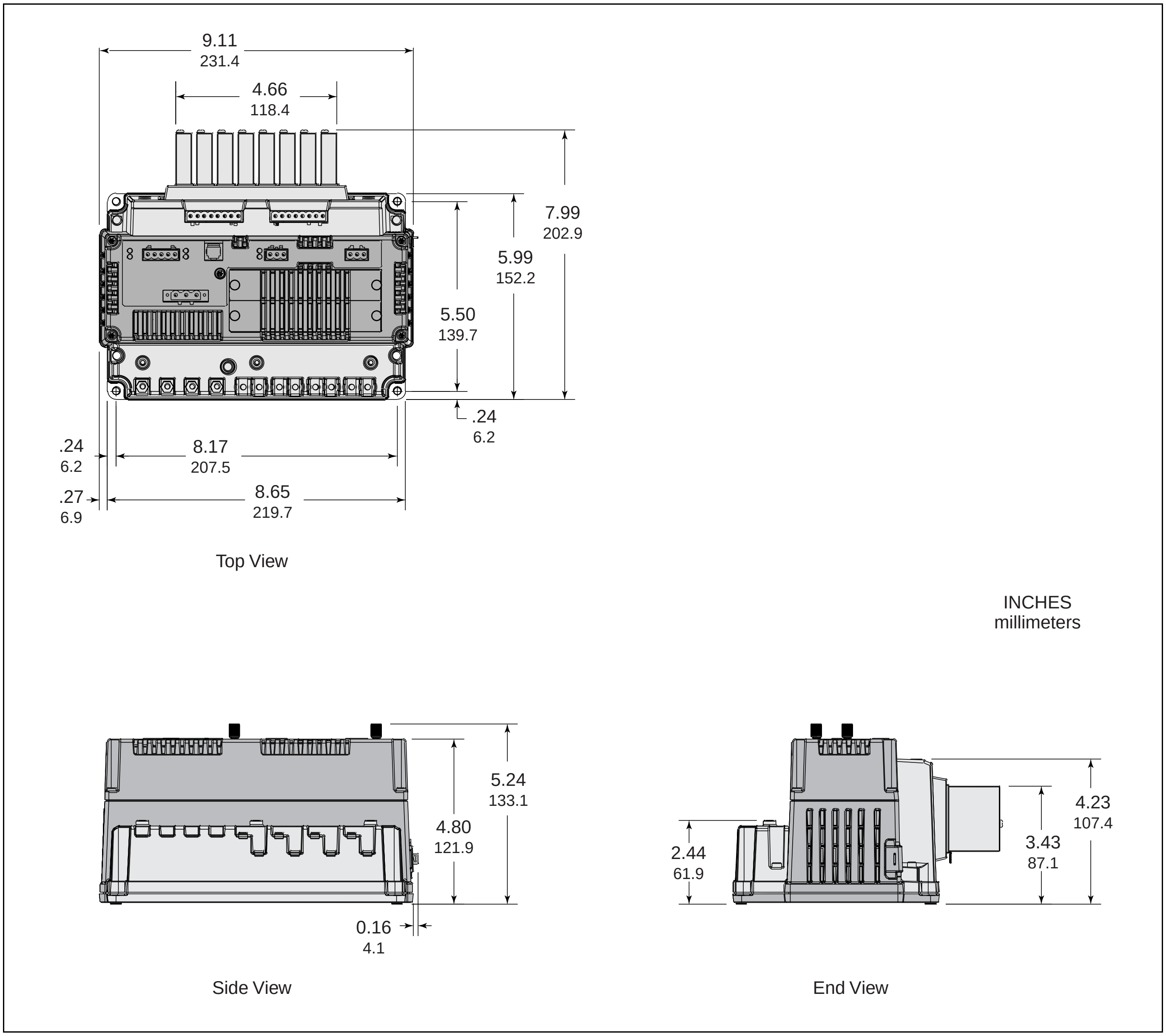


Figure 4–2 Circuit monitor dimensions

Mounting

Before mounting the circuit monitor, understand all mounting considerations described in the following section.

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, shorting blocks, accessories, or other components. Make sure to route the wires so that they do not cover the option cards, removable modules, or cooling vents on the circuit monitor. Refer to Table 4–2 on page 16 for required clearances.
- For CE compliance, see “Required Protection for CE Compliance” on page 33.
- The circuit monitor can be mounted horizontally or vertically to any side of an equipment enclosure or wall. The recommended orientation is to mount it vertically, making sure the control power connector is towards the top (see Figure 4–3).

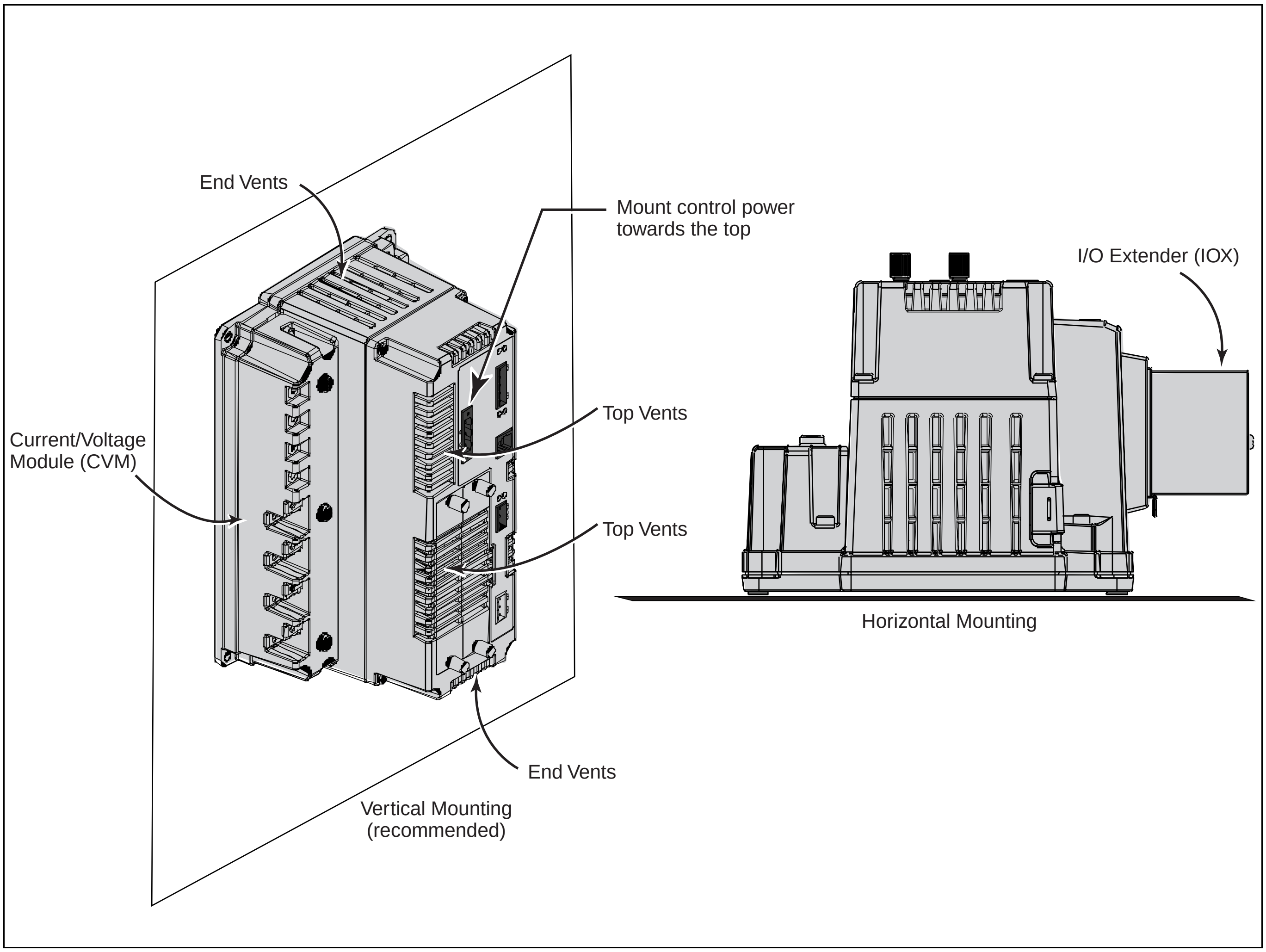


Figure 4–3 Possible ways to orient the circuit monitor

CAUTION

IMPROPER VENTILATION

- Do not mount the circuit monitor to a ceiling (A) or in vertical orientations shown in Figure 4–4 (B, C and D).
- Provide the following clearances around the circuit monitor as described in Table 4–2:

Failure to follow these instructions can result in equipment damage.

Table 4–2: Clearance Requirements

	Vertical		Horizontal	
Max. Ambient Temperature	**≤ 50°C**	**> 50 °C**	**≤ 50°C**	**> 50 °C**
Mounting Orientation				
Side Vents	1.0 in (25 mm)	3.0 in (76 mm)	1.0 in (25 mm)	2.0 in (51 mm)
Top Vents	1.0 in (25 mm)	2.0 in (51 mm)	2.0 in (51 mm)	3.0 in (76 mm)
Current/Voltage Module (CVM) ①	0.5 in (13 mm)	1.0 in (25 mm)	0.5 in (13 mm)	1.0 in (25 mm)
I/O Extender (IOX)	2.5 in (64 mm)	3.0 in (76 mm)	2.5 in (64 mm)	3.0 in (76 mm)

①Add 1.0 in (25 mm) to CVM clearances to accommodate possible future installation of Current/Voltage Module (CVMT) with transient detection.

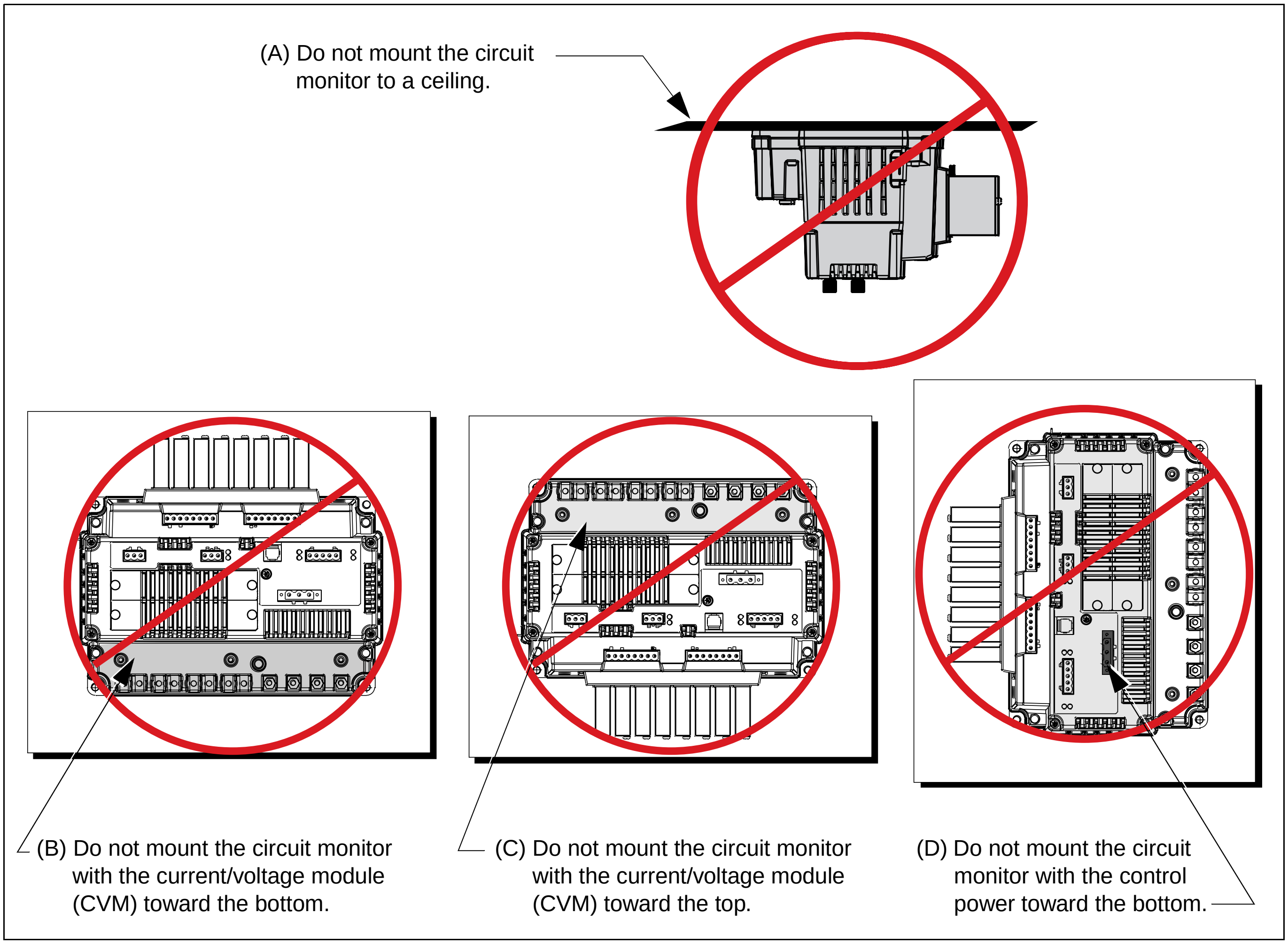


Figure 4–4 Incorrect mounting of the circuit monitor

- 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	CM4000 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

① No 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.
② Ambient 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, 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.

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 15.
2. Tape the mounting template, included in the circuit monitor shipping carton, to the selected location. Refer to Figure 4–5 on page 18.
3. Making sure wires or equipment on the inside of the enclosure will not be damaged, drill four .225 in (5.72 mm) diameter mounting holes in location "A" marked on the template. Remove 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 4–5 on page 18, secure the circuit monitor. Using the (M4 x 10 mm) thread-forming mounting screws provided in the circuit monitor hardware kit no. 63230-300-25, 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).

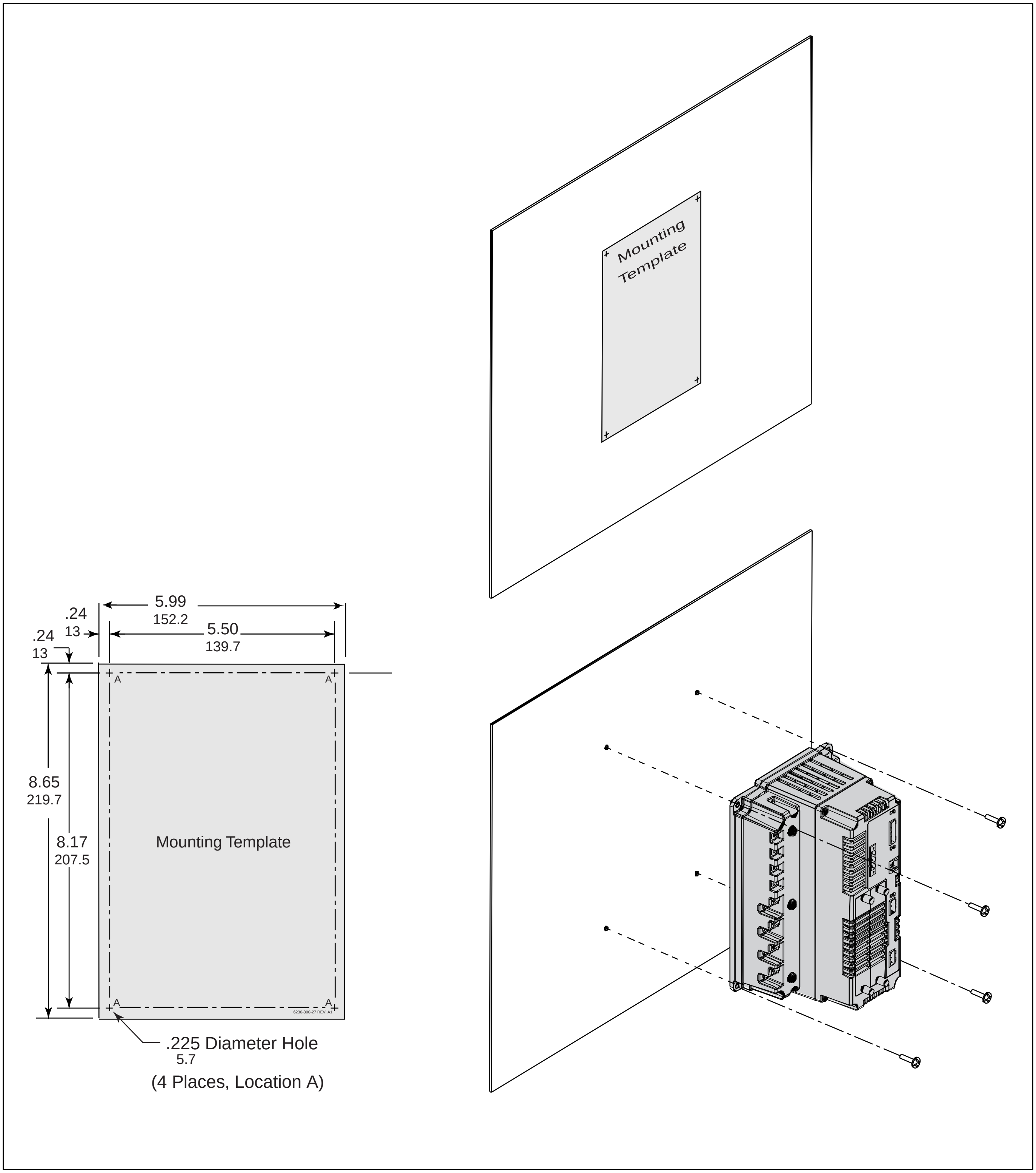


Figure 4–5 Circuit monitor mounting hole dimensions and locations

DISPLAY INSTALLATION

This section describes the display, provides dimensional drawings, and explains how to mount it. Operating the circuit monitor from the display is described in **Chapter 7—Operation** on page 71.

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. The display includes a viewing area to display information, a red alarm LED, four buttons used to enter and select information, and a contrast button. Table 4–4 describes the parts of the display. Two display models are available:

- LCD display (see Figure 4–6)
- VFD display has an additional proximity sensor and infrared port (see Figure 4–6)

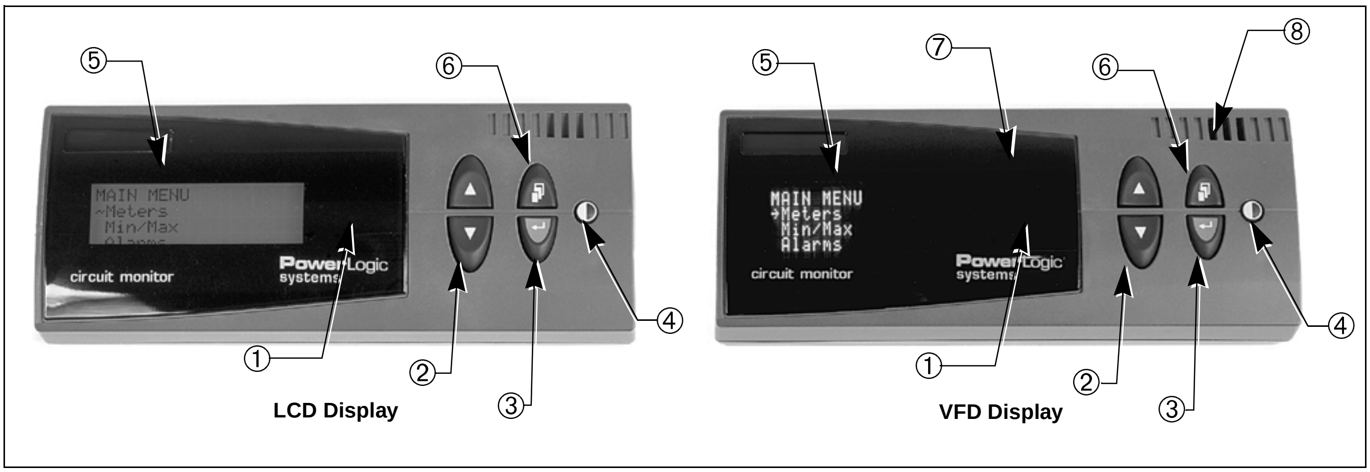


Figure 4–6 LCD and VFD Displays

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 reader (OCIVDF) and a laptop (VFD display only).
⑧ Proximity sensor	Detects when you are approaching and lights up the display and buttons (VFD display only).

Dimensions

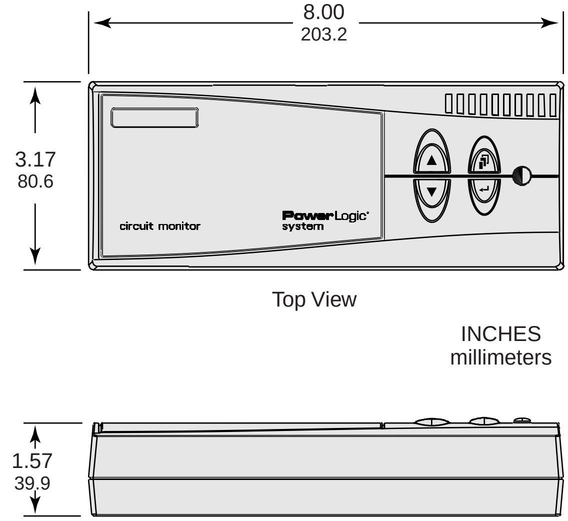


Figure 4–7 Display dimensions

Mounting

Before mounting the display, read the following 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 **Appendix B—Specifications** on page 231.
- 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 4–7).
- Use the four mounting screws (M3.5 x 10mm Phillips pan-head threaded screws) provided in the display hardware kit (no. 63230-305-22). If using screws other than those provided, the screws can be no longer than .25 in. (6.35 mm) long plus the panel thickness. For example, if the panel is .090 in. thick, the screw is to be a maximum of .25 + .09 = .34 in. (6.35 + 2.29 = 8.64 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, BURN, OR EXPLOSION

- 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.
- Do not use mounting screws longer than .25 in. (6.35 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 (no. 63230-305-22) to the selected location. Refer to Figure 4–8.
3. Making sure wires or equipment on the inside of the enclosure will not be damaged, drill four 1.6 in. (40.6 mm) diameter mounting holes in location "A" marked on the template.
4. At the center of the template, drill or punch one hole that is one inch minimum to 2.25 inches maximum (25.4-57.2 mm) diameter through the panel. Remove the template. Smooth the edges of the hole to remove any sharp edges.

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

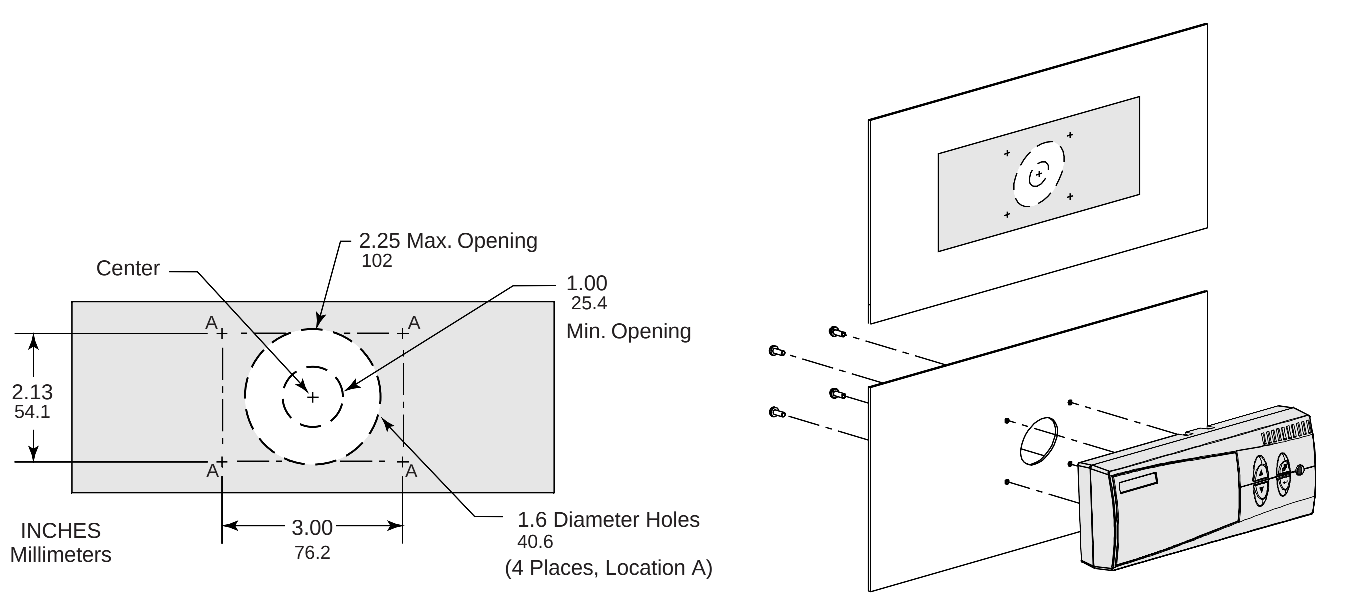


Figure 4–8 Display mounting hole dimensions and locations

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 (kit no. 63230-305-22) 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 RJ11 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 cable is provided, but 4-ft and 30-ft 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 4–9.

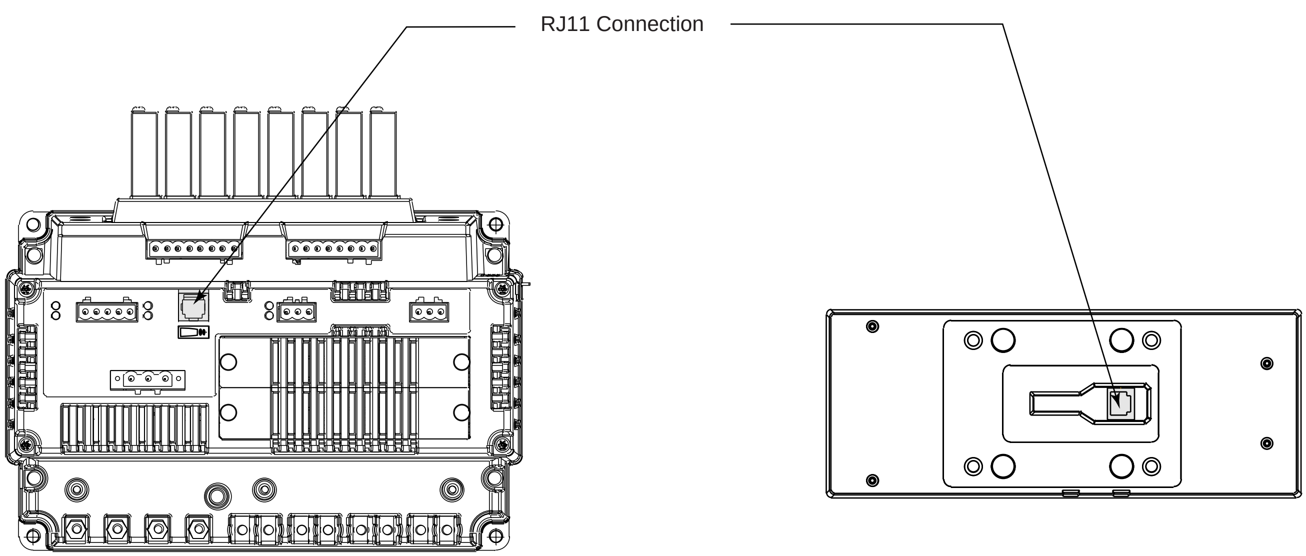


Figure 4–9 Display connection to the circuit monitor

RJ11 Display Cable Pinout

The pinout for the display cable and cable requirements are shown in Figure 4–10.

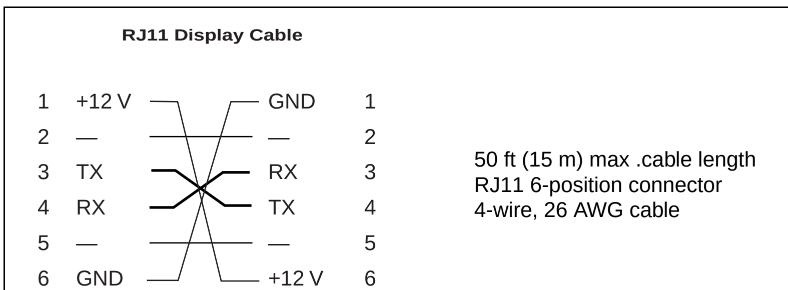


Figure 4–10 RJ11 display cable pinout

CURRENT / VOLTAGE MODULE (CVM)

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

Normally, the circuit monitor is calibrated at the factory at the time of manufacture and does not need to be recalibrated. However, in special cases where annual calibration is specified by the user, the CVM can be removed and sent to the factory for recalibration without removing the entire circuit monitor. If you need to do this, replace the CVM module (part no. CMV) with a spare while the other is being calibrated.

Replacing the CVM

To remove and reinstall the CVM, follow these instructions and refer to Figure 4–11 on page 24:

⚠ DANGER

HAZARD OF ELECTRIC SHOCK, BURN, OR EXPLOSION

Turn off all power supplying the circuit monitor and the equipment in which it is installed before working on it.

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

1. If the circuit monitor is connected to power, turn OFF all power to the circuit monitor. To do this:
   a. Disconnect the metered voltage by removing the fuses from the potential transformer (PT) or disconnecting the voltage disconnect switch.
   b. Short circuit the current transformer (CT) secondaries to disconnect the metered current.
   c. Remove the control power from the circuit monitor.
   d. Remove the terminal cover. See “Installing the Terminal Cover” on page 36 for instructions.

2. Loosen the three Torx socket-head screws of the CVM until they disengage.
3. Pull the CVM straight up until it disengages from the circuit monitor as shown in Figure 4–11.

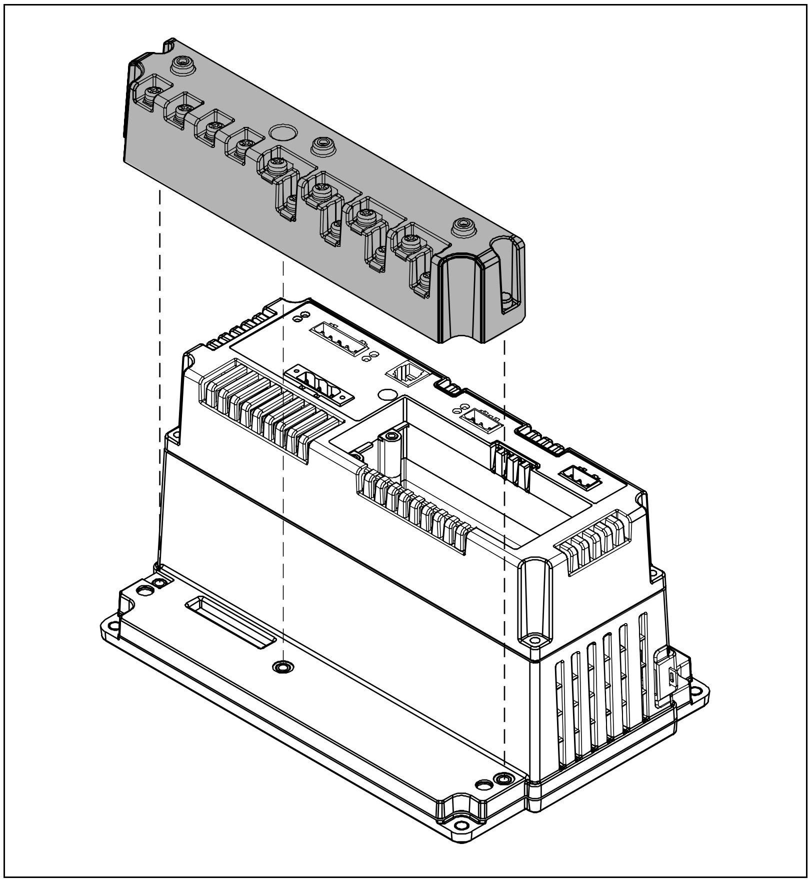


Figure 4–11 Removal of Current/Voltage Module (CVM)

4. Align the replacement CVM with the mounting holes on the circuit monitor.
5. Seat the CVM and tighten the three Torx socket-head screws until snug.
6. Re-install the fuses to the PT and reconnect the CT and PT leads.
7. Re-install the terminal cover.
8. Restore control 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 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 installation instructions, see document no. 63230-302-200 that ships with the product. Table 4–6 lists the options available with the I/O extender module.

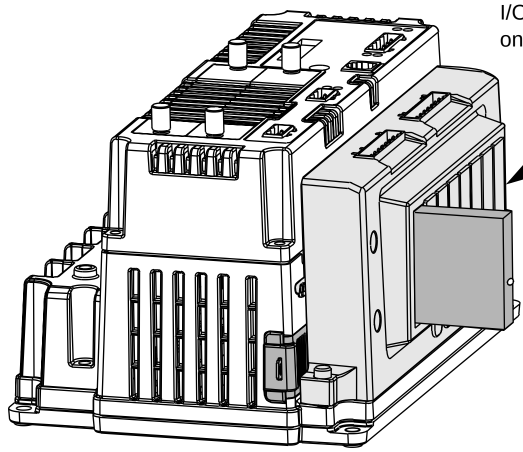


Figure 4–12 I/O Extender Module

Table 4–6: I/O 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, 3 relay (10 A) outputs, and 1 pulse output (KYZ)	IOC44
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	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	DO120AC
200 Vdc output	DO200DC
240 Vac output	DO240AC
60 Vdc output	DO60DC
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

Optional accessory 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 onboard Ethernet communications. Figure 4–13 shows the location of the accessory slots in the circuit monitor.

NOTE: The ECC (part no. ECC21) must be installed in the outermost slot (A) and only one ECC can be used per circuit monitor. Refer to document no. 63230-304-200 for ECC installation instructions. For the digital I/O card (part no. IOC44) installation instructions, see document no. 63230-303-200.

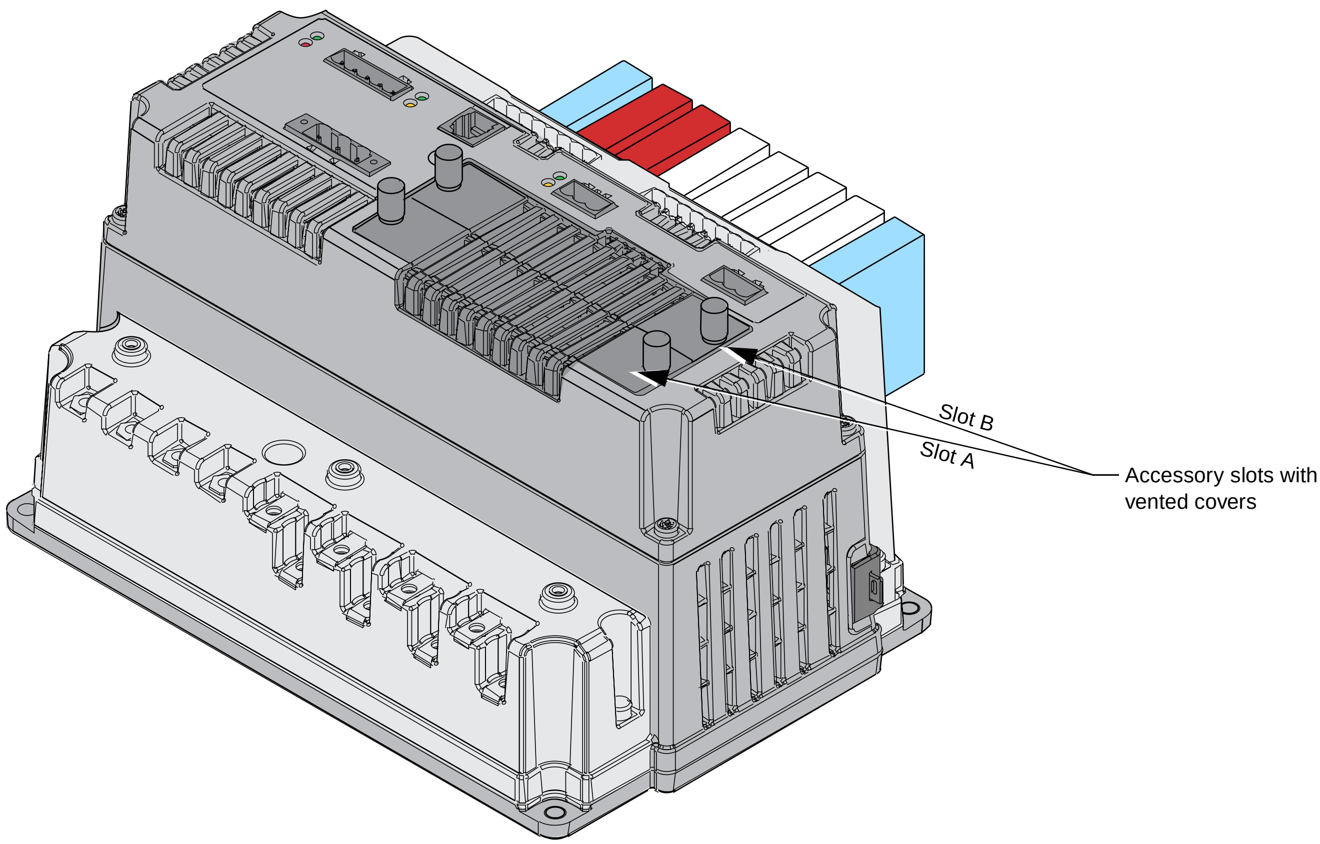


Figure 4–13 Location of vented slots for optional accessory cards

ACTIVATING REVENUE SECURITY

The access door, shown in Figure 4–14 on page 28, lets you access the revenue metering security switch. When you press this button, it locks set up of the circuit monitor so that the set up options of the circuit monitor cannot be changed from the display or over the communications link. In addition, you can attach a standard lead/wire seal to secure the door closed and to visually detect any tampering with the meter. The following information is locked when the security is enabled:

- 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
- Energy reset

This door also gives you access to the memory chip for upgrading memory. For information about upgrading memory, see “Upgrading Memory in the Circuit Monitor” on page 177 in **Chapter 14—Maintenance and Troubleshooting**.

To open the access door and enable security, follow these instructions. Control power to the circuit monitor must be ON to use this feature.

⚠ DANGER

HAZARD OF ELECTRIC SHOCK, BURN, OR EXPLOSION

- If control power is derived from a separate source, turn off all power to the equipment in which the circuit monitor is installed.
- If control power is derived internally from the metered voltages, beware of potential hazards, wear personal protective equipment, carefully inspect the work area for tools and objects that may have been left inside the equipment.
- Remove power to the individual I/O modules (if present).

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

1. Refering to Figure 4–14, remove the I/O extender module if present:
   a. Remove power to the individual I/O modules in the I/O extender module.
   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.

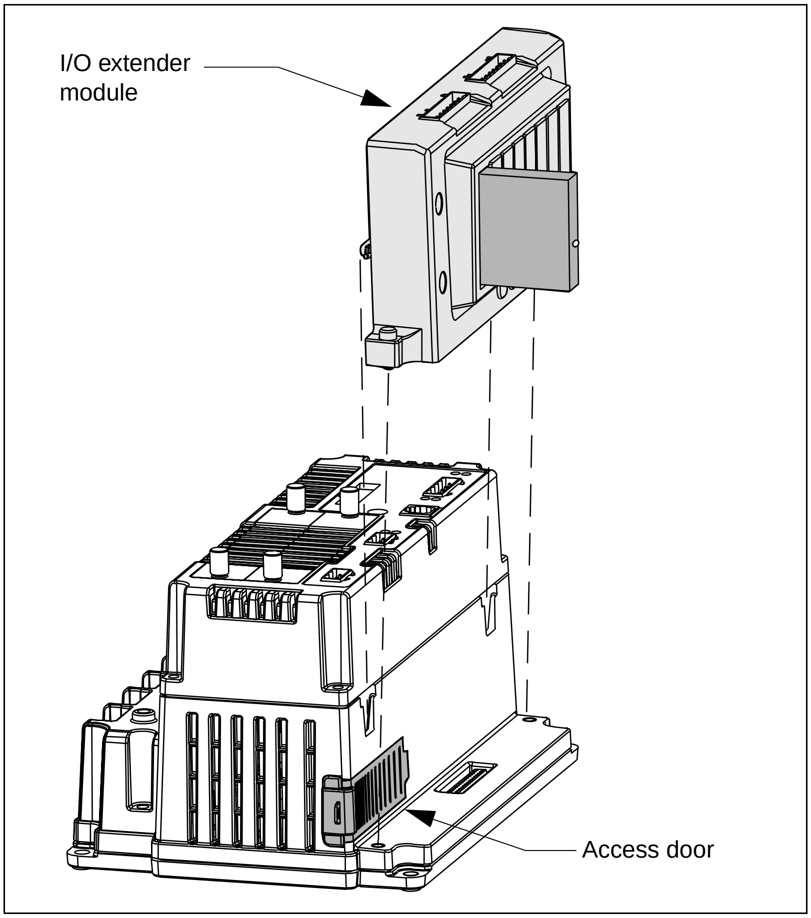


Figure 4–14 Removal of the I/O extender module

2. To open the door, refer to Figure 4–15. Slide the door along the side of the circuit monitor (A), then gently pull the door down to open it (B).

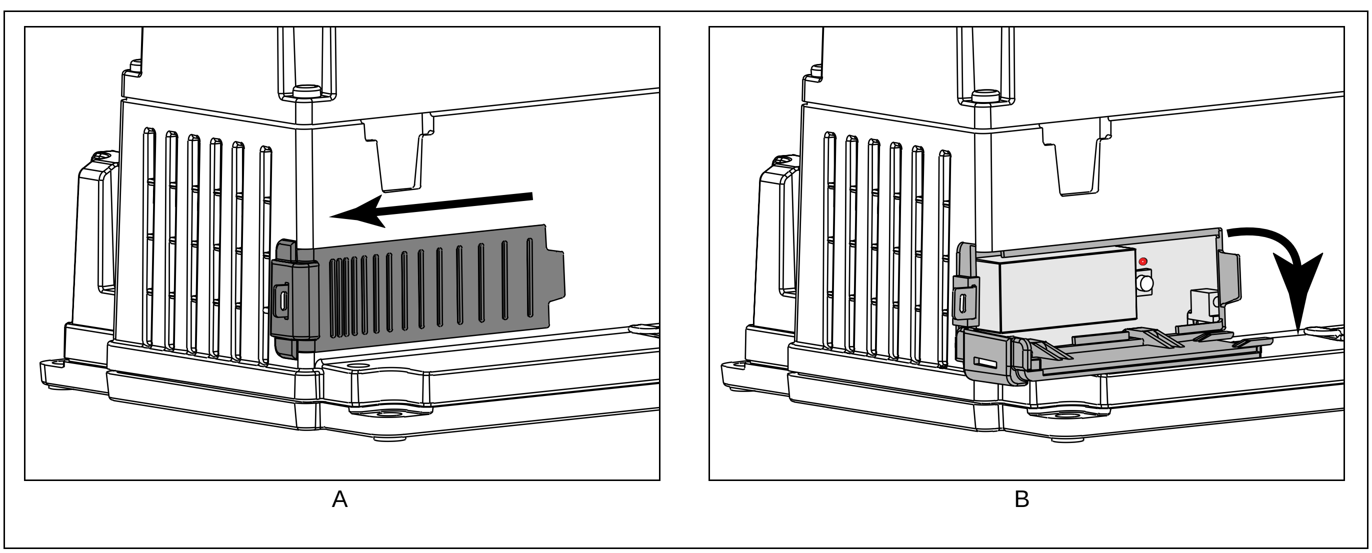


Figure 4–15 Opening the access door

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.

3. To discharge static, place one hand momentarily on any grounded metal surface, then press and hold the security button until the LED is lit (see Figure 4–16).

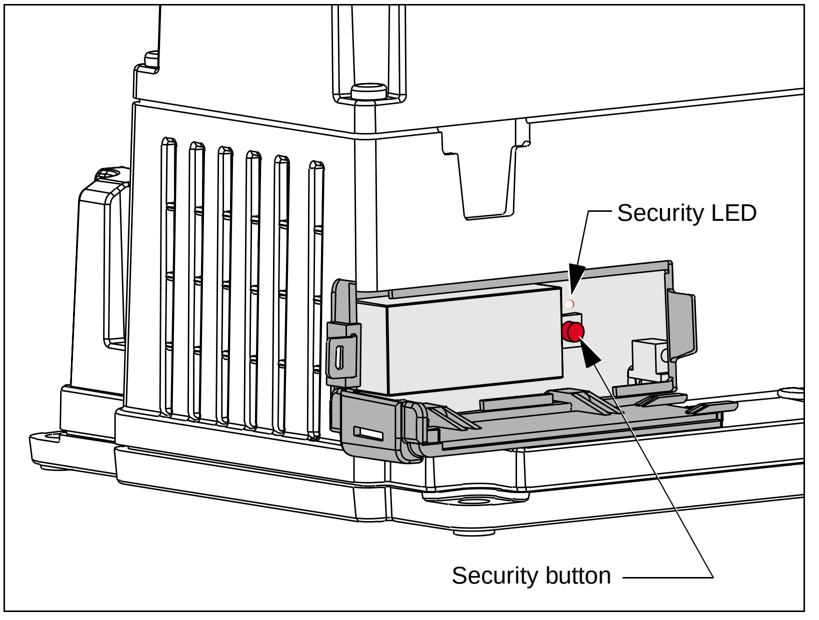


Figure 4–16 Security button location

4. Close the door.
5. Insert your utility seal through the hasp on the door (if required).

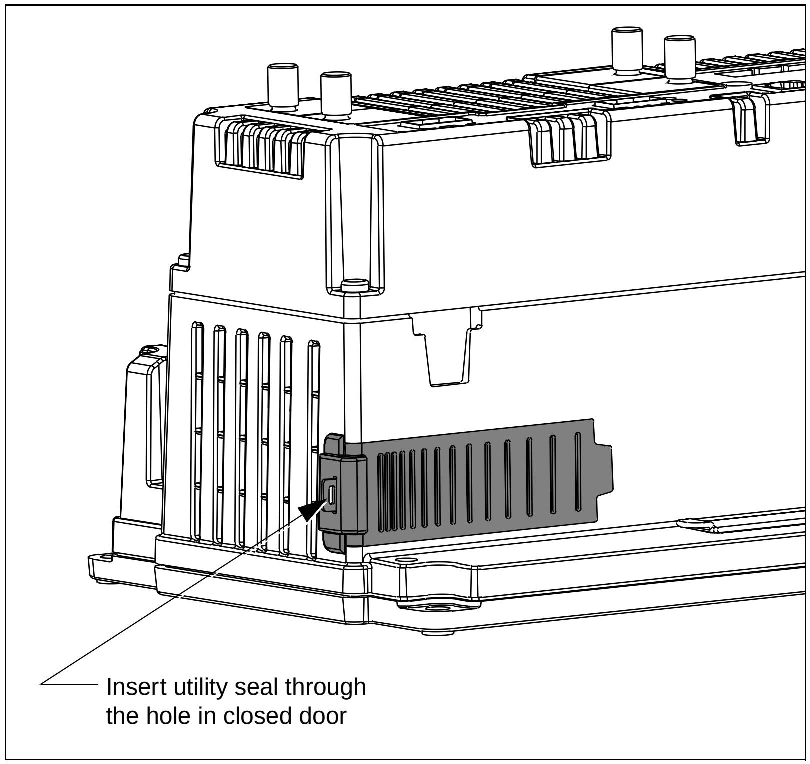


Figure 4–17 Securing the access door

6. Reinstall the I/O extender if present.
7. Restore all power to the circuit monitor.

De-activating Revenue Security

You can de-activate the revenue security feature at any time by following the same steps to activate it (refer to the steps beginning on page page 27). The security LED light shown in Figure 4–16 on page 29 will go out when the security feature is turned OFF.

CHAPTER 5—WIRING

This chapter explains how to make the wiring connections for the circuit monitor.

NOTE: Through out this bulletin the phases will be described as A, B, C, but are equivalent to phases 1, 2, 3 or R, Y, B.

CHAPTER CONTENTS

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.

Control Power Transformers

If you are using control power transformers (CPTs), refer to Table 5–1 to see the correct CPT size to use for the number of circuit monitors.

Table 5–1: 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 must be individually fused under all circumstances. When deriving control power from either a control power transformer or a metering potential transformers where the secondary is 250 Vac or less, use a standard 250 Vac, 1 A fuse. If the control power is derived directly from the line voltage (305 Vac or less), use a 1 A time-delay fuse rated for the maximum applied voltage, one that is also rated to interrupt the available current supplied from the source. An example of a suitable fuse is the Bussman type FNQ device which is rated for 500 Vac and 10,000 A interruption current. For European safety compliance (EN61010 / LVD), see “Required Protection for CE Compliance” on page 33 for details on installation of protection devices in the control power circuit.

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 600 V or less. Connect the voltage metering inputs directly to the line voltages. However, for power systems with voltages higher than 600 V line-to-line, you **must** use potential transformers.

Required Protection for CE Compliance

For CE compliance, use CE-compliant protection devices such as Merlin Gerin Disconnect Circuit Breakers Type P25M #21104 (or IEC 947 equivalent), which must be connected directly to the metering voltage and control power inputs (see Figure 5–1).

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

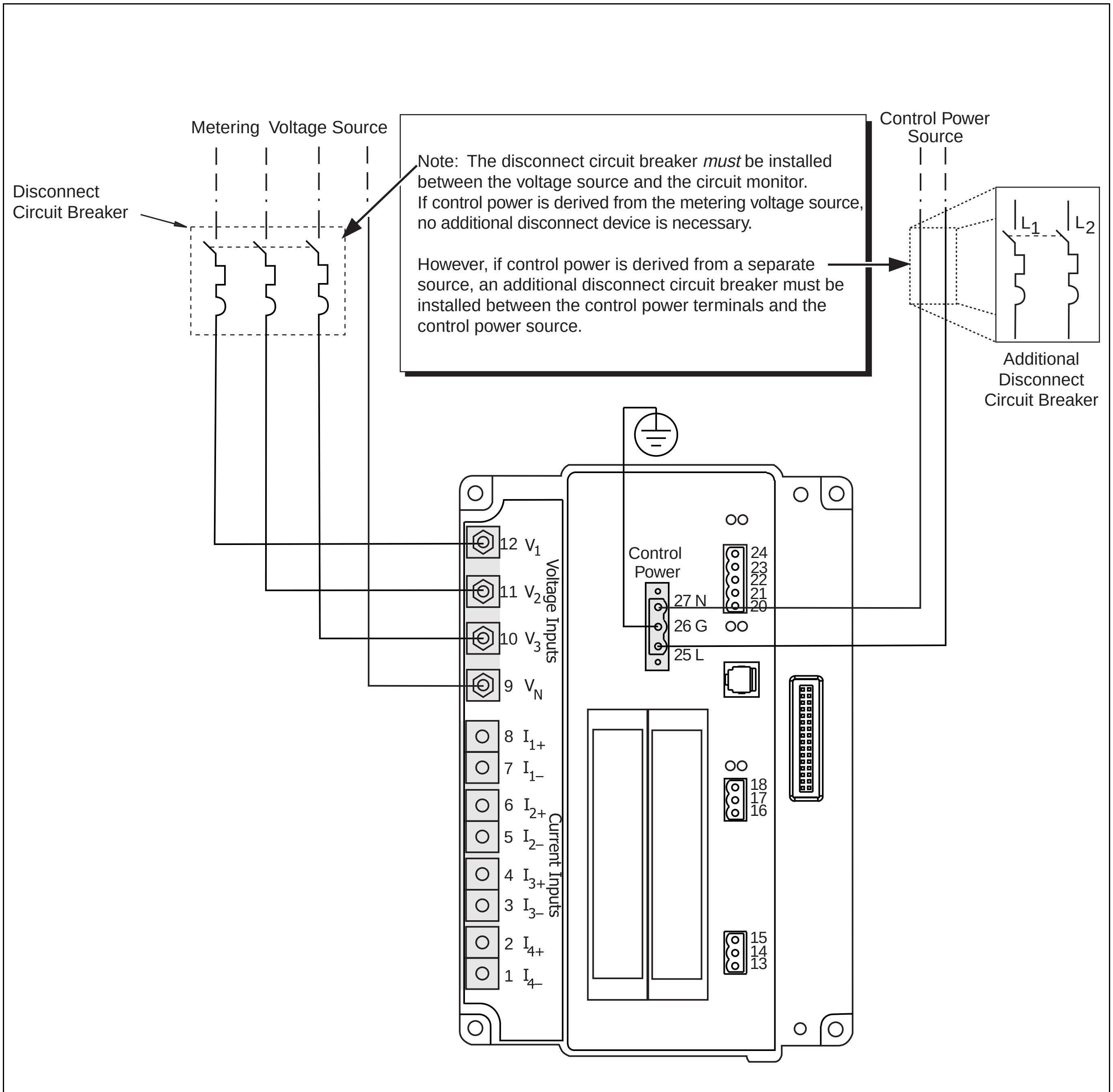
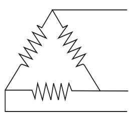
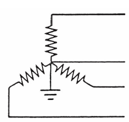


Figure 5–1 Example of a disconnect breaker connection for CE compliance

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 from 208V L–L/120V L–N through 600V L-L/347V 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 69 V. Table 5–2 lists the supported system connections and references the wiring diagrams on pages 37 through 45. Figures 5–3 through 5–9 beginning on page 43 show wiring to the circuit monitor for connections to the current transformers CTs, PTs, and control power. Figure 5–12 on page 46 shows dc control power.

Table 5–2: Supported Types of System Connections

System Wiring		Number of CTs	Auxiliary CT	Number of PTs	PT Connection	Currents	Voltages	System Type①	Figure Number
	3Ø, 3-Wire Delta	2	None	2	Open Delta	A, B②, C	A-B, B-C, C-A②	3Ø3W2CT (30)	Figure 5–4 on page 38
		3	None	2		A, B, C	A-B,B-C,C-A②	3Ø3W3CT (31)	Figure 5–5 on page 39
	3Ø, 4-Wire Wye, Ground	3	None	3	Wye-Wye	A, B, C, N②	A-N, B-N, C-N A-B②, B-C②, C-A②, N-G③	3Ø4W3CT (40)	Figure 5–6 on page 40
		4	Neutral	3		A, B, C, N, G②	A-N, B-N, C-N A-B②, B-C②, C-A② N-G③	3Ø4W4CT (41)	Figure 5–7 on page 41
		3	None	2	Open Wye	A, B, C, N②	A-N, B-N②, C-N A-B②, B-C②, C-A②, N-G③	3Ø4W3CT2PT (42)	Figure 5–10 on page 44
		4	Neutral	2		A, B, C, N, G②	A-N, B-N②, C-N A-B②, B-C②, C-A②, N-G③	3Ø4W4CT2PT (43)	Figure 5–11 on page 45

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

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

③ $V_{N\text{-}G}$ is derived from the metered neutral and control power ground.

Making the Connections

Follow these step to make the connections to the voltage and current inputs:

⚠ DANGER

HAZARD OF ELECTRIC SHOCK, BURN, OR EXPLOSION

- 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.
- Turn off all power to the equipment in which the circuit monitor 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.

Notes:

- *When wiring the circuit monitor, do not route wires over unused option card slots or over the I/O extender module that you might install in the future. Do not block the circuit monitor vents with the wires. See “Mounting” on page 15 for clearances.*
- *For CE wiring requirements, see “Required Protection for CE Compliance” on page 33.*
- *If the current/voltage module is not installed, you must mount it onto the circuit monitor first.*

To wire the circuit monitor, refer to the appropriate wiring diagram (see “Wiring Diagrams” on page 37.

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 CVM. (Spade lugs are provided in the CVM kit no. 63230-301-26.)
2. Loosen the terminal screws for each terminal on the CVM 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. See “Grounding the Circuit Monitor” on page 49 for instructions.
4. Install the plastic terminal cover over the terminal. For instructions, see “Installing the Terminal Cover” on page 36.

Installing the Terminal Cover

The plastic terminal cover and its three mounting screws (M3) are provided in the CVM hardware kit no. 63230-301-26. After wiring the CVM, install the terminal cover as illustrated in Figure 5–2. Follow these steps:

1. Place the terminal cover over the terminals of the CVM.
2. Insert the three M3 screws and torque 5–7 lb-in (0.56–0.79 N m). Do not overtighten.

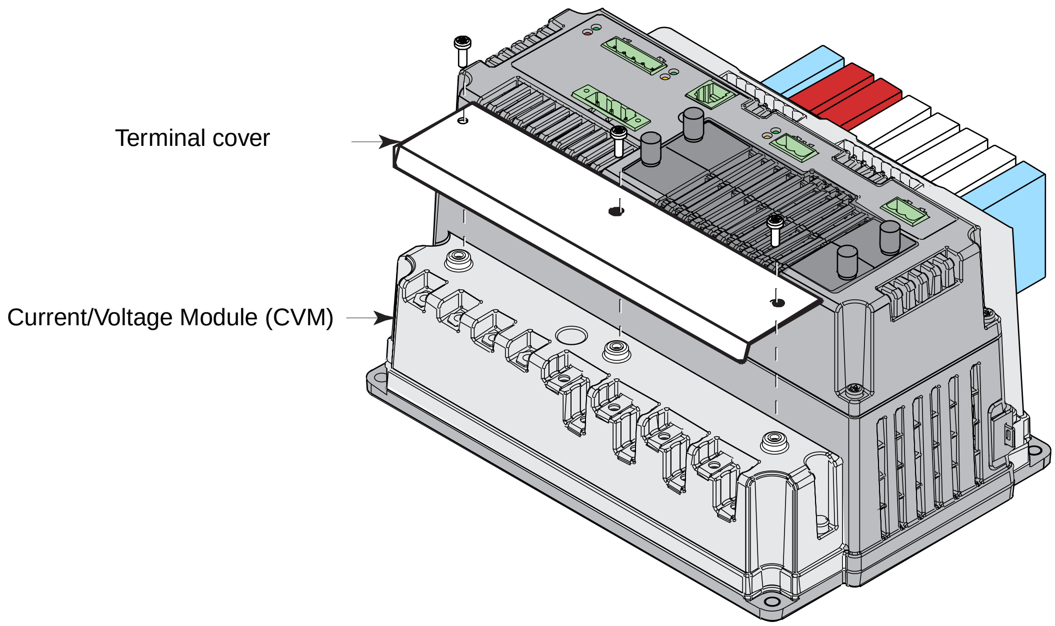
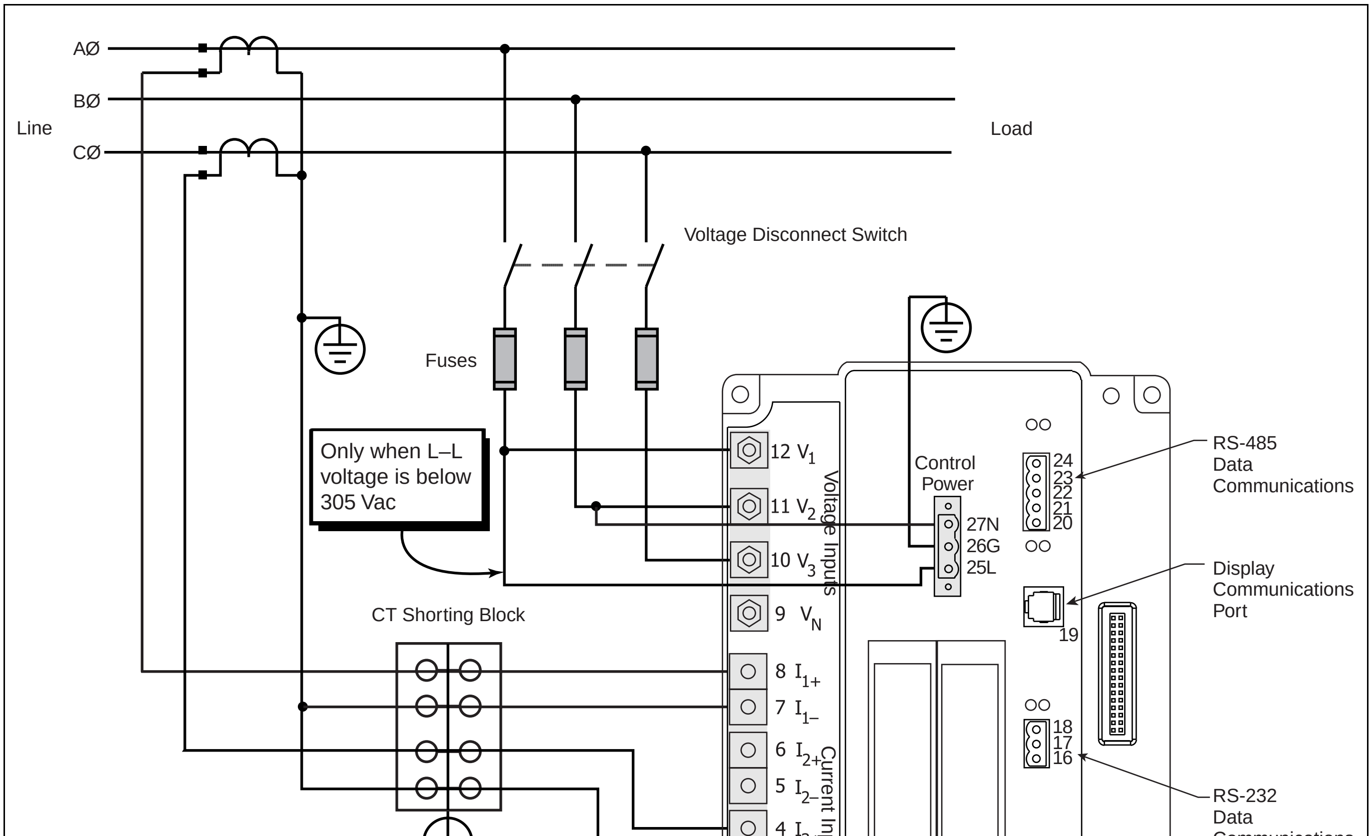


Figure 5–2 Installing terminal covers

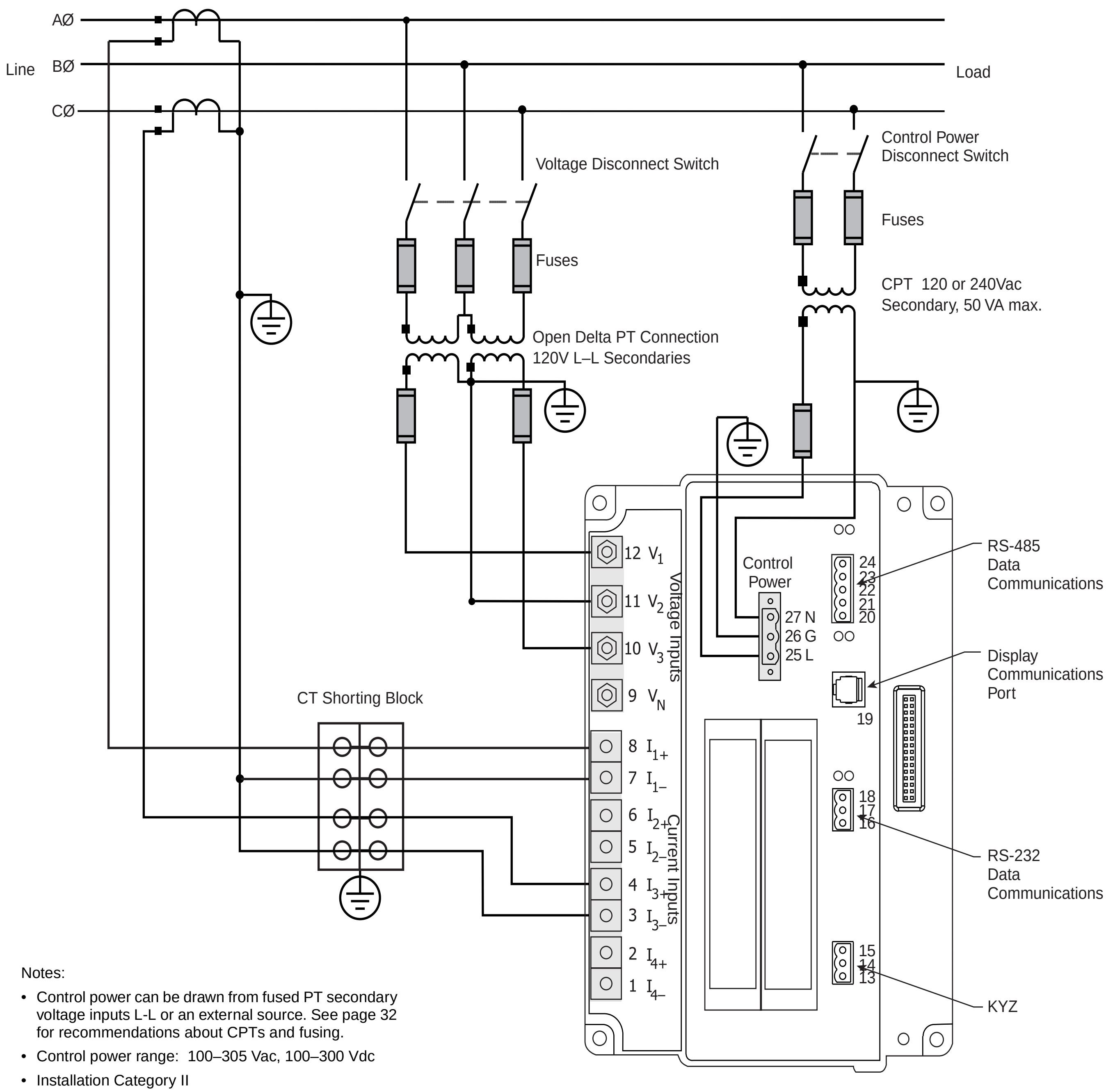
WIRING DIAGRAMS



Notes:

- Control power can be drawn from fused voltage inputs L-L or an external source. See page 32 for recommendations about CPTs and fusing.
- Control power range: 100–305 Vac, 100–300 Vdc
- Installation Category II
- Pay close attention to polarity marks (■) when connnecting CTs.
- For corner grounded delta applications, use PTs as shown in Figure 5–4 on page 38.
- Use system type: 3Ø3W2CT

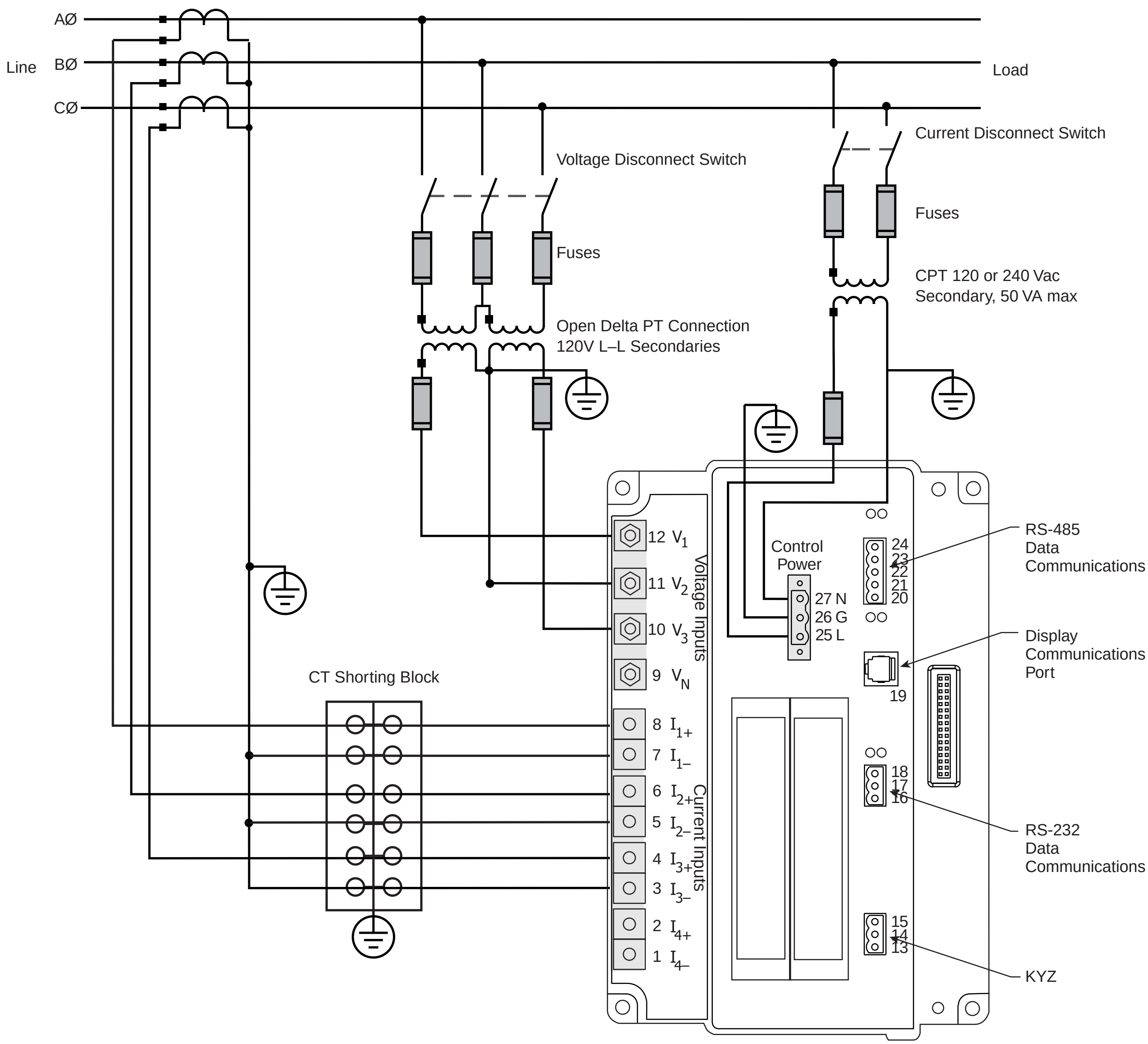
Figure 5–3 3-Phase, 3-Wire Delta Direct Voltage Connection with 2 CTs



Notes:

- Control power can be drawn from fused PT secondary voltage inputs L-L or an external source. See page 32 for recommendations about CPTs and fusing.
- Control power range: 100–305 Vac, 100–300 Vdc
- Installation Category II
- Pay close attention to polarity marks (■) when connnecting CTs and PTs.

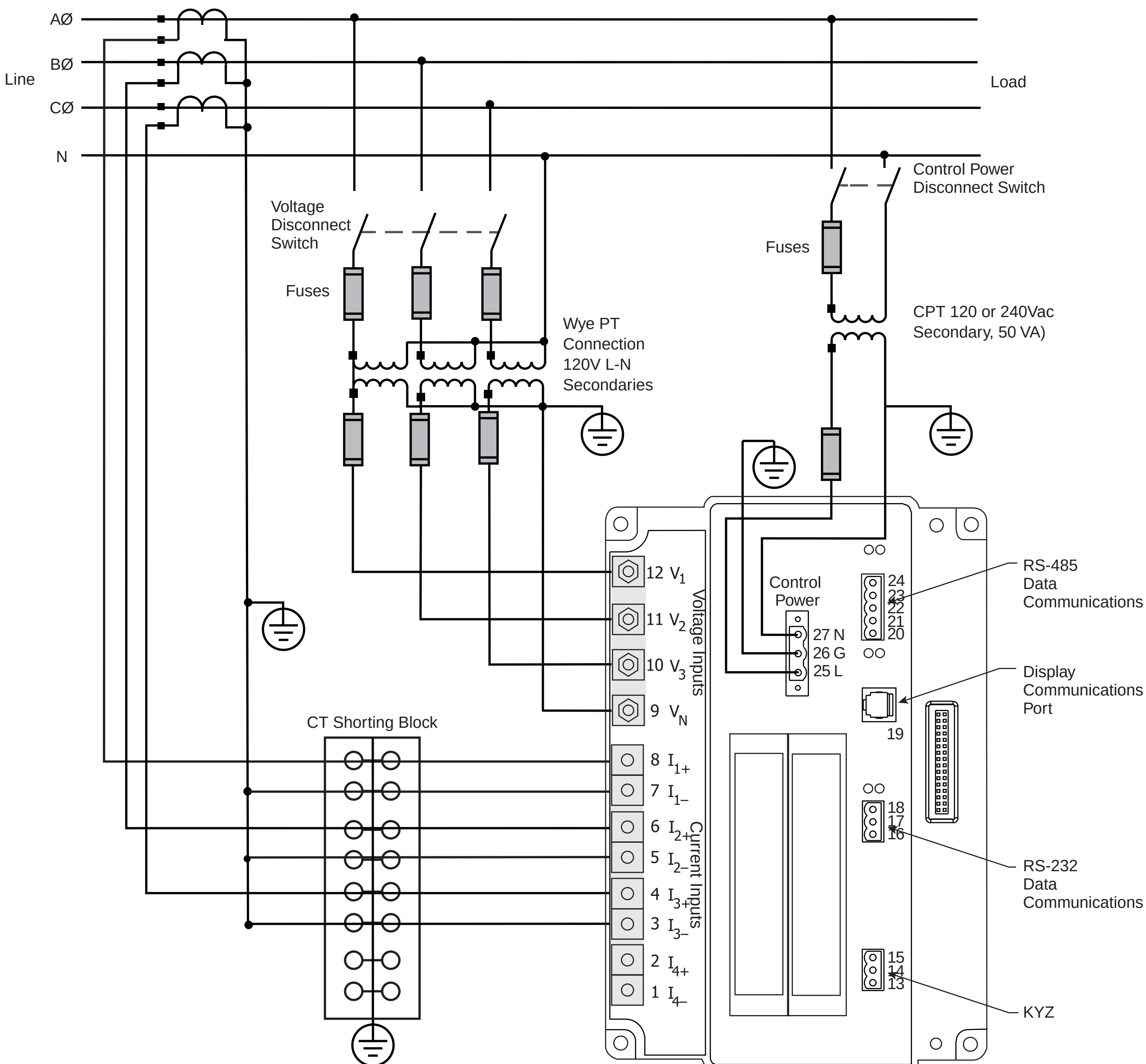
Figure 5–4 3-Phase, 3-Wire Delta Connection with 2 PTs and 2 CTs



Notes:

- Control power can be drawn from fused PT secondary voltage inputs L-L or an external source. See page 32 for recommendations about CPTs and fusing.
- Control power range: 100–305 Vac, 100–300 Vdc
- Installation Category II
- Pay close attention to polarity marks (■) when connnecting CTs and PTs.

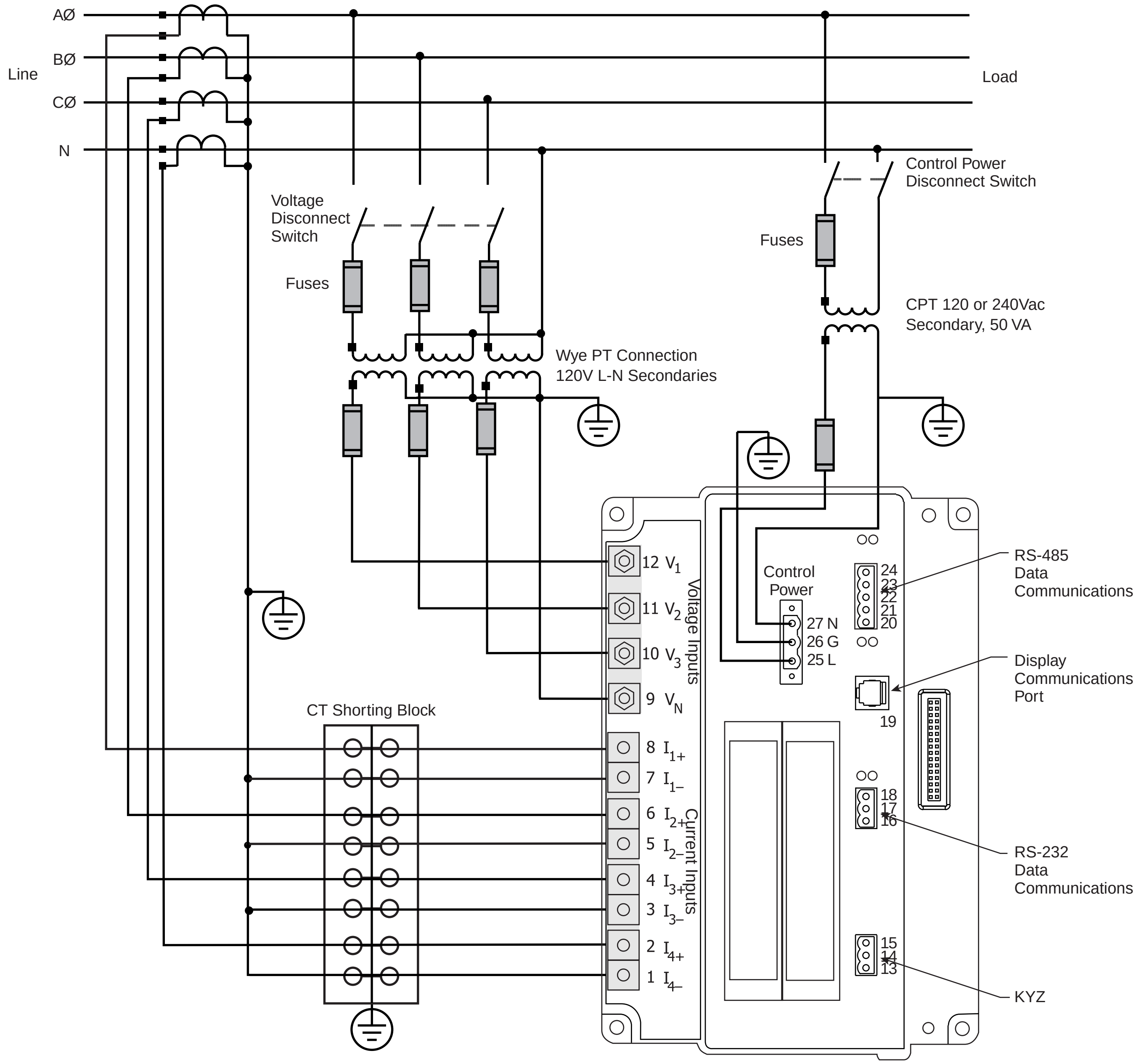
Figure 5–5 3-Phase, 3-Wire Delta Connection with 2 PTs and 3 CTs



Notes:

- Control power can be drawn from fused voltage inputs L-N or an external source. See page 32 for recommendations about CPTs and fusing.
- Control power range: 100–305 Vac, 100–300 Vdc
- Installation Category II
- Pay close attention to polarity marks (■) when connnecting CTs and PTs.

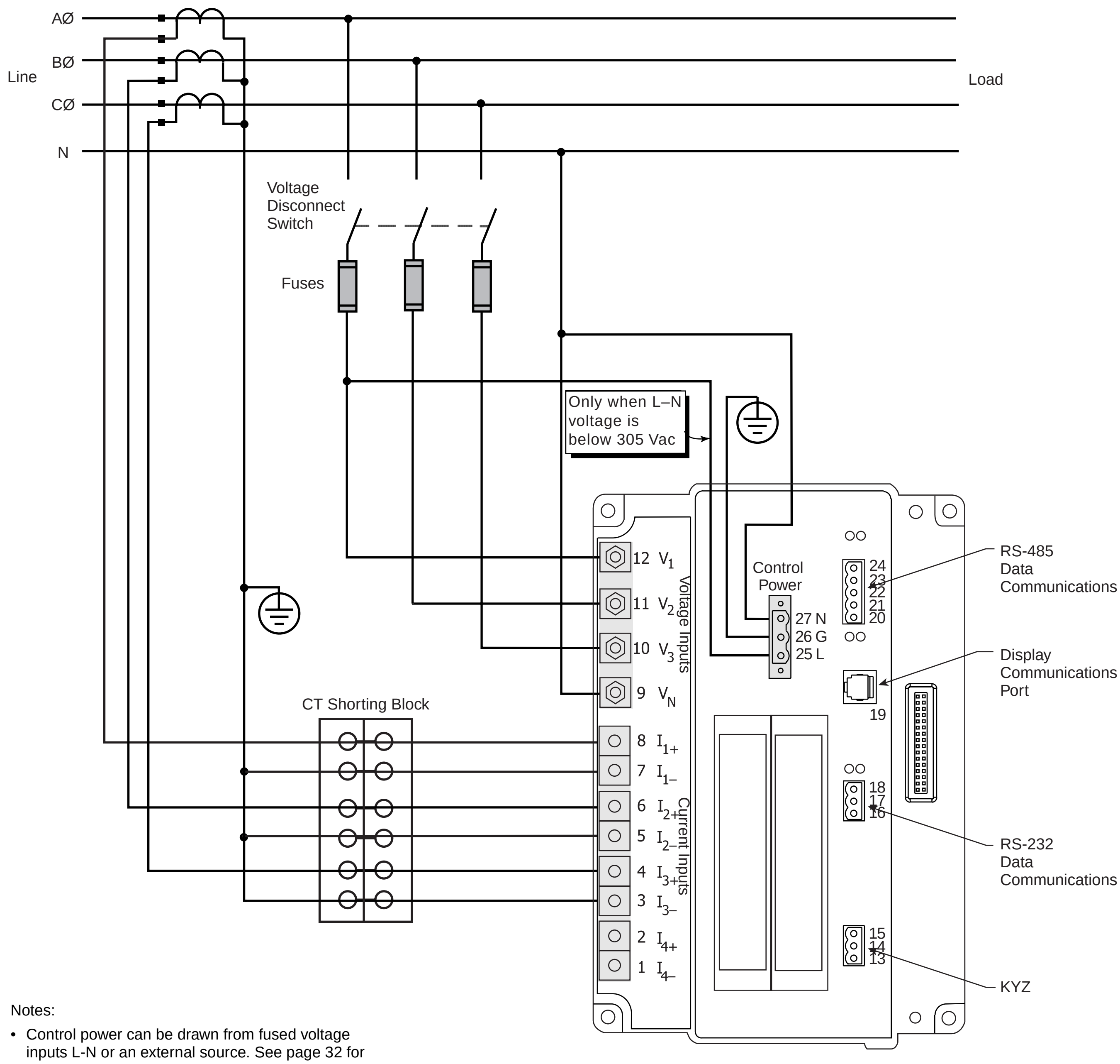
Figure 5–6 3-Phase, 4-Wire Wye Ground with 3 PTs and 3CTs



Notes:

- Control power can be drawn from fused voltage PT secondary inputs L-N or an external source. See page 32 for recommendations about CPTs and fusing.
- Control power range: 100–305 Vac, 100–300 Vdc
- Installation Category II
- Pay close attention to polarity marks (■) when connnecting CTs and PTs.

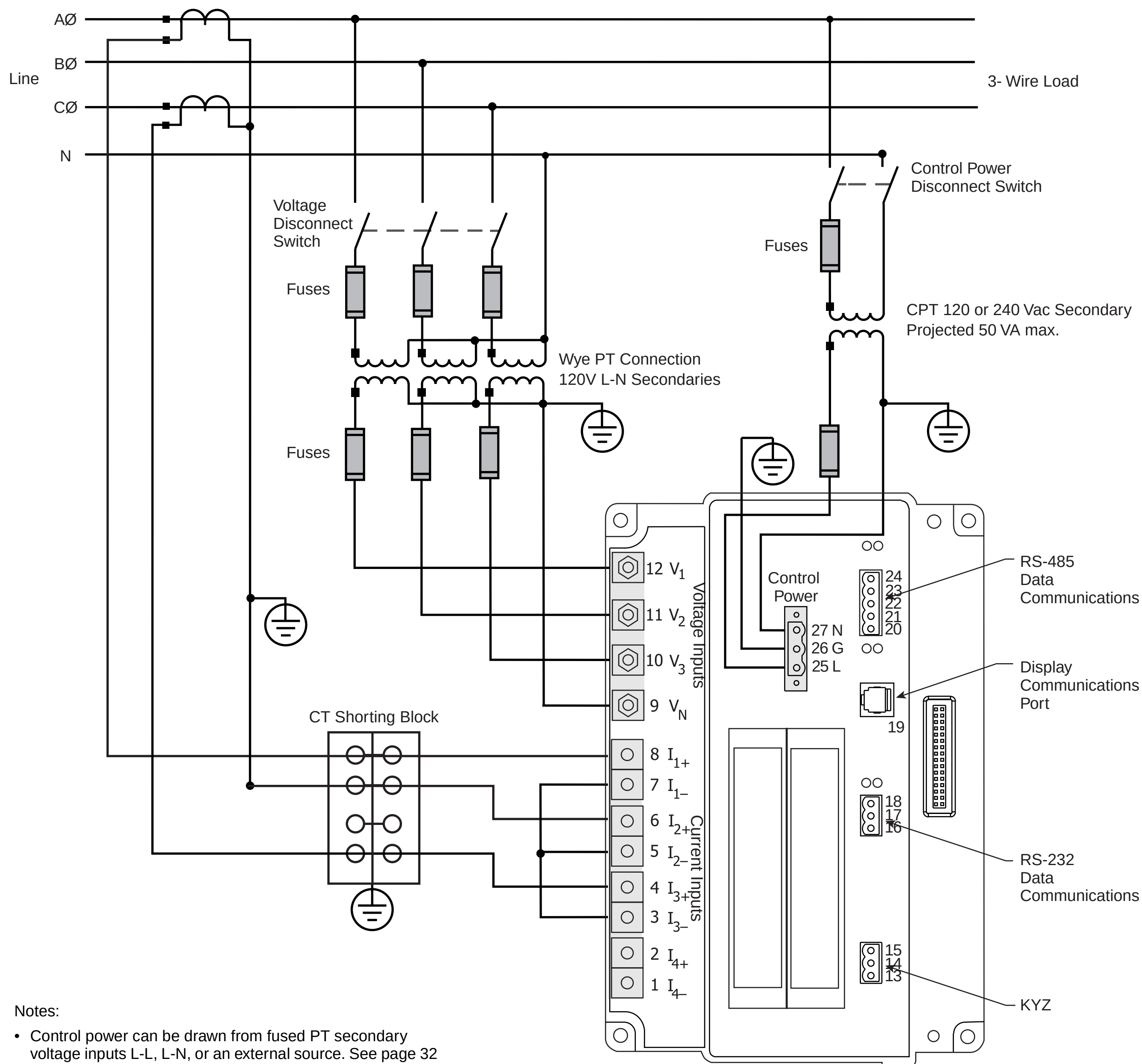
Figure 5–7 3-Phase, 4-Wire Wye Ground Connection with 3 PTs and 4 CTs



Notes:

- Control power can be drawn from fused voltage inputs L-N or an external source. See page 32 for recommendations about CPTs and fusing.
- Control power range: 100–305 Vac, 100–300 Vdc
- Use with 480/277 V and 208/120 V systems
- Use system type: 3Ø4W3CT
- Installation Category II
- Pay close attention to polarity marks (■) when connnecting CTs.

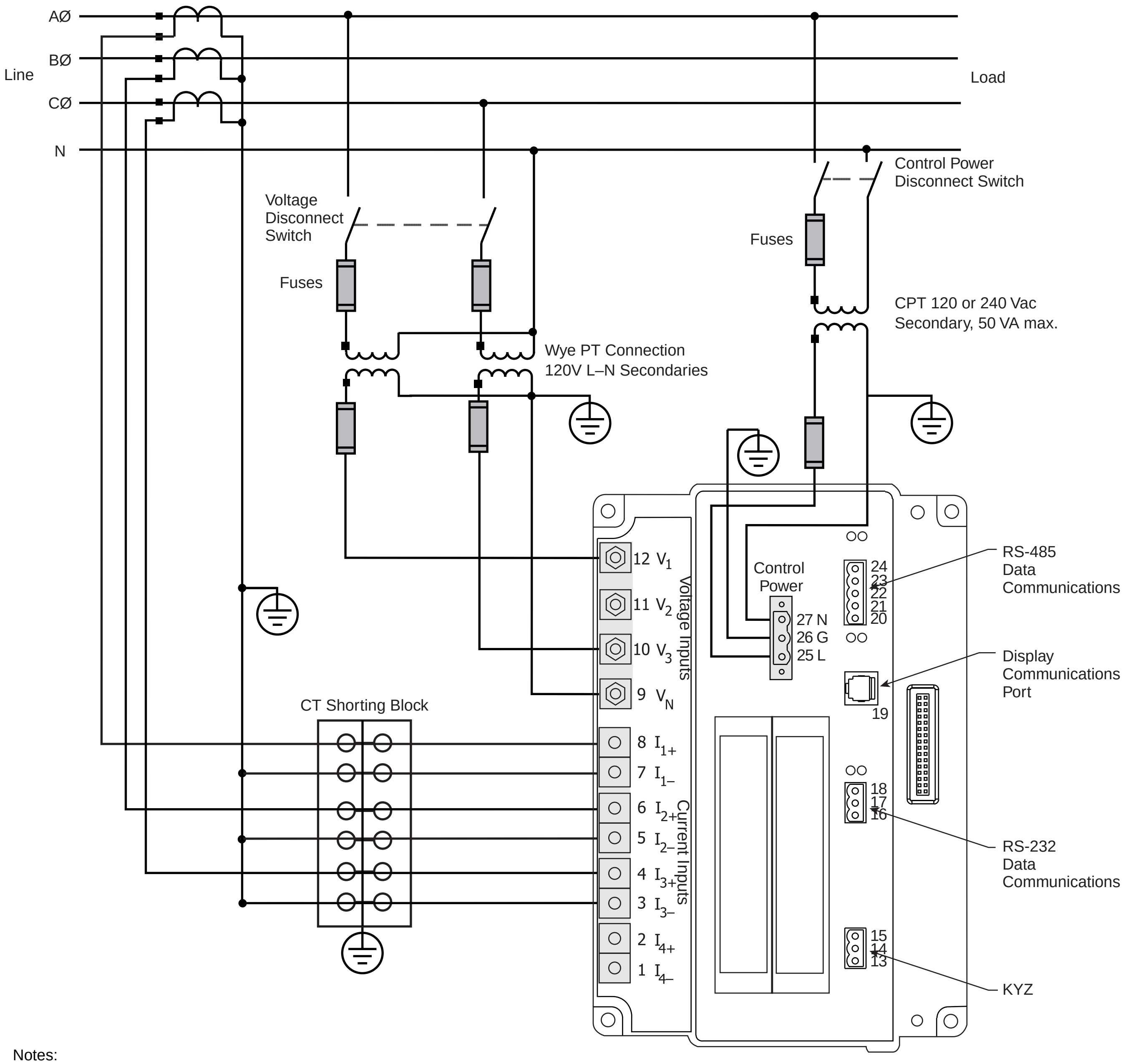
Figure 5–8 3-Phase, 4-Wire Wye with Direct Voltage Connection and 3CTs



Notes:

- Control power can be drawn from fused PT secondary voltage inputs L-L, L-N, or an external source. See page 32 for recommendations about CPTs and fusing.
- Control power range: 100–305 Vac, 100–300 Vdc
- Installation Category II
- Pay close attention to polarity marks (■) when connnecting CTs and PTs.
- Use system type: 3Ø4W3CT

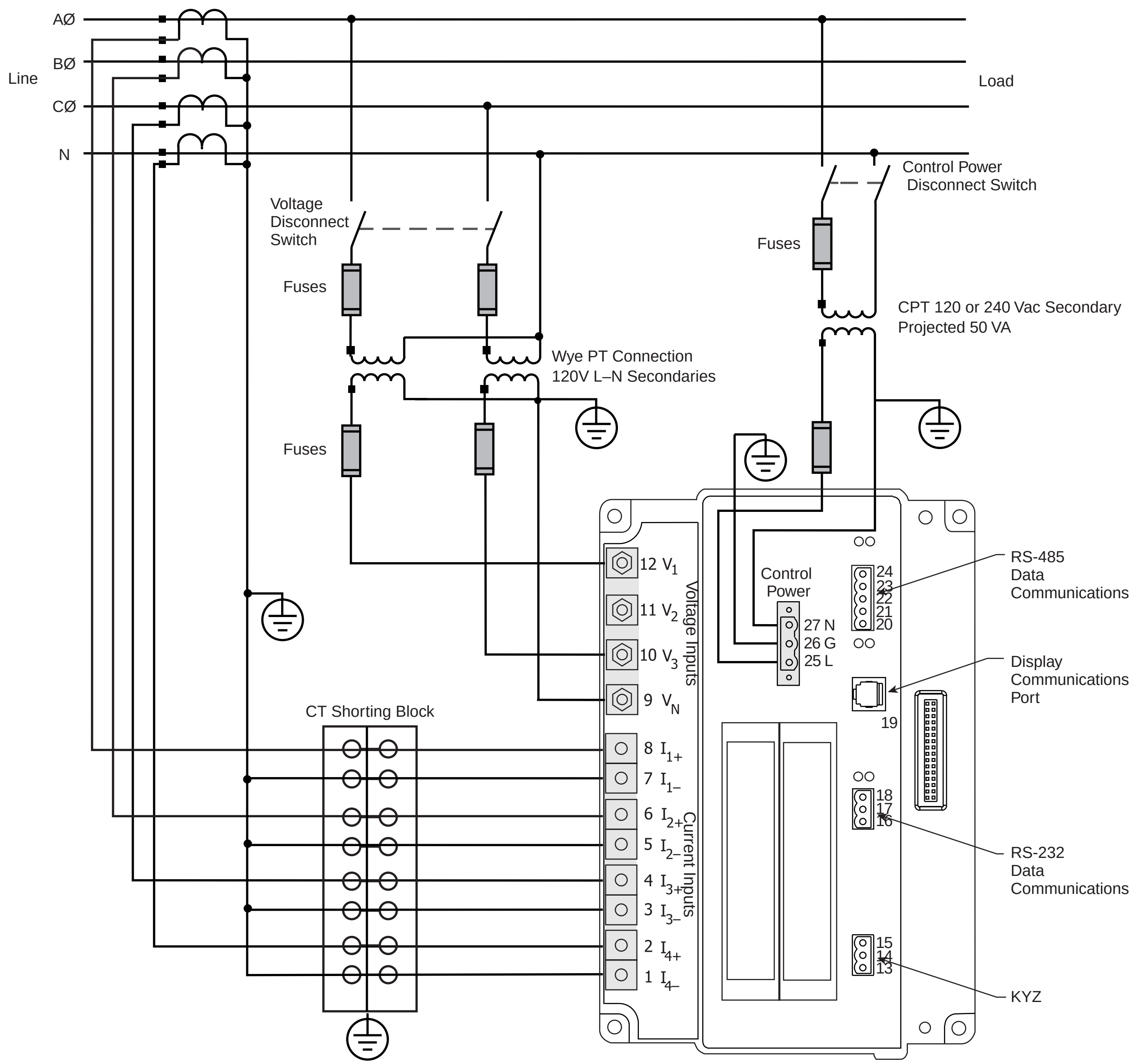
Figure 5–9 3-Phase, 4-Wire Wye, 3-Wire Load with 3 PTs and 2 CTs



Notes:

- Control power can be drawn from fused PT secondary voltage inputs L-L, L-N, or an external source. See page 32 for recommendations about CPTs and fusing.
- Control power range: 100–305 Vac, 100–300 Vdc
- Installation Category II
- Pay close attention to polarity marks (■) when connnecting CTs and PTs.

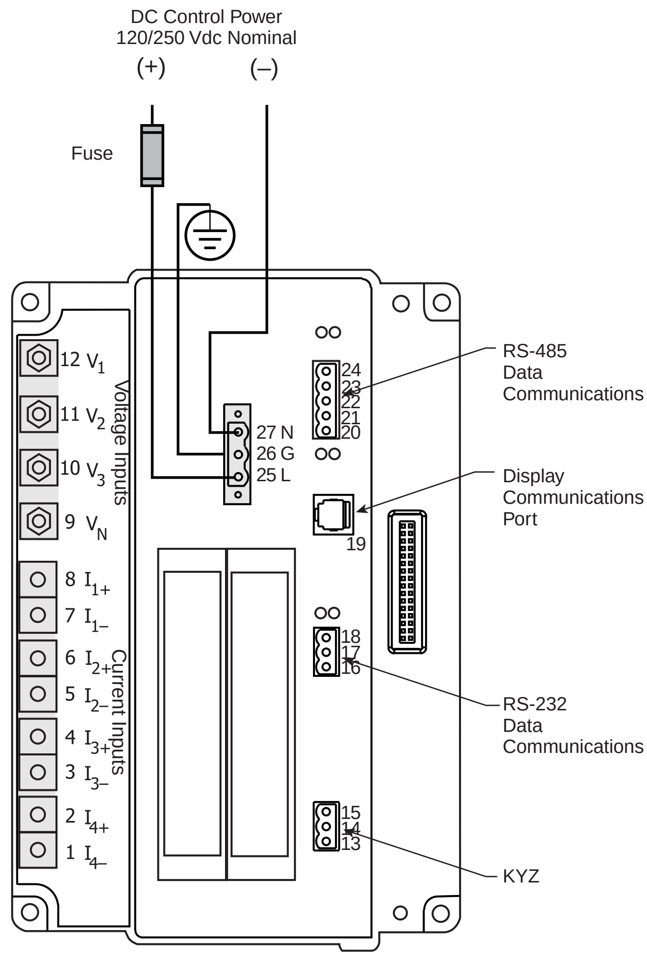
Figure 5–10 3-Phase, 4-Wire Wye with 3CTs and 2 PTs (calculated neutral).



Notes:

- Control power can be drawn from fused PT secondary voltage inputs L-L, L-N, or an external source. See page 32 for recommendations about CPTs and fusing.
- Control power range: 100–305 Vac, 100–300 Vdc
- Installation Category II
- Pay close attention to polarity marks (■) when connnecting CTs and PTs.

Figure 5–11   3-Phase, 4-Wire Wye with 4 CTs and 2 PTs



Notes:

- Control power range: 100–305 Vac, 100–300 Vdc
- Installation Category II

Figure 5–12 DC Control Power Wiring

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

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 3-11 shows how to connect multiple circuit monitors to a single set of PTs and one CPT.

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

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

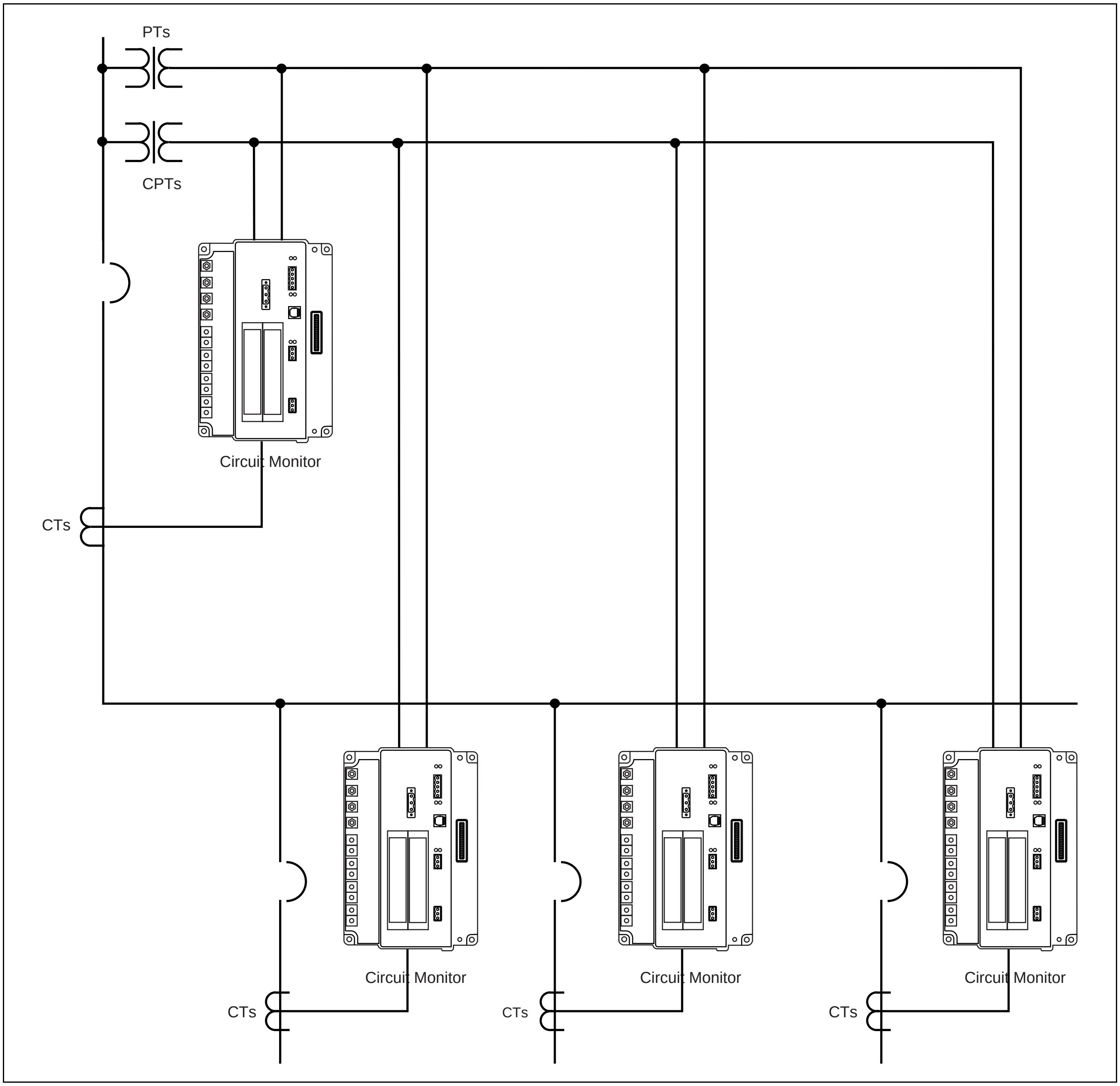


Figure 5–13   Wiring multiple circuit monitors

Deriving Control Power from Phase PT Inputs

Whenever possible, obtain control power for the circuit monitor from a stable voltage source. 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 and enables more reliable operation during voltage disturbances.

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.

Referring to Figure 5–14 and Figure 5–15, complete the following steps to obtain control power from phase PT inputs:

1. Connect the V_1 terminal (terminal 12) to the L terminal (terminal 25).
2. For L-N control power, connect the Vn terminal (terminal 9) to the N terminal (terminal 27). For L-L control power, connect the V_3 terminal (terminal 10) to the N terminal (terminal 27).
3. Install the protective terminal strip cover. See "Installing the Terminal Cover" on page 36 for instructions.

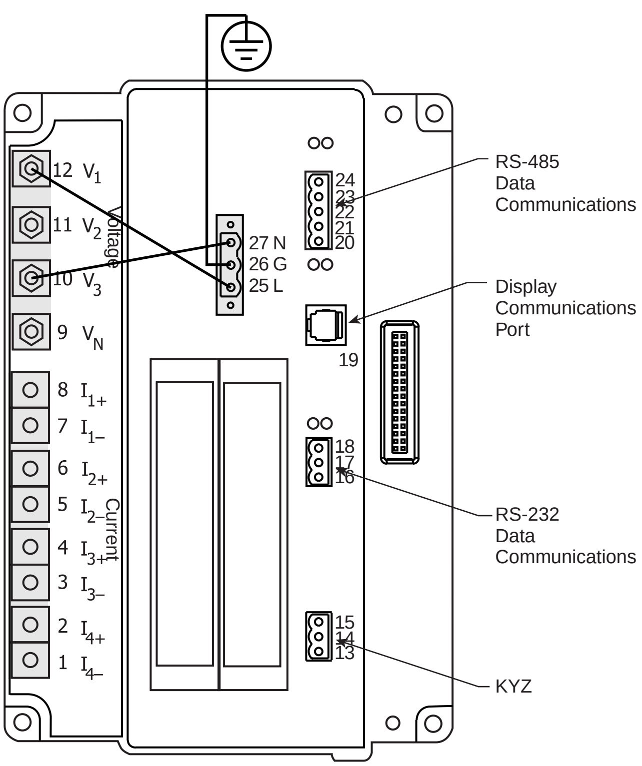


Figure 5–14 Deriving L-L control power from phase PT inputs (305 Vac maximum)

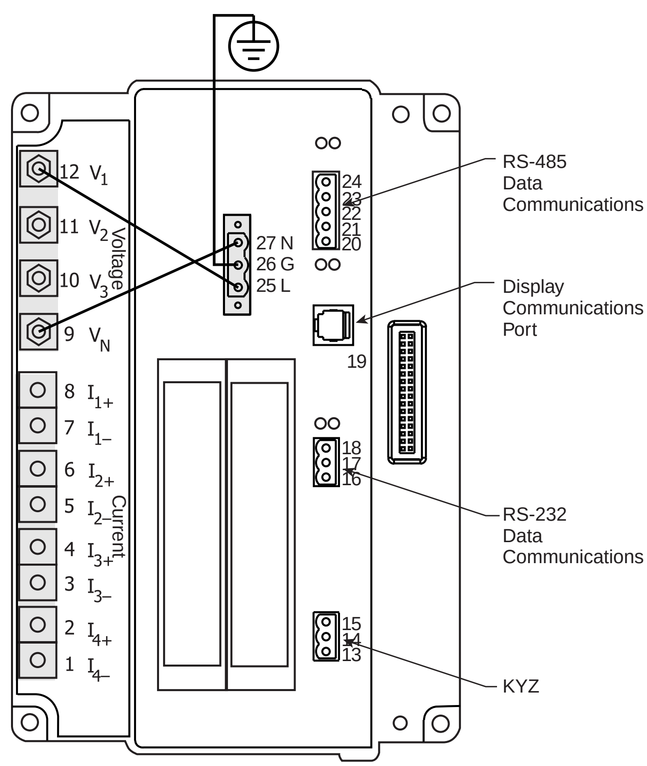


Figure 5–15 Deriving L-N control power from phase PT inputs (305 Vac maximum)

GROUNDING THE CIRCUIT MONITOR

To ground the circuit monitor, connect the ground terminal (terminal 26) of the circuit monitor to a true earth ground, using #14 AWG wire or larger (see Figure 5–16).

NOTE: You must ground the circuit monitor as described in these instructions. Failure to properly ground the circuit monitor may induce noise on the power conductor.

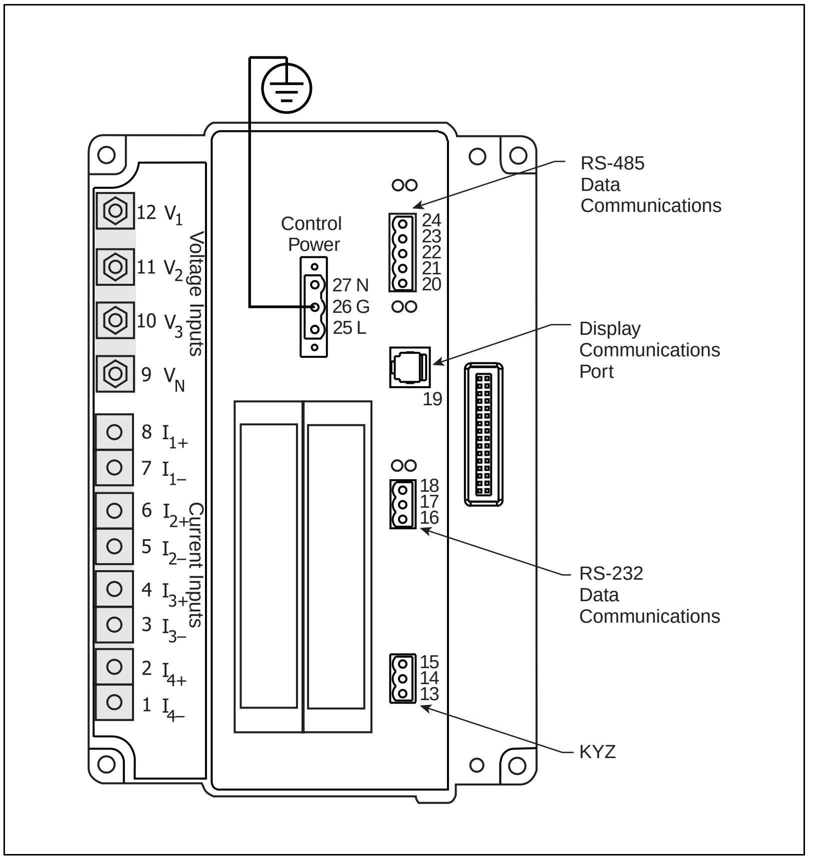


Figure 5–16 Connector for grounding the circuit monitor

WIRING THE SOLID-STATE KYZ OUTPUT

⚠ DANGER

HAZARD OF ELECTRIC SHOCK, BURN, OR EXPLOSION

- 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.

You can wire the KYZ output to a 2-wire or 3-wire pulse receiver. To wire to a 2-wire pulse receiver, use the K and Y terminals only (see Figure 5–17). 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).

NOTE: Use SMS to set up the KYZ output. See the SMS online help for instructions. To determine the pulse constant, see “Calculating the Watthour-Per-Pulse Value” on page 133.

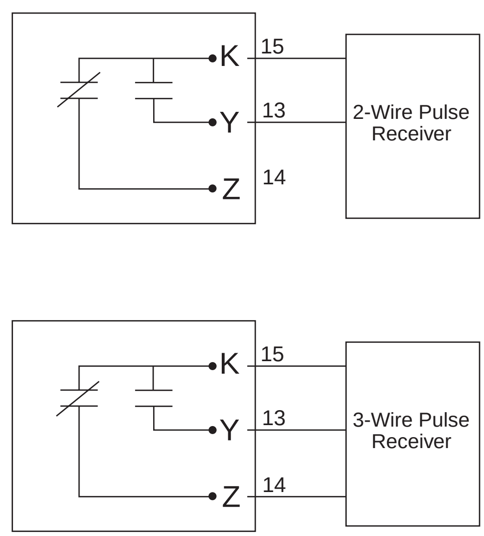


Figure 5–17 KYZ pulse output wiring diagram.

WIRING ERROR DETECTION

The circuit monitor can diagnose possible wiring errors when you initiate the wiring test on the Diagnostic 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 the six possible system types (see Table 5–2 on page 34 for a description of system types).
- Expected displacement power factor is between .60 lagging and .99 leading.

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 to 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 current input to perform the check.
6. Indicates if the 3-phase real power (kW) total is negative, which could represent a possible wiring error.
7. Compares each current angle to its respective voltage.

Running the Diagnostics Wiring Test

When the circuit monitor detects a possible error, you can find and correct the problem and then run the check 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 password prompt displays.
2. Select your password. The default password is 0.

The Diagnostics menu displays.

```
DIAGNOSTICS
  Meter Information
  Read/Write Regs
  Wiring Error Test
```

3. Select Wiring Test.

   The circuit monitor asks if you’d like to perform a wiring check.

```
Perform Test          Yes
```

4. Press the enter button.

   The circuit monitor asks if the wiring matches the test assumptions.

```
Test Assumptions:
Va and Vn for 4wire
Va and Vb for 3wire
are correct?          Yes
```

5. Press the enter button.

   The circuit monitor asks if the expected displacement power factor is between .60 lagging and .99 leading.

```
Test assumption:
  Displacement PF is
  between 0.60 lag
  and 0.99 lead?      Yes
```

6. Press the enter button.

   The circuit monitor performs the wiring test.

   If it doesn’t find any errors, the circuit monitor displays “Wire test complete. No errors found!”. If it finds possible errors, it displays “Error detected. See following screens for details.”

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

   Table 5–3 on page 53 explains the possible wiring error messages.

⚠ DANGER

HAZARD OF ELECTRIC SHOCK, BURN, OR EXPLOSION

- 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. Repeat these steps until all errors are corrected.

Table 5–3: Wiring Error Messages

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.

Table 5–3: Wiring Error Messages

Message	Description
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.
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 CONNECTIONS

This chapter explains how to make the communications connections to the the circuit monitor and display.

CHAPTER CONTENTS

⚠ DANGER

HAZARD OF ELECTRIC SHOCK, BURN, OR EXPLOSION

- 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.

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 ports, an Ethernet port and an RS-485. 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 all five communication ports.

Protocols

The circuit monitor can use either MODBUS or JBUS protocols. During setup, select which protocol will be used. 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. See the instruction bulletin (63230-306-200) provided with the OCIVF for more information about using this accessory.

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.

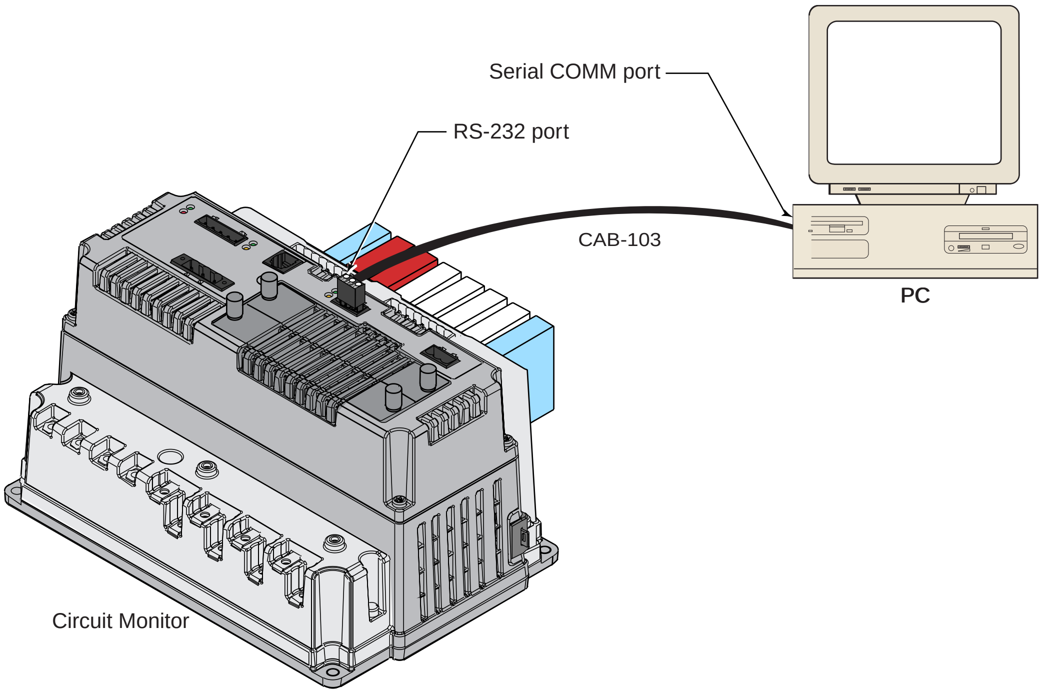


Figure 6–1 Circuit monitor connected directly to a PC

The pinout for the CAB-103 (RS-232) cable is shown in Figure 6–2.

CAB-103
RS-232 Cable

RS-232 Port			DB-9 Connector
18	GND	——	5
17	TX	╳	3
16	RX	╳	2

Figure 6–2 CAB-103 cable pinout

DAISY-CHAINING DEVICES TO THE CIRCUIT MONITOR

The RS-485 port lets you daisy chain up to 32, 4-wire MODBUS or JBUS 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 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 CM4000 Circuit Monitors 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 in-lb (0.56–0.79 N•m).

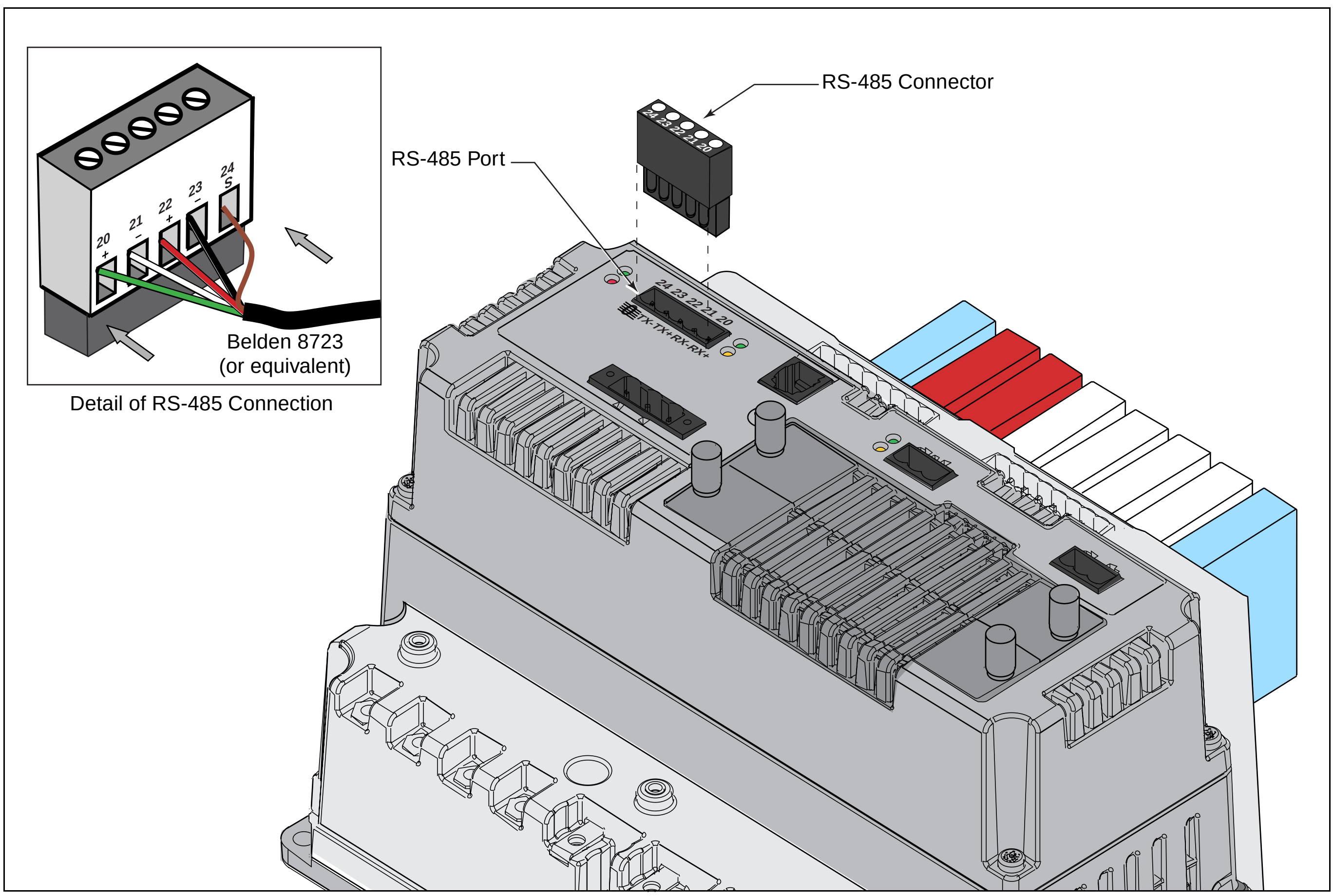
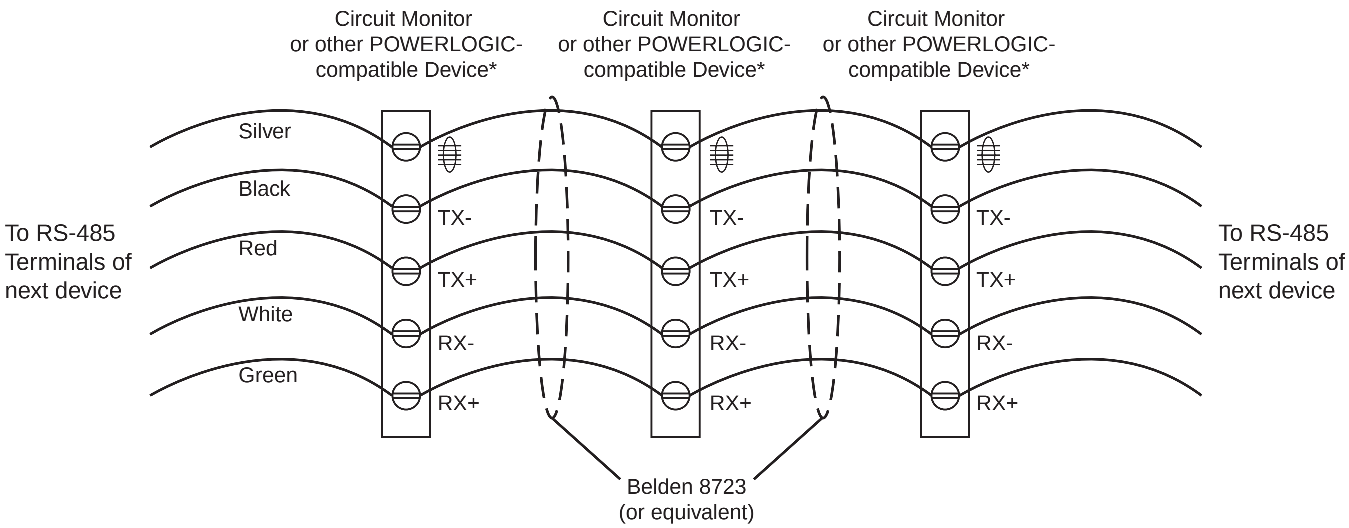


Figure 6–3 RS-485 connection

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.



*Note: POWERLOGIC Power Meters and CM2000 Circuit Monitors are labelled IN, OUT, and SHLD instead of RX and TX. Corresponding CM4000 labels are:
RX → IN, TX → OUT, and → SHLD

Figure 6–4 Daisy-chaining devices

- 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 62 in this chapter for instructions.
- If the circuit monitor is the last device on the daisy chain, terminate it. See "Terminating the Communications Link" on page 63 in this chapter 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:

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

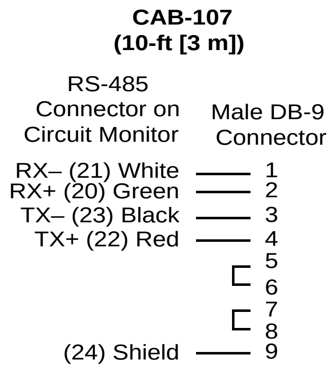


Figure 6–5 CAB-107 Cable Pinout

1. Carefully mark the leads on the CAB-107 cable as indicated in Table 6–1.

Table 6–1: Labeling the leads on the CAB-107 cable

Existing Label	Wire Color	Mark As
20	Green	RX+
21	White	RX–
22	Red	TX+
23	Black	TX–
24	Silver	SHLD

2. Cut a length of Belden cable long enough to reach from the terminal block to the circuit monitor. Strip 1-1/4 in. (32 mm) of cable sheath from both ends.
3. On one end of the Belden cable, carefully strip .25 in (6 mm) of insulation from the end of each wire to be connected. Using a suitable crimping tool, securely attach a forked terminal (insulated spade lug) to each wire.
4. Connect the Belden cable end with the attached spade connectors to the terminal block as shown in Figure 6–6. Torque all terminal screws to 6–9 in-lb (0.68–1 N•m).
5. 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.
6. 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 in-lb (0.56–0.79 N•m).

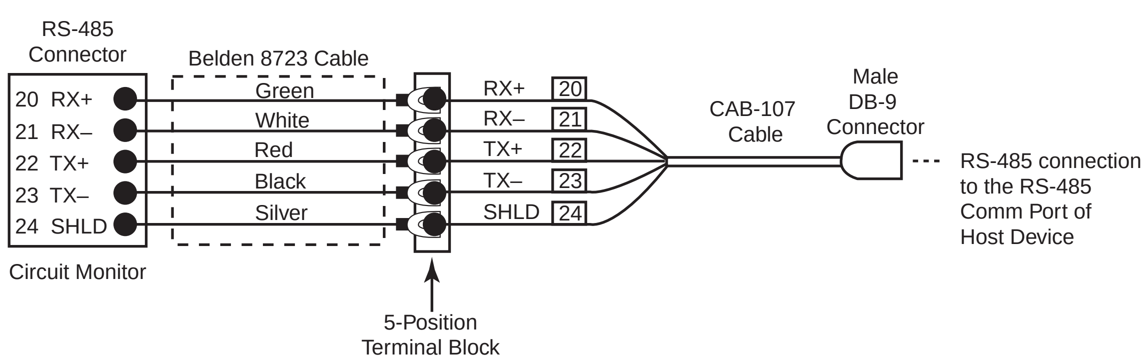


Figure 6–6 Connecting the first device on the daisy chain

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 PC or processor 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 3-3 shows the maximum distances at different baud rates.

Table 6–2: Maximum distances of 4-wire comms 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 on page 64.
- 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 on page 65.

Notes:

- *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.

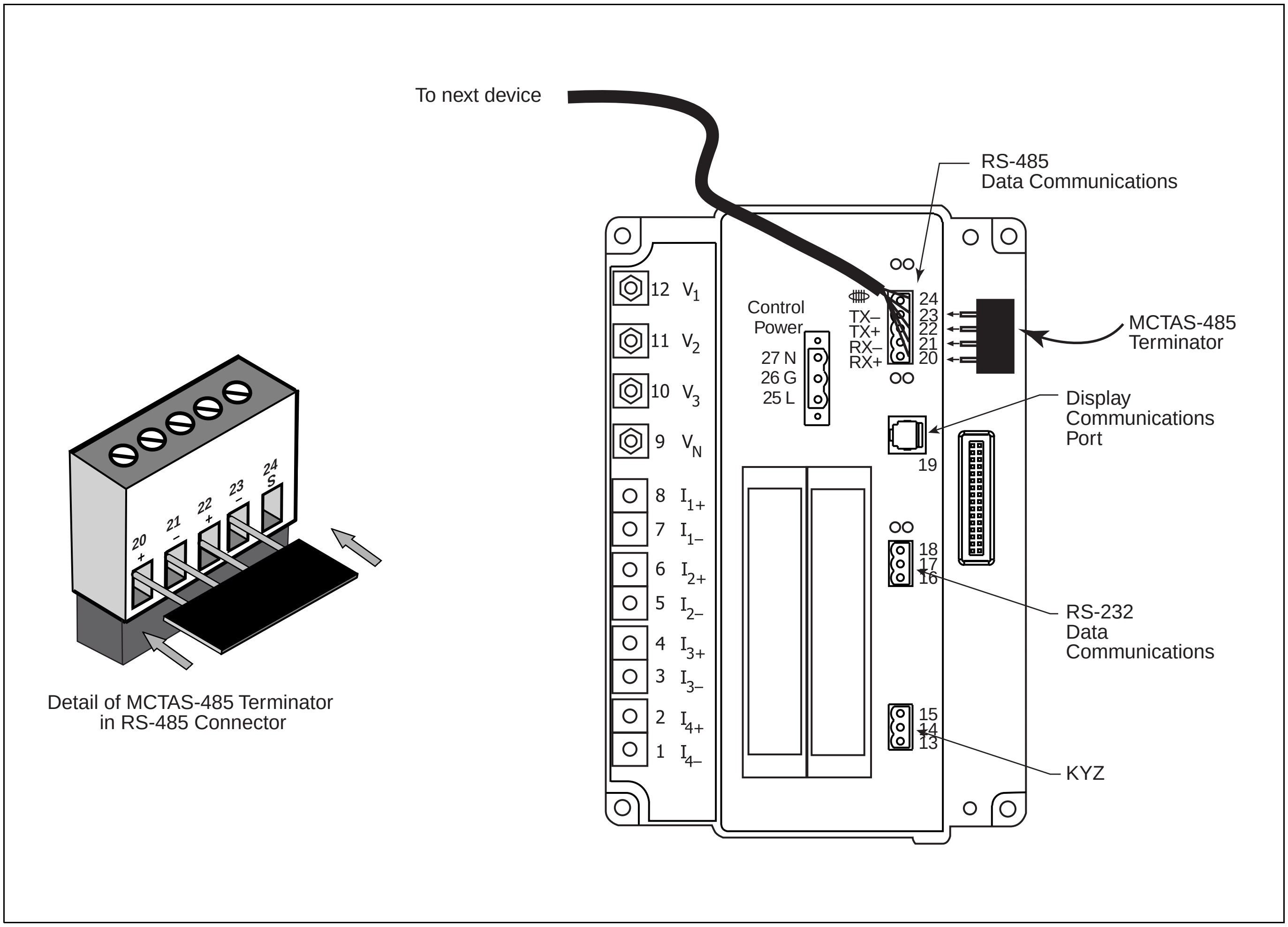


Figure 6–7 Terminating the circuit monitor using the MCTAS-485 terminator.

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:

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

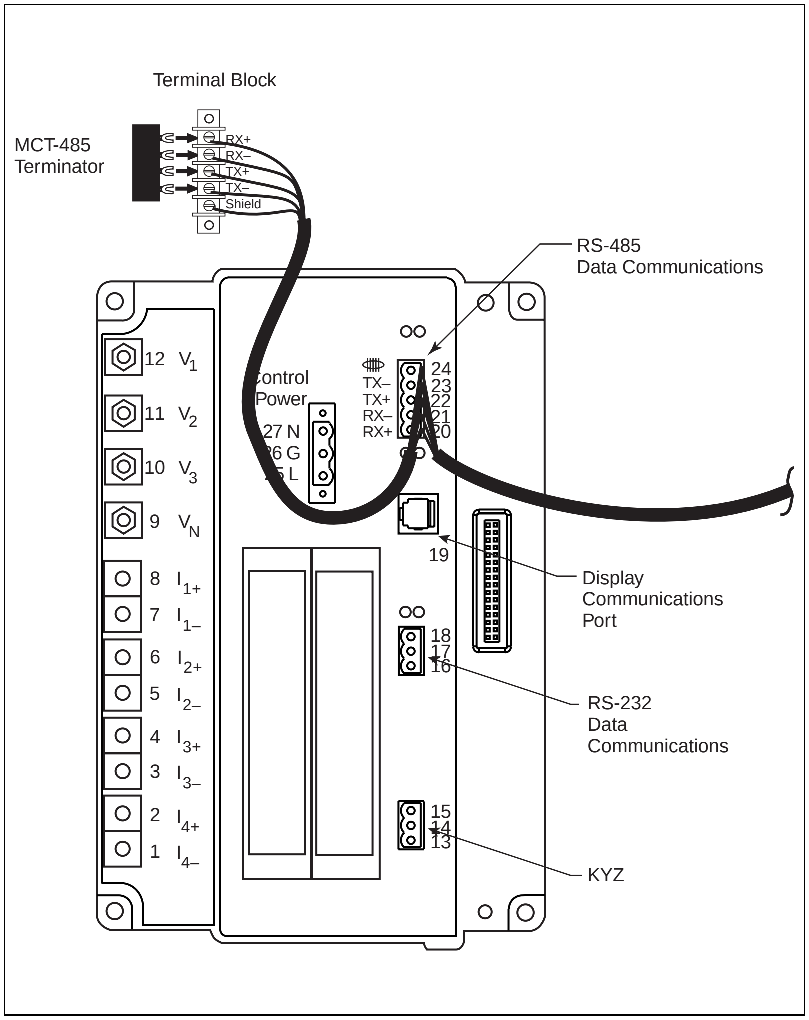


Figure 6–8 Terminating the circuit monitor using the MCT-485 terminator and a terminal block.

CONNECTING TO A PC USING THE RS-485 PORT

You can use the RS-485 port on the circuit monitor to connect up to 32 MODBUS or JBUS devices to the serial communications port on a PC (see Figure 6–9). Refer to “Length of the Communications Link” on page 63 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 no. MCI-101). For connection instructions, refer to the instruction bulletin included with the MCI-101 kit.

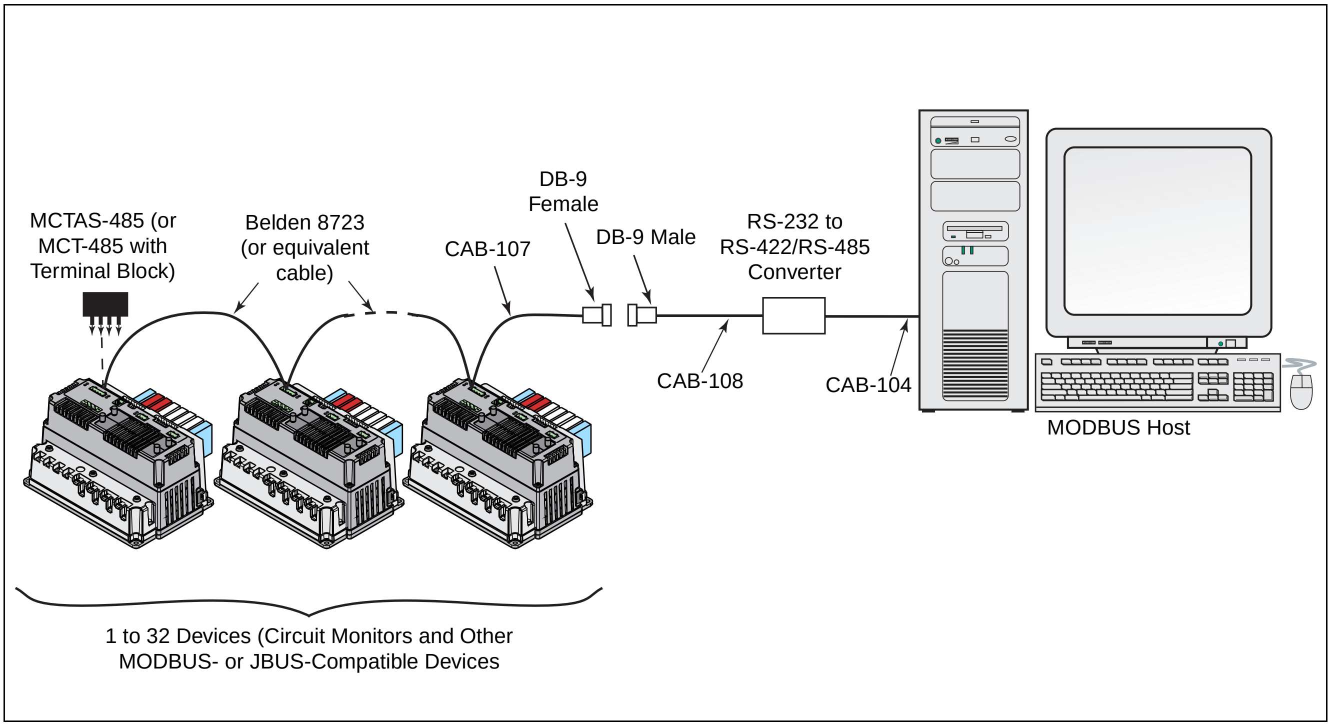


Figure 6–9 Circuit monitors connected to a PC serial port through the RS-485 port on the circuit monitor.

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

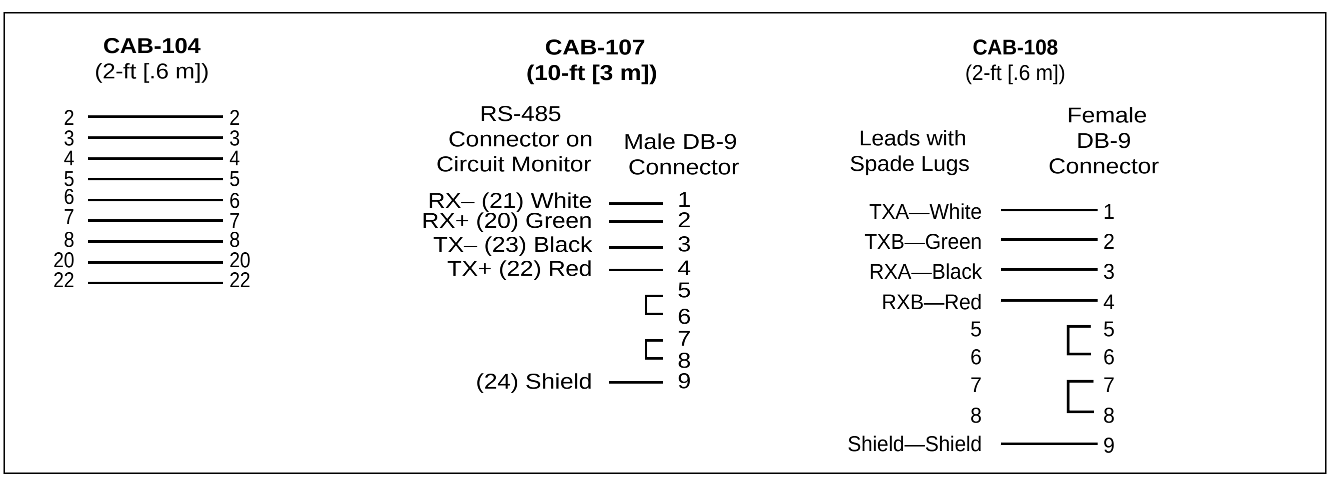


Figure 6–10 Cable Pinouts for RS-485 Connection

WIRING FOR 2-WIRE MODBUS OR JBUS COMMUNICATION

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

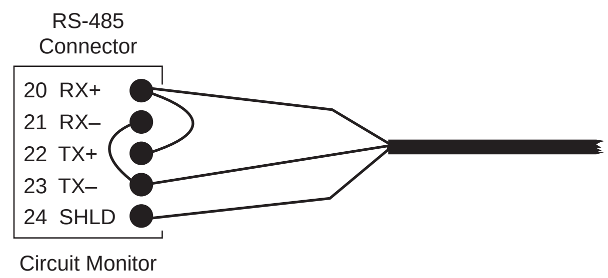


Figure 6–11 2-wire MODBUS or JBUS wiring

Table 6–3 shows the maximum distance of a daisy chain devices 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 6–3: Maximum distances of 2-wire MODBUS or JBUS comms link at different baud rates

BaudRate	Maximum Distances	
	1–8 Devices	9–16 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 (1,524 m)	2,500 ft (762 m)
38400	3,000 ft (914 m)	2,000 ft (610 m)

CONNECTING TO A POWERLOGIC ETHERNET GATEWAY (EGW)

Two models of the POWERLOGIC Ethernet Gateway are available:

- A single-port model (EGW1) and
- A dual-port model (EGW2)

The serial port on the EGW1 can support up to 8 POWERLOGIC devices. Each serial port on the EGW2 can support up to 32 devices on a daisy chain, or up to 64 devices when a signal repeater is used.

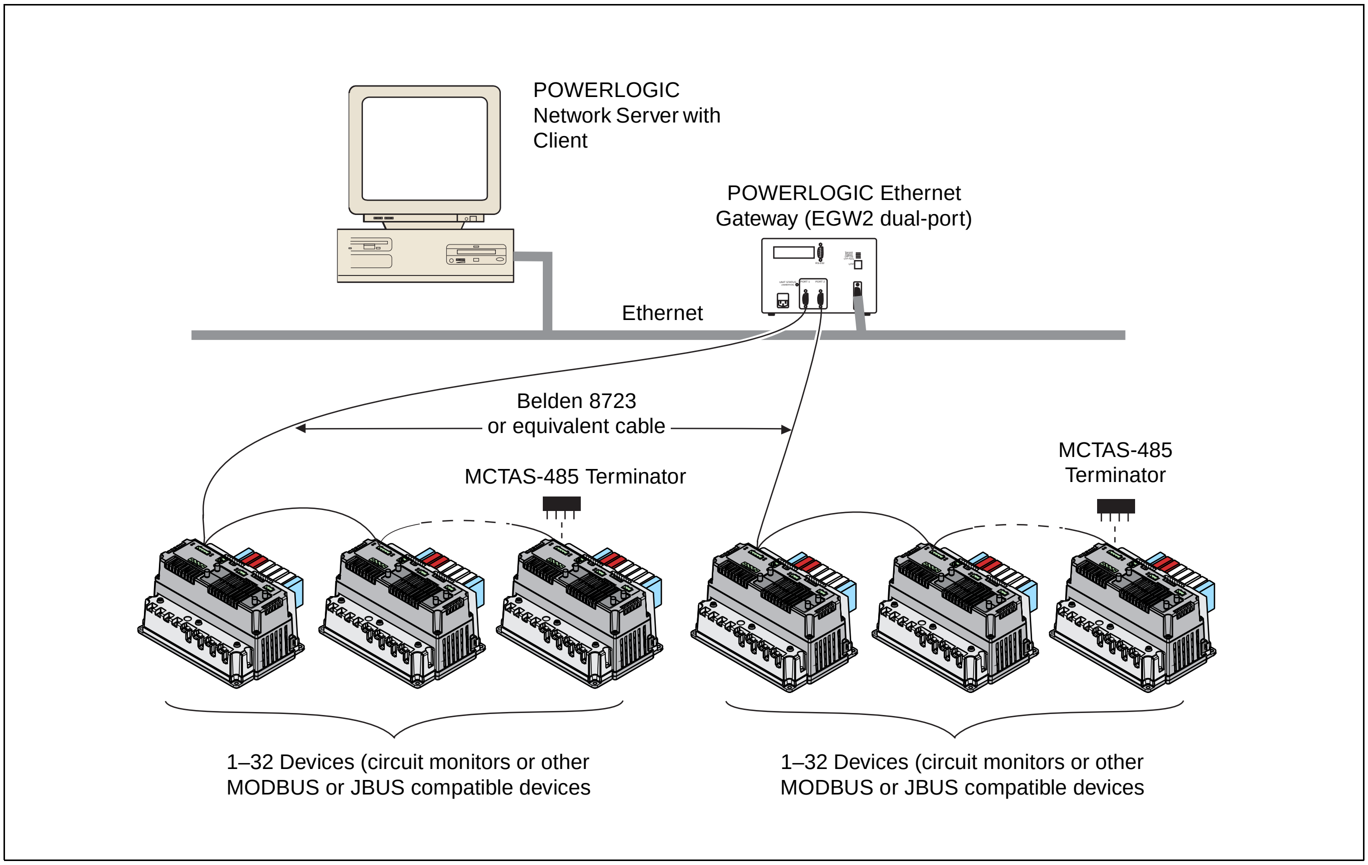


Figure 6–12 Circuit monitors connected to Ethernet using a POWERLOGIC Ethernet Gateway

CONNECTING TO A POWERLOGIC ETHERNET COMMUNICATIONS 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 imbedded web page feature of the ECC, 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.

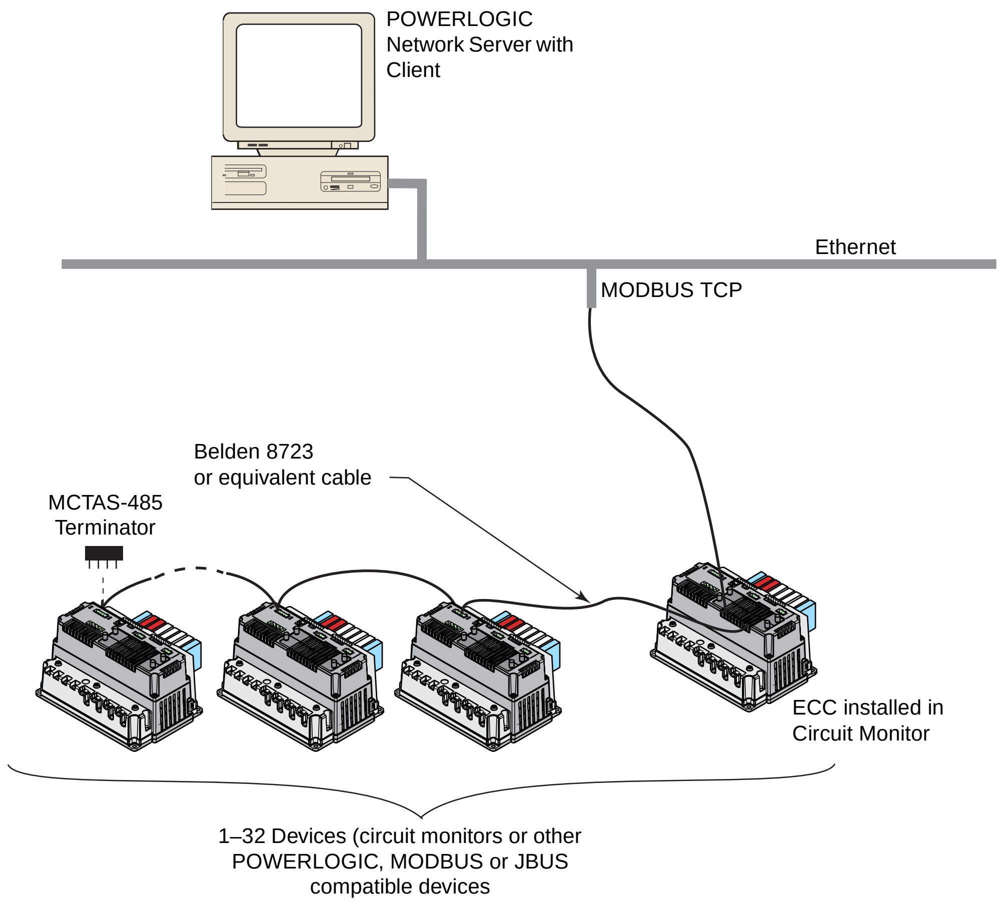


Figure 6–13 Circuit monitors connected to an Ethernet Communications Card (ECC)

CHAPTER 7—OPERATION

This chapter tells how to set up the circuit monitor from the display only. 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.

CHAPTER CONTENTS

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.

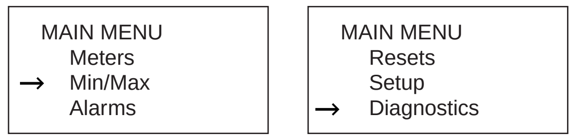


Figure 7–1 Arrow on the display screen

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.

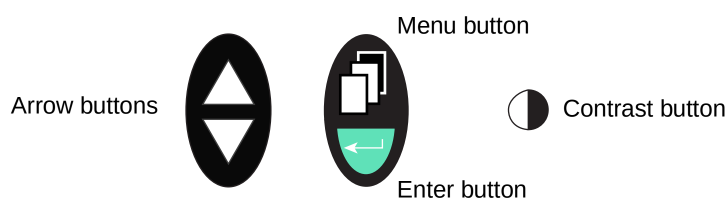


Figure 7–2 Display buttons

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, it takes you 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

This section explains a few conventions that were developed to streamline instructions in this chapter. Figure 7–3 shows the parts of a menu.

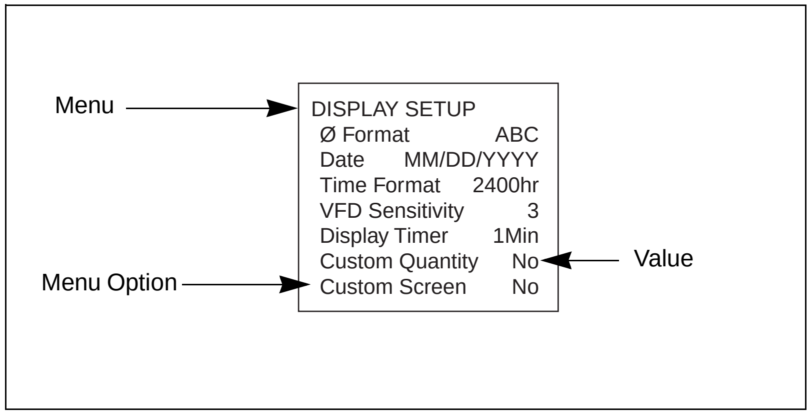


Figure 7–3 Parts of a menu

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 in a menu option, 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”
5. Press the arrow to change to “Yes” and press the enter button to save the changes.

MAIN MENU OVERVIEW

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 options on the Main Menu. The menus are briefly described below:

- **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 ten of the most recent high priority alarms.
- **I/O Display**. From this menu, you can view the designation and status of each input or output.
- **Resets**. This menu lets you peak demand.
- **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 is also an option 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.

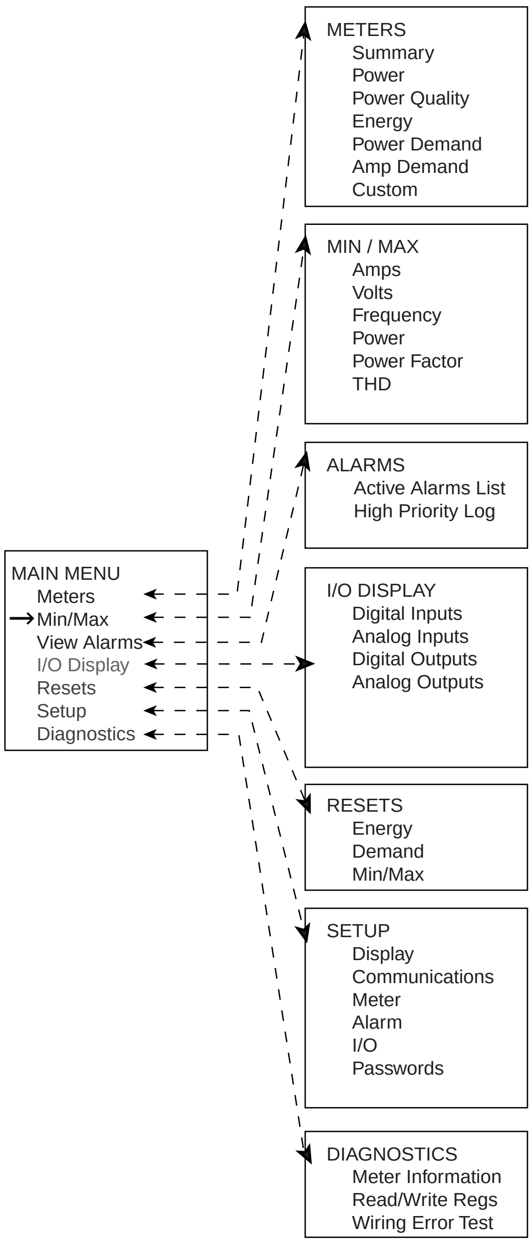


Figure 7–4 Menu options on the Main Menu

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. The default password is 0. To change the password, see “Setting Up Passwords” on page 87. The Setup menu has the following options:

- Display
- Communications
- Meter
- Alarm
- I/O
- Passwords

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

Setting Up the Display

Setting up the display involves, for example, selecting the phase format or choosing a date and time format that you want to be displayed. If you want to reset the date and time of the circuit monitor, see “Setting Up the Metering Functions of the Circuit Monitor” on page 79. 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.

```
DISPLAY SETUP
 Ø Format            ABC
 Date         MM/DD/YYYY
 Time Format      2400hr
 VFD Sensitivity       3
 Display Timer      1Min
 Custom Quantity      No
 Custom Screen        No
```

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
Ø Format	ABC 123	Phase format you want to use when viewing metered values.	ABC
Date	MM/DD/YYYY YYYY/MM/DD	Data format for all date-related values of the circuit monitor.	MM/DD/YYYY
Time Format	2400 hour AM/PM	Time format can be 24-hour military time or 12-hour clock with AM and PM.	AM/PM
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” on page 88.		
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” on page 90.		

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.

   ```
   COMMUNICATIONS
    RS-485
    RS-232
    Infrared Port
    Ethernet Option
   ```

   NOTE: You can set up Ethernet communications only if the circuit monitor is equipped with an ECC card.

2. From the Comms Setup menu, select the type of communications that you are using. Depending on what you select, the screen for that communications setup displays.

RS-485	
Protocol	Modbus
Addres	1
Baud Rate	9600
Parity	Even

RS-232	
Protocol	Modbus
Address	1
Baud Rate	9600
Parity	Even

INFRARED PORT	
Protocol	Modbus
Address	1
Baud Rate	9600

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	1–247	Device address of the circuit monitor. See “Setting the Device Address” on page 77 for requirements of device addressing.	1
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. (Only 9600 and 19200 are available for infrared port communication.)	9600
Parity	Even 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 26 in **Chapter 4—Installation** for more information. To set up the Ethernet communications between the circuit monitor and the network, refer to instruction bulletin no. 63230-304-200 provided with the ECC.

Setting Up the Metering Functions of the Circuit Monitor

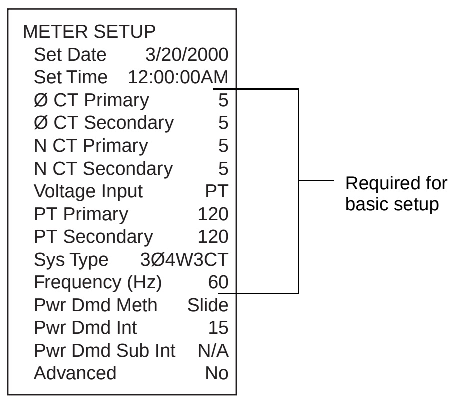
To set up the metering within the circuit monitor, you must configure the following items on the Meter Setup screen for basic setup:

- CT and PT ratios
- System type
- Frequency

The date and time of the circuit monitor, 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 if you are accepting the factory defaults already defined in the circuit monitor. Follow these steps to set up the circuit monitor:

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

   The Meter Setup screen displays. Table 7–3 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
Set Date	Numeric	Manually change the date. To change the format, see “Setting Up the Display” on page 76.	Current Date
Set Time	Numeric	Manually change the time. To change the format, see “Setting Up the Display” on page 76.	Greenwich Mean Time
CT Primary	1–32,768	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
Voltage Input	No PT PT	No PT—for direct connect, the PT Primary and PT Secondary will display as N/A. PT—for connection using PTs, enter the PT Primary and PT Secondary values.	No PT
PT Primary	1–1,700,000	Set the rating for the PT primary.	120
PT Secondary	100 110 115 120	Set the rating for the PT secondaries.	120

Table 7–3: Options for Meter Setup

Sys Type	3Ø3W2CT 3Ø3W3CT 3Ø4W3CT 3Ø4W4CT 3Ø4W3CT 3Ø4W4CT	3Ø3W2CT is system type 30 3Ø3W3CT is system type 31 3Ø4W3CT is system type 40 3Ø4W4CT is system type 41 3Ø4W3CT is system type 42 3Ø4W4CT is system type 43 Set the system type. A system type code is assigned to each type of system connection. See Table 5–2 on page 34 for a description of system connection types.	3Ø4W3CT (40)
Frequency	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” on page 111 for a detailed description. Slide—Sliding Block Demand Block—Fixed Block Demand RBlock—Rolling Block Demand Clock—Clock-Synchronized Block Demand RClock—Clock-Synchronized Rolling Block Demand RInput—Input-Synchronized Rolling Block Demand Comms—Command-Synchronized Block Demand RComms—Command-Synchronized Rolling Block Demand Input—Input-Synchronized Block Demand Thermal—Thermal Demand		Slide
Pwr Dmd Int	1–60	Power demand interval—set the space of 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	Change to Yes if you want to use this feature. See “Advanced Meter Setup” on page 93 in this chapter for more information.		

Setting Up Alarms

This section describes how to setup alarms and create new ones. For a detailed description of alarm capabilities, see **Chapter 10—Alarms** on page 137. The circuit monitor can detect over 100 alarm conditions, including over/under conditions, status input changes, phase unbalance conditions, and more. Some alarms are preconfigured and enabled at the factory. See "Factory Defaults" on page 9 in **Chapter 3—Getting Started** for information about preconfigured alarms. You can edit the parameters of any preconfigured alarm from the display.

For each alarm that you set up, do the following:

- Select the alarm group that defines the type of alarm:
  - — *Standard speed* alarms have a detection rate of one second and are useful for detecting conditions such as over current and under voltage. Up to 80 alarms can be set up in this alarm group.
  - — *High speed* alarms have a detection rate of 100 milliseconds and are useful for detecting voltage sags and swells that last a few cycles. Up to 20 alarms can be set up in this group.
  - — *Disturbance monitoring* alarms have a detection rate of less than one cycle and are useful for detecting voltage sags and swells. Up to 20 alarms can be set up in this group.
  - — *Digital* alarms are triggered by an exception such as the transition of a status input or the end of an incremental energy interval. Up to 40 alarms can be set up in this group.
- Select the alarm that you want to configure. Keep the default name or input a new name with up to 15 characters.
- Enable the alarm condition.
- Assign a priority to the alarm condition:
  - — If *high priority* alarm occurs, the display informs you in two ways: the red LED flashes until you acknowledge the alarm and a message flashes displaying whether the alarm is active or unacknowledged. You can also view a log of the last 10 high priority alarms on the display.
  - — If *medium priority* alarm occurs, the LED and message flashes only while the alarm is active. When the alarm becomes inactive, the LED and message stop.
  - — If *low priority* alarm occurs, the LED on the display flashes only while the alarm is active. No alarm message displays.
  - — If an alarm is setup with *no priority*, no visible representation will appear on the display.
- Define any required pickup and dropout setpoints, and pickup and dropout time delays (for standard, high speed, and disturbance alarm groups only, refer to "Scaling Alarm Setpoints" on page 146 in **Chapter 10—Alarms**).

Creating a New Custom Alarm

In addition to editing an alarm, you can also create new custom alarms by performing two steps:

1. Create the custom alarm.
2. Setup and enable the new alarm.

To use custom alarms, you must first create a custom alarm and then set up the alarm to be used by the circuit monitor. Creating an alarm defines information about the alarm including:

- Alarm group (standard, high speed, or digital)
  NOTE: Disturbance alarms are not available as custom alarms.
- Name of the alarm
- Type (such as whether it alarms on an over or under condition)
- Register number of the value that will be alarm upon

To create an alarm, follow these steps:

1. From the Main Menu, select Setup > Alarm > Create Custom.
   The Create Custom screen displays.

```
CREATE CUSTOM
 Standard        1 sec
 High Speed      100ms
 Digital
```

2. Select the Alarm Group for the alarm that you are creating:
   - Standard—detection rate of 1 second
   - High Speed—detection rate of 100 millisecond
   - Digital—triggered by an exception such as a status input or the end of an interval

   The Select Position screen displays and jumps to the first open position in the alarm list.

```
SELECT POSITION
 42 Over THD Vca
 43 *******************
 44 *******************
```

3. Select the position of the new alarm.
   The Alarm Parameters screen displays.

```
ALARM PARAMETERS
 Lbl:
 Type          OverVal
 Register         1000
```

   Table 7–4 on page 83 describes the options on this menu.

Table 7–4: Options for Creating an Alarm

Option	Available Values	Selection Description	Default
Lbl	Alphanumeric	Label—name of the alarm. Press the down arrow button to scroll through the alphabet. The lower case letters are presented first, then uppercase, then numbers and symbols. Press the enter button to select a letter and move to the next character field. To move to the next option, press the menu button.	—
Type	Select the type of alarm that you are creating. *Note: For digital alarms, the type is either ON state, OFF state, or Unary to describe the state of the digital input. Unary is available for digital alarms only.* ① OverVal—over value OverPwr—over power OverRevPwr—over reverse power UnderVal—under value Undr Pwr—under power PhsRev—phase reversal PhsLossVolt—phase loss, voltage PhsLossCur—phase loss, current PF Lead—leading power factor PF Lag—lagging power factor See Table 10–3 on page 150 for a description of alarm types.		OverVal
Register	4- or 5-digits 1–84	For standard or high speed alarms this is the register number that holds the quantity to be evaluated. For digital alarms, this value (1–84) represents the I/O reference number of the input that you want to alarm upon. See “I/O Position Numbers” on page 240 to determine the reference number.	—

① Unary is a special type of alarm used for ”end of” digital alarms. It does not apply to setting up alarms for digital inputs.

4. Press the menu button to save. Now, you are ready to set up the newly created custom alarm.

Setting Up and Editing Alarms

To set up a newly created custom alarm for use by the circuit monitor, use the Edit Parameters option on the Alarm screen. You can also change parameters of any alarm, new or existing. For example, using the Edit option you can enable or disable an alarm, change its priority, and change its pickup and dropout setpoints.

Follow these instructions to set up or edit an alarm:

1. From the Main Menu, select Setup > Alarm > Edit Parameters.
   The Create Custom screen displays.

```
CREATE CUSTOM
 Standard        1 sec
 High Speed      100ms
 Digital
```

2. Select the Alarm Group:
   - Standard—detection rate of 1 second
   - High Speed—detection rate of 100 millisecond
   - Digital—triggered by an exception such as a status input or the end of an interval

The Select Alarm screen displays.

```
SELECT ALARM
→*1 Over Ia
  2 Over Ib
  3 Over Ic
```

NOTE: If you are setting up or editing a digital alarm, alarm names such as Breaker 1 trip, Breaker 1 reset will display instead.

3. Select the alarm you want to set up or edit.

   The Edit Alarm screen with the alarm parameters displays. Table 7–5 describes the options on this menu.

```
EDIT ALARM
Lbl:           Over Current B
Enable                      N
Priority                 None
Pickup                      0
P/up Delay(s)               0
Dropout                     0
D/out Delay(s)              0
```

NOTE: If you are setting up or editing a digital alarm, fields related to pickup and dropout are not applicable and will not be displayed.

4. Use the arrow buttons to scroll to the menu option you want to change.
5. Change the options and press the menu button to save.

   The Select Alarm screen displays. The pound sign (#) indicates that the alarm has been edited.
6. Press the menu button to exit Setup and enable the alarm.

   NOTE: An asterisk next to the alarm in the alarm list indicates that the alarm is enabled.

Table 7–5: Options for Editing an Alarm

Option	Available Values	Selection Description	Default
Lbl	Alphanumeric	Label—name of the alarm assigned to this position. Press the down arrow button to scroll through the alphabet. The lower case letters are presented first, then uppercase, then numbers and symbols. Press the enter button to select a letter and move to the next character field. To move to the next option, press the menu button.	Name of the alarm assigned to this position.
Enable	Y N	Select *Y* to make the alarm available for use by the circuit monitor. On preconfigured alarms, the alarm may already be enabled. Select *N* to makes the alarm function unavailable to the circuit monitor.	Depends on individual alarm.
Priority	None Low Medium High	*Low* is the lowest priority alarm. *High* is the highest priority alarm and also places the active alarm in the list of high priority alarms. To view this list from the Main Menu, select Alarms > High Priority Alarms. For more information, see “Viewing Alarms” on page 99.	Depends on individual alarm.
Pickup	1–32,767	When you enter a delay time, the number is multiples of time. For example, for standard speed the time is 2 for 2 seconds, 3 for 3 seconds, etc. For high speed alarms, 1 indicates a 100 ms delay, 2 indicates a 200 ms delay, and so forth. For disturbance the time constant is 1 cycle. See “Setpoint-Driven Alarms” on page 139 for an explanation of pickup and dropout setpoints.	Depends on individual alarm.
PU Dly Multpl	Pickup Delay 1–32,767		
Dropout	1–32,767		
PO Dly Multpl	Dropout Delay 1–32,767		

Setting Up I/Os

To set up an I/O, you must do the following:

1. Install the I/O option module following the instructions provided with the product.
2. Use the display to select which IOX option is installed.
3. Use SMS to setup each individual input and output.

For a description of I/O options, see **Chapter 9—Input/Output Capabilities** on page 121. To view the status of an I/O, see “Viewing I/O Status” on page 101. You need to know the position number of the I/O to set it up. See “I/O Position Numbers” on page 240 to determine this number. To set up an I/O, follow these steps:

1. From the Main Menu, select Setup.

   The password prompt displays.
2. Select your password. The default password is 0.

   The Setup menu displays.

```
SETUP
   Display
   Communications
   Meter
   Alarm
   I/O
   Passwords
```

3. Select I/O.

   The I/O Setup menu displays.

```
I/O
   I/O Extender (C)
```

4. Select the I/O option that you have installed. In this example, we selected the I/O Extender (C).

   The I/O Extender selection menu displays.

```
EXTENDER (C)
→IOX-08
 IOX-0404
 IOX-2411
 Custom
```

If you have the IOX-08, IOX-0404, or IOX-2411, select the option you have installed. A pound sign (#) appears next to the option to indicate that the circuit monitor has recognized the module. If you installed individual custom I/Os, select Custom on the Extender (C) menu.

The Custom Extender menu displays.

```
CUSTOM
→Postion 1
 Postion 2
 Postion 3
 Postion 4
 Postion 5
 Postion 6
 Postion 7
 Postion 8
```

5. Select the position in which the I/O is installed. Then, select which I/O module is located in that position. The individual I/Os are described in Table 7–6.

```
Position 1

→DI32DC
 DI120AC
 DI240AC
 DO120AC
 DO60DC
 DO200DC
 DO120AC
 DO240AC
 AI05
 AI420
 AO420
```

Table 7–6: I/O Descriptions

I/O Name	Description
Digital I/Os	
DI32DC	32 Vdc input (0.2ms turn on) polarized
DI120AC	120 Vac input
DO120AC	120 Vac output
DI240AC	240 Vac input
DO60DC	60 Vdc output
DO200DC	200 Vdc output
DO240AC	240 Vac output
Analog I/Os	
AI05	0 to 5 Vdc analog input
AI420	4 to 20 mA analog input
AO420	4 to 20 mA analog output

When you select an input or output, a pound sign (#) is displayed next to it to indicate your selection.

```
Position 1
→#DI132DC
  DI120AC
  DO240AC
```

6. Press the menu button to save.

Setting Up Passwords

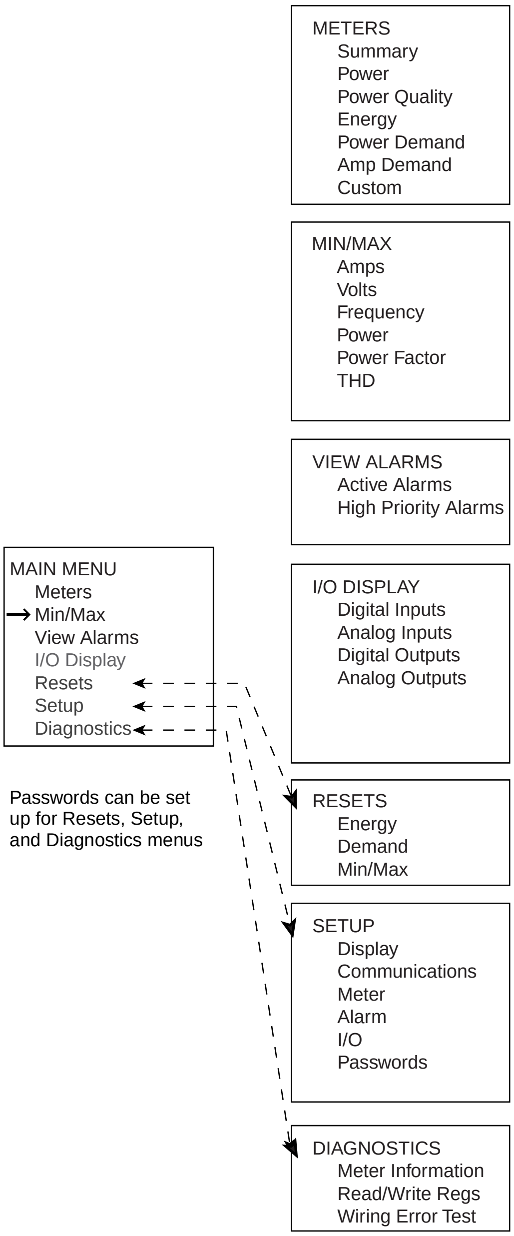


Figure 7–5 Menus that can be password protected

A password is always required to access the following menus from the Main Menu:

- Resets (a separate password can be set up for Energy/Demand Reset and Min/Max Reset)
- Setup
- Diagnostics

The default password is 0. Therefore, when you receive a new circuit monitor, the password for the Setup, Diagnostics, and Reset menu is 0. If you choose to set up passwords, you can set up a different password for each of the four menus options listed above.

To set up a 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.

```
SETUP
   Display
   Communications
   Meter
   Alarm
   I/O
   Passwords
```

3. Select Passwords.
   The Password Setup menu displays. Table 7–7 describes the options.

```
PASSWORDS
  Setup            0
  Diagnostics      0
  Engy/Dmd Reset   0
  Min/Max Reset    0
```

Table 7–7: Options for Password Setup

Option	Available Values	Description
Setup	0–9999	Enter a password in the Setup field to create a password for the Setup option on the Main Menu.
Diagnostics	0–9999	Enter a password in the Diagnostics field to create a password for the Diagnostics option on the Main Menu.
Engy/Dmd Reset	0–9999	Enter a password in the Engy/Dmd Reset field to create a password for resetting Energy and Demand. These options appear on the Reset menu, and they can also be locked. See “Advanced Meter Setup” on page 93 for instructions.
Min/Max Reset	0–9999	Enter a password in the Min/Max Reset field to create a password for resetting the Min/ Max, which appears on the Reset menu. This option can also be locked. See “Advanced Meter Setup” on page 93 for instructions.

Advanced Setup Features

The features discussed in this section are not required for basic circuit monitor setup, but can be used to customize your circuit monitor to suit your needs.

Creating Custom Quantities to be Displayed

Any quantity that is stored in a register in the circuit monitor can be displayed on the remote display. The circuit monitor has a list of viewable quantities already defined such as average current, power factor total, and so forth. In addition to these predefined values, you can define custom quantities that can be displayed on a custom screen. For example, if your facility uses different types of utility services such as water, gas, and steam, you may want to track usage of the three services on one convenient screen. To do this, you could set up inputs to receive pulses from each utility meter, then display the scaled register quantity.

For the circuit monitor display, custom quantities can be used to display a value. Don’t confuse this feature with SMS custom quantities. SMS custom quantities are used to add new parameters on which SMS can use to perform functions. SMS custom quantities are defined, for example, when you add a new POWERLOGIC-compatible device to SMS or if you want to import data into SMS from another software package. You can use the SMS custom quantities in custom tables and interactive graphics diagrams, but you cannot use circuit monitor display custom quantities in this way. *Custom quantities that you define for display from the circuit monitor are not available to SMS. They must be defined separated in SMS.*

To use a custom quantity, perform these tasks:

1. **Create the custom quantity** as described in this section.
2. **Create a custom screen** on which the custom quantity can be displayed.
   See “Creating Custom Screens” on page 90 in the following section. You can view the custom screen by selecting from the Main Menu, Meters > Custom. See “Viewing Custom Screens” on page 93 for more information.

To create a custom quantity, follow these steps:

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

```
SETUP
   Display
   Communications
   Meter
   Alarm
   I/O
   Passwords
```

3. Select Display.

The Display Setup menu displays.

```
DISPLAY SETUP
 Ø Format            ABC
 Date        MM/DD/YYYY
 Time Format      2400hr
 VFD Sensitivity       3
 Display Timer      1Min
 Custom Quantity      No
 Custom Screen        No
```

4. Select Custom Quantity.

   The “No” begins to flash.
5. Press the arrow button to change to “Yes” and press the enter button.

   The Custom Quantity Setup screen displays.

```
CUSTOM QUANT SETUP
 Custom Quantity 1
 Custom Quantity 2
 Custom Quantity 3
 Custom Quantity 4
```

6. Select a custom quantity.

   In this example, we selected Custom Quantity 1. Table 7–8 shows the available values.

```
Custom Quantity 1
 Label   ***************
 Register           ####
 Scale               1.0
 Format          Integer
```

7. Use the arrow buttons to scroll to the menu option you want to change.
8. 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.
9. 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 7–8: Options for Custom Quantities

Option	Available Values	Default
Label	Name of the quantity up to 10 characters. Press the arrow buttons to scroll through the characters. To move to the next option, press the menu button.	********
Register	4- or 5-digit number of the register in which the quantity exists.	#####
Scale	Multiplier of the register value can be one of the following: .001, .01, .1, 1.0, 10, 100 or 1,000. See “Scale Factors” on page 145 for more information.	1.0
Format	Integer D/T—date and time MOD10L4—Modulo 10,000 with 4 registers① MOD10L3—Modulo 10,000 with 3 registers① Label ②	Integer

① Modulo 10,000 is used to store energy. See the SMS online help for more.
② Use the Label format only when a label has been defined with no corresponding register.

An asterisk (*) next to the quantity indicates that the quantity has been added to the list.

10. To save the changes to the Display Setup screen, press the menu button.

The custom quantity is added to the Quantities List in the Custom Screen Setup. The new quantity appears at the end of this list after the standard quantities. After creating the custom quantity, you must create a custom screen to be able to view the new quantity.

Creating Custom Screens

You choose the quantities that are to be displayed on a custom screen. The quantities can be standard or custom quantities. If you want to display a custom quantity, you must first create the custom quantity so that it appears on the Quantities List. See “Creating Custom Quantities to be Displayed” on page 88 for instructions.

To create a custom screen, follow these steps:

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

```
SETUP
   Display
   Communications
   Meter
   Alarm
   I/O
   Passwords
```

3. Select Display.
   The Display Setup menu displays.

DISPLAY SETUP	
Ø Format	ABC
Date	MM/DD/YYYY
Time Format	2400hr
VFD Sensitivity	3
Display Timer	1Min
Custom Quantity	No
Custom Screen	No

4. Select Custom Screen.
   The “No” begins to flash.
5. Press the arrow button to change to “Yes” and press the enter button.
   The Custom Screen Setup screen displays.

```
CUSTOM SCREEN SETUP
→Custom Screen 1
  Custom Screen 2
  Custom Screen 3
  Custom Screen 4
  Custom Screen 5
```

6. Select a custom screen.

In this example, we selected Custom Screen 1.

```
SCREEN 1
  Blank Line
  Blank Line
  Blank Line
```

The cursor begins to blink.

7. Create a name for the custom screen. Press the arrow buttons to scroll through the alphabet. Press the enter button to move to the next character field.
8. When you have finished naming the screen, press the menu button to jump to the first blank line.

```
Monthly Energy Cost
  Blank Line
  Blank Line
  Blank Line
```

The first blank line begins to blink.

9. To choose a quantity to be displayed on this line, press the enter button.

   The Quantities List displays.

```
  QUANTITIES LIST
    Blank Line
→   Ia
    Ib
    :
```

10. Select the quantity that you want to be displayed on your custom screen.

    Table 7–9 lists the default quantities that appear in the Quantities List. If you have created a custom quantity, it will be displayed at the bottom of this list. Press the up arrow button to quickly jump to the custom quantities.

Table 7–9: Available Default Quantities

Quantity	Label (displayed on the screen)
Current A	Ia
Current B	Ib
Current C	Ic
Current N	In
Current G	Ig
Current Average	I Avg
Voltage A–B	Vab
Voltage B–C	Vbc
Voltage C-A	Vca
Voltage L–L Average	V L-L Avg
Voltage A–N	Van
Voltage B–N	Vbn
Voltage C–N	Vcn
Voltage L–N Average	V L-N Avg
Frequency	Freq
Power Factor Total	PF Total
Displacement Power Factor Total	Dis PF Tot

Table 7–9: Available Default Quantities

Quantity	Label (displayed on the screen)
Real Power Total	kW Total
Reactive Power Total	kVAR Total
Apparent Power Total	kVA Total
THD Current A	THD Ia
THD Current B	THD Ib
THD Current C	THD Ic
THD Current N	THD In
THD Voltage A–N	THD Van
THD Voltage B–N	THD Vbn
THD Voltage C–N	THD Vcn
THD Voltage A–B	THD Vab
THD Voltage B–C	THD Vbc
THD Voltage C–A	THD Vca
Real Energy, Total	kWHr Tot
Reactive Energy, Total	kVARHr Tot
Apparent Energy, Total	kVAHr Tot
Demand Current Average	Dmd I Avg
Demand Current A	Dmd Ia
Demand Current B	Dmd Ib
Demand Current C	Dmd Ic
Demand Current N	Dmd In
Demand Voltage A–N	Dmd Van
Demand Voltage B–N	Dmd Vbn
Demand Voltage C–N	Dmd Vcn
Demand Voltage L–N Average	Dmd V L-N
Demand Voltage A–B	Dmd Vab
Demand Voltage B–C	Dmd Vbc
Demand Voltage C–A	Dmd Vca
Demand Voltage L–L Avg	Dmd V L-L
Demand Real Power (kWD)	Dmd kW
Demand Reactive Power (kVARD)	Dmd kVAR
Demand Apparent Power (kVA)	Dmd kVA
3rd Harmonic Magnitude Voltage A	Van 3rd
5th Harmonic Magnitude Voltage A	Van 5th
7th Harmonic Magnitude Voltage A	Van 7th
3rd Harmonic Magnitude Voltage B	Vbn 3rd
5th Harmonic Magnitude Voltage B	Vbn 5th
7th Harmonic Magnitude Voltage B	Vbn 7th
3rd Harmonic Magnitude Voltage C	Vcn 3rd
5th Harmonic Magnitude Voltage C	Vcn 5th
7th Harmonic Magnitude Voltage C	Vcn 7th
Current Unbalance Max	I Unbl Mx
Voltage Unbalance Max L-L	V Unbl Mx L–L
Voltage Unbalance Max L-N	V Unbl Mx L–N

Viewing Custom Screens

If you have a custom screen setup, a "Custom" option will be displayed on the Meters menu.

To view a custom screen, from the Main Menu select Meters > Custom. In this example, a custom screen was created for monthly energy cost. Press the arrow button to view the next custom screen. Press the menu button to exit and return to the Main Menu.

```
Monthly Energy Cost

  Dollars            8632
```

Advanced Meter Setup

The Advanced option on the Meter Setup screen lets you perform miscellaneous advanced setup functions on the metering portion of the circuit monitor. For example, on this menu you can change the phase rotation or the VAR sign convention. The advanced options are described below.

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

```
SETUP
    Display
    Communications
    Meter
    Alarm
    I/O
    Passwords
```

3. Select Meter.
   The Meter Setup screen displays.

```
METER SETUP
  Set Date         3/20/2000
  Set Time       12:00:00AM
  Ø CT Primary             5
  Ø CT Secondary           5
  N CT Primary             5
  N CT Secondary           5
  Voltage Input           PT
  PT Primary             120
  PT Secondary           120
  Sys Type           3Ø4W3CT
  Frequency (Hz)          60
  Pwr Dmd Meth         Slide
  Pwr Dmd Int             15
  Pwr Dmd Sub Int        N/A
  Advanced                No
```

4. Scroll to the bottom of the list and select Advanced.
5. Change the "No" to "Yes" and press the enter button.

The Advanced Meter Setup screen displays. Table 7–10 on page 94 describes the options on this menu.

```
ADVANCED METER SETUP
  Phase Rotation     ABC
  Incr Energy Int     60
  THD Select         THD
  VAR Sign      Standard
  Lock Energy Reset    N
  Lock Pk Dmd Reset    N
  Lock M/M Reset       N
```

6. Change the desired options and press the menu button to save.

Table 7–10: Options for Advanced Meter Setup

Option	Available Values	Selection Description	Default
Phase Rotation	ABC or CBA	Set the phase rotation to match the system.	ABC
Incr Energy Int	0–1440	Set incremental energy interval in minutes. The interval must be evenly divisible into 24 hours.	60
THD Select	THD or thd	Set the calculation for total harmonic distortion. See “Power Analysis Values” on page 119 for a detailed description.	THD
VAR Sign	Standard Old CM2	Set the VAR sign convention. See “VAR Sign Conventions” on page 109 for a discussion about VAR sign convention.	Standard
Lock Energy Reset	Y or N	Lock the energy reset on Energy/Dmd Reset option, which is used to reset accumulated energy. If set to Y (yes), the Energy/Dmd Reset option on the Reset menu will be locked so that the value cannot be reset from the display, even if a password has been set up for the Energy/Dmd Reset option. See “Resetting Min/Max, Demand, and Energy Values” on page 95 for more information.	N
Lock Pk Dmd Reset	Y or N	Lock the peak demand reset on Energy/Dmd Reset option, which is used to reset peak demand. If set to Y (yes), the Energy/Dmd Reset option on the Reset menu will be locked so that the value cannot be reset from the display, even if a password has been set up for the Energy/Dmd Reset option. See “Resetting Min/Max, Demand, and Energy Values” on page 95 for more information.	N
Lock M/M Reset	Y or N	Lock the M/M Reset option (minimum/maximum), which is used to reset the min/max values. If set to Y (yes), the Min/Max option on the Reset menu will be locked so that the value cannot be reset from the display, even if a password has been set up for the Min/Max Reset option. See “Resetting Min/Max, Demand, and Energy Values” on page 95 for more information.	N

RESETTING MIN/MAX, DEMAND, AND ENERGY VALUES

A reset clears the circuit monitor’s memory of the last recorded value. For example, you might need to perform a reset to look at the hourly, daily, or monthly energy use. From the Reset menu, shown in Figure 7–6, you can reset the following values:

- Energy—accumulated energy and conditional energy
- Demand—peak power demand and peak current demand
- Min/Max—minimum and maximum values for all real-time readings

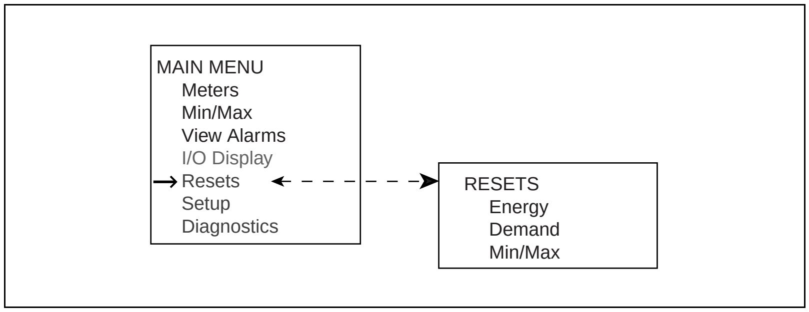


Figure 7–6 Performing resets from the Reset menu

A password is required to reset any of the options on the Reset menu. The default password is 0. See “Setting Up Passwords” on page 87 for more information about passwords.

You can perform resets from the circuit monitor as described in this section or if you are using SMS, you can set up a task to perform the reset automatically at a specified time. See the SMS online help for instructions.

NOTE: To stop users from using the display to reset energy, peak demand, and min/max values, see “Advanced Meter Setup” on page 93 for instructions on using the reset locking feature.

To perform resets, follow these steps:

1. From the Main Menu, select Resets.

   The Resets menu displays.

   ```
   RESETS
     Energy
   → Demand
     Min/Max
   ```

2. Use the arrow buttons to scroll through the menu options on the Resets menu. To select a menu option, press the enter button.

   Depending on the option you selected, the screen for that value displays.

   ```
   ENERGY                    DEMAND                     MIN/MAX
    Accumulated     No        Pk Power Dmd      No       Min/Max          No
    Conditional     No        Pk Current Dmd    No
   ```

3. Select the option you would like to reset and change No to Yes by pressing the arrow button.
4. Press Enter to move to the next option or press the menu button to reset the value.

VIEWING METERED DATA

The Meters menu and the Min/Max menu, shown in Figure 7–7, are view-only menus where you can view metered data in real time.

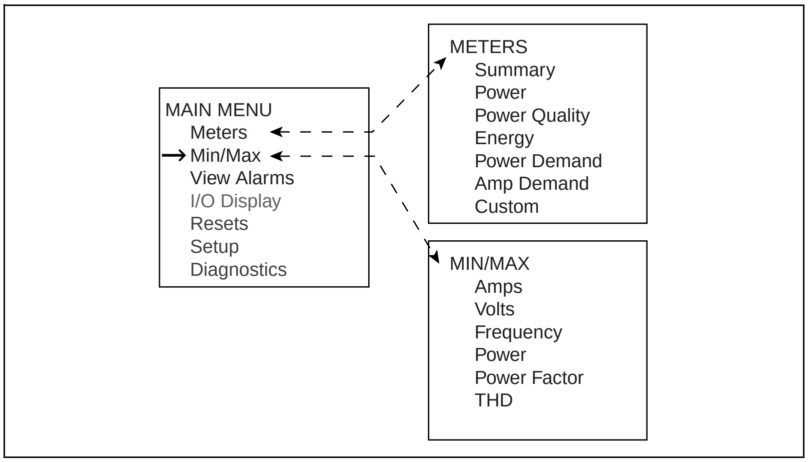


Figure 7–7 Viewing metered data on the Meters and Min/Max menus

Use the arrow buttons to scroll through the menu options on the Meters menu. To select a menu option, press the enter button. To select another option, press the menu button.

Viewing Metered Data from the Meters Menu

From the Meters menu you can view the following information.

- **Summary**—lets you quickly move through and view the following:
  - — Summary total of volts, amperes, and kW.
  - — Amperes and volts for all three phases, neutral and ground, line to line, line to neutral.
  - — Power kW, kVAR, and kVA (real, reactive, and apparent power) 3-phase totals.
  - — Power factor (true and displacement) 3-phase totals.
  - — Total energy kWh, kVARh, and kVAh 3-phase totals (real, reactive, and apparent energy).
  - — Frequency in hertz.
- **Power**—is displayed only if the circuit monitor is configured for 4-wire system; it will not appear for 3-wire systems. If you are using a 4-wire system, you can view the leading and lagging values for true and displacement power factor. Also this option lets you view power per-phase kW, kVAR, and kVA (real, reactive, and apparent power).
- **Power Quality**—shows the following values per phase:
  - — THD voltage line to neutral and line to line.
  - — THD amperes
  - — K-factor
  - — Fundamental volts and phase angle
  - — Fundamental amperes and phase angle
- **Energy**—shows accumulated and incremental readings for real and reactive energy into and out of the load, and the real, reactive, and apparent total of all three phases.

- **Power Demand**—displays total and peak power demand kW, kVAR, and kVA (real, reactive, and apparent power) for the last completed demand interval. It also shows the peak power demand kW, kVAR, and kVA with date, time, and coincident power factor (leading and lagging) associated with that peak.
- **Amp Demand**—shows total and peak demand current for all three phases, neutral, and ground. It also shows the date and time of the peak demand current.
- **Custom**—lists quantities that you have selected to be displayed. This option displays only if you have created a custom screen.To display custom values, you must first create a custom screen as described in "Creating Custom Screens" on page 90.

Viewing Minimum and Maximum Values from the Min/Max Menu

From the Min/Max menu you can view the minimum and maximum values recorded by the circuit monitor, and the date and time when that min or max value occurred. These values that can be view are:

- Amperes
- Volts
- Frequency
- Power
- Power Factor
- THD

To use the Min/Max menu, follow these steps:

1. Use the arrow buttons to scroll through the menu options on the Min/Max menu.

```
MIN/MAX
→ Amps
  Volts
  Frequency
  Power
  Power Factor
  THD
```

2. To select a menu option, press the enter button.

   The screen for that value displays. Press the arrow buttons to scroll through the min/max quantities.

```
AMPS A
  Min              300
  Max              350
  Press Enter for D/T
```

3. To view the date and time when the minimum and maximum value was reached, press the enter button. Press the arrow buttons to scroll through the dates and times.

```
AMPS A
Mn  01/22/2000   1:59A
Mx  01/22/2000   8:15A
```

4. Press the menu button to return to the Min/Max values
5. Press the menu button again to return to the Min/Max menu.

VIEWING ALARMS

The Alarms menu shown in Figure 7–8, lets you view active and high priority alarms.

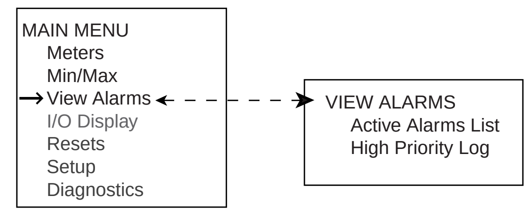


Figure 7–8 View Alarms menu

When an alarm is first set up, an alarm priority is selected. Four alarm levels are available:

- High priority—if high priority alarm occurs, the display informs you in two ways:
  - — The LED on the display flashes while the alarm is active and until you acknowledge the alarm
  - — A message flashes whether the alarm is active or unacknowledged.
- Medium priority—if medium priority alarm occurs, the LED and message flashes only while the alarm is active. Once the alarm becomes inactive, the LED and message stop.
- Low priority—if low priority alarm occurs, the LED on the display flashes only while the alarm is active. No alarm message is displayed.
- No priority—if an alarm is setup with no priority, no visible representation will appear on the display.

If multiple alarms with different priorities are active at the same time, the display shows the alarm message for the highest priority alarm.

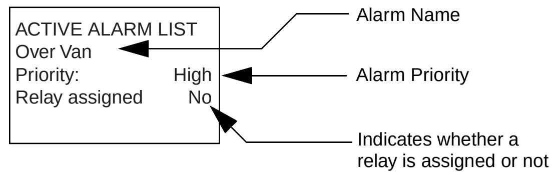
Each time an alarm occurs, the circuit monitor does the following:

- Puts the alarm in the list of active alarms. See “Viewing Active Alarms” on page 100 for more about active alarms.
- Performs any assigned action. The action could be one of the following:
  - — Operate one or more relays (you can view the status from the display)
  - — Force data log entries into the user-defined data log files (1–14 data logs can be viewed from SMS)
  - — Perform a waveform capture (can be viewed from SMS)
- Records the occurrence in the circuit monitor’s event log (can be viewed using SMS).

Also, the display LED and alarm messages will operate according to the priority selected when an alarm occurs.

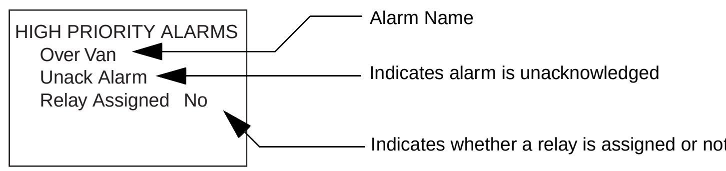
Viewing Active Alarms

The Active Alarms List displays currently active alarms, regardless of their priority. You can view all active alarms from the Main Menu by selecting View Alarms > Active Alarms List. The Active Alarm screen displays. Use the arrow buttons to scroll through the alarms that are active.



View and Acknowledging High Priority Alarms

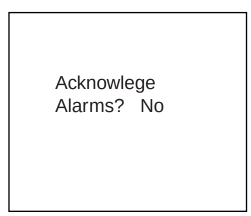
To view high priority alarms, from the Main Menu select View Alarms > High Priority Log. The High Priority Log screen displays. Use the arrow buttons to scroll through the alarms.



The High Priority Alarms screen displays the ten most recent, high-priority alarms. When you acknowledge the high priority alarms, any digital outputs (relays) that are configured for latched mode will be released. To acknowledge all high priority alarms follow these steps:

1. After viewing the alarms, press the menu button to exit.

   The display asks you whether you would like to acknowledge the alarm.



2. To acknowledge the alarms, press the arrow button to change No to Yes. Then, press the enter button.
3. Press the menu button to exit.

NOTE: You have acknowledged the alarms, but the LED will continue to flash as long as any high priority alarm is active.

VIEWING I/O STATUS

The I/O Display menu shows the ON or OFF status of the digital inputs or outputs. For analog inputs and outputs, it displays the present value. To view the status of inputs and outputs:

1. From the Main Menu, select I/O Display.

   The I/O Display screen displays.

   ```
   I/O DISPLAY
       Digital Inputs
       Analog Inputs
       Digital Outputs
       Analog Outputs
   ```

2. Select the input or output on which you'd like to view the status. In this example, we selected Digital Outputs to display the status of the KYZ output.

   ```
   DIGITAL OUTPUTS
       KYZ    OFF
   ```

3. Press the menu button to exit.

READING AND WRITING REGISTERS

You can access the read and write register menu option on the circuit monitor's display by selecting from the Main Menu > Diagnostics > Read/Write Regs as shown in Figure 7–9. This option lets you read and write circuit monitor registers from the display. This capability is most useful to users who 1) need to set up an advanced feature which *cannot* be set up using the circuit monitor's normal front panel setup mode, and 2) do not have access to SMS to set up the feature.

For example, the default operating mode for a circuit monitor relay output is *normal*. To change a relay's operating mode from normal to another mode (for example, latched mode), use either SMS or the Read/Write Regs option of the Diagnostics menu.

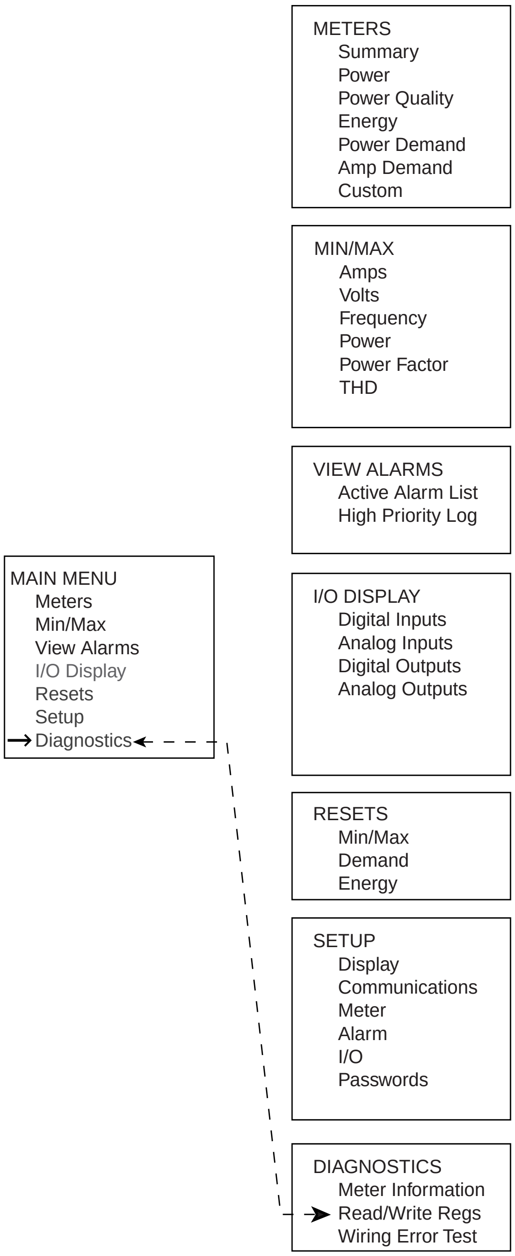


Figure 7–9 Diagnostics Menu accessed from the Main Menu

NOTE: Use this feature with caution. Writing an incorrect value, or writing to the wrong register could cause the circuit monitor to operate incorrectly.

To read or write registers, follow these steps:

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

```
DIAGNOSTICS
  Meter Information
  Read/Write Regs
  Wiring Error Test
```

3. Select Read/Write Regs.
   The Read/Write Registers screen displays. Table 7–11 describes the options on this screen.

```
READ/WRITE REGS

 Reg     Hex    Dec
 1003    0000    10
```

Table 7–11: Read/Write Register Options

Option	Available Values
Reg	List the register numbers.
Hex	List the hexidecimal value of that register.
Dec	List the decimal value of that register.

If you are viewing a metered value, such as voltage, the circuit monitor updates the displayed value as the register contents change. Note that scale factors are not taken into account automatically when viewing register contents.

4. To scroll through the register numbers, use the arrow buttons.
5. To change the value in the register, press the enter button.

The Hex and Dec option begins to blink. Use the arrow buttons to scroll through the numeric values available.

*NOTE: Some circuit monitor registers are **read/write**, some are **read only**. You can write to read/write registers only.*

6. When you are finished making changes to that register, press the enter button to continue to the next register or press the menu button to save the changes.

PERFORMING A WIRING TEST

The circuit monitor has the ability to perform a wiring diagnostic self-check when you select the Diagnostic > Wiring Error Test from the Main Menu as shown in Figure 7–10. For instruction on how to use this feature, see "Wiring Error Detection" on page 51 in **Chapter 5—Wiring**.

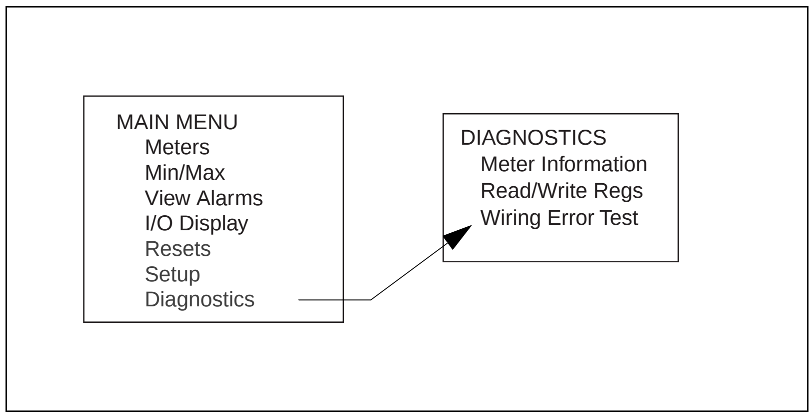


Figure 7–10   Wiring Error Test option on the Diagnostics menu.

CHAPTER 8—METERING CAPABILITIES

This chapter details the types of meter readings you can obtain from the circuit monitor.

CHAPTER CONTENTS

REAL-TIME READINGS

The circuit monitor measures currents and voltages and reports in real time the rms values for all three phases, neutral, and ground current. In addition, the circuit monitor calculates power factor, real power, reactive power, and more.

Table 8–1 lists the real-time readings that are updated every second along with their reportable ranges. When you are viewing real-time readings from the remote display or SMS, the circuit monitor is displaying one-second readings.

Table 8–1: One-Second, Real-Time Readings

Real-Time Readings	Reportable Range
Current	
Per-Phase	0 to 32,767 A
Neutral	0 to 32,767 A
Ground	0 to 32,767 A
3-Phase Average	0 to 32,767 A
Apparent rms	0 to 32,767 A
% Unbalance	0 to ±100.0%
Voltage	
Line-to-Line, Per-Phase	0 to 1,200 kV
Line-to-Line, 3-Phase Average	0 to 1,200 kV
Line-to-Neutral, Per-Phase	0 to 1,200 kV
Neutral to Ground	0 to 1,200 kV
Line-to-Neutral, 3-Phase Average	0 to 1,200 kV
% Unbalance	0 to 100.0%
Real Power	
Per-Phase①	0 to ± 3,276.70 MW
3-Phase Total	0 to ± 3,276.70 MW
Reactive Power	
Per-Phase①	0 to ± 3,276.70 MVAR
3-Phase Total	0 to ± 3,276.70 MVAR
Apparent Power	
Per-Phase①	0 to 3,276.70 MVA
3-Phase Total	0 to 3,276.70 MVA
Power Factor (True)	
Per-Phase①	–0.010 to 1.000 to +0.010
3-Phase Total	–0.010 to 1.000 to +0.010
Power Factor (Displacement)	
Per-Phase ①	–0.010 to 1.000 to +0.010
3-Phase Total	–0.010 to 1.000 to +0.010
Frequency	
45–65 Hz	23.00 to 67.00 Hz
350–450 Hz	350.00 to 450.00 Hz
Temperature (Internal Ambient)	–100.00°C to +100.00°C

① Wye systems only.

The circuit monitor also has the capability of 100 ms updates. The 100 ms readings listed in Table 8–2 can be communicated over MODBUS TCP and are useful for rms event recording and high-speed alarms.

Table 8–2: 100 ms Real-Time Readings

Real-Time Readings	Reportable Range
Current	
Per-Phase	0 to 32,767 A
Neutral	0 to 32,767 A
Ground	0 to 32,767 A
3-Phase Average	0 to 32,767 A
Apparent rms	0 to 32,767 A
Voltage	
Line-to-Line, Per-Phase	0 to 1,200 kV
Line-to-Line, 3-Phase Average	0 to 1,200 kV
Line-to-Neutral, Per-Phase	0 to 1,200 kV
Neutral to Ground	0 to 1,200 kV
Line-to-Neutral, 3-Phase Average	0 to 1,200 kV
Real Power	
Per-Phase①	0 to +/– 3,276.70 MW
3-Phase Total	0 to +/– 3,276.70 MW
Reactive Power	
Per-Phase①	0 to ± 3,276.70 MVAR
3-Phase Total	0 to ± 3,276.70 MVAR
Apparent Power	
Per-Phase①	0 to ± 3,276.70 MVA
3-Phase Total	0 to ± 3,276.70 MVA
Power Factor	
3-Phase Total	0 to ± 3,276.70 MVA

① Wye systems only.

MIN/MAX VALUES FOR REAL-TIME READINGS

When any real-time reading reaches its highest or lowest value, the circuit monitor saves the value in its nonvolatile memory. These values are called the minimum and maximum (min/max) values. Two logs are associated with min/max values. The Min/Max Log stores the minimum and maximum values since the last reset of the min/max values. The other log, the Interval Min/ Max/Average Log, determines min/max values over a specified interval and records the minimum, maximum, and average values for pre-defined quantities over that specified interval. For example, the circuit monitor could record the min, max, and average every 1440 minutes (total minutes in a day) to record the daily value of quantities such as kW demand. See **Chapter 11—Logging** on page 153 for more about the Min/Max/Average log.

From the circuit monitor display you can:

- View all min/max values since the last reset and view their associated dates and times. See “Viewing Minimum and Maximum Values from the Min/Max Menu” on page 97 for instructions.
- Reset min/max values. See “Resetting Min/Max, Demand, and Energy Values” on page 95 for reset instructions.

Using SMS you can also upload both onboard logs—and their associated dates and times—from the circuit monitor and save them to disk. For instructions on working with logs using SMS, refer to the SMS online help file included with the software.

Power Factor Min/Max Conventions

All running min/max values, except for power factor, are arithmetic minimum and maximum values. For example, the minimum phase A–B voltage is the lowest value in the range 0 to 1200 kV that has occurred since the min/max values were last reset. In contrast, because the power factor's midpoint is unity (equal to one), the power factor min/max values are not true arithmetic minimums and maximums. Instead, the minimum value represents the measurement closest to –0 on a continuous scale for all real-time readings –0 to 1.00 to +0. The maximum value is the measurement closest to +0 on the same scale.

Figure 8–1 below shows the min/max values in a typical environment in which a positive power flow is assumed. In the figure, the minimum power factor is –.7 (lagging) and the maximum is .8 (leading). Note that the minimum power factor need not be lagging, and the maximum power factor need not be leading. For example, if the power factor values ranged from –.75 to –.95, then the minimum power factor would be –.75 (lagging) and the maximum power factor would be –.95 (lagging). Both would be negative. Likewise, if the power factor ranged from +.9 to +.95, the minimum would be +.95 (leading) and the maximum would be +.90 (leading). Both would be positive in this case.

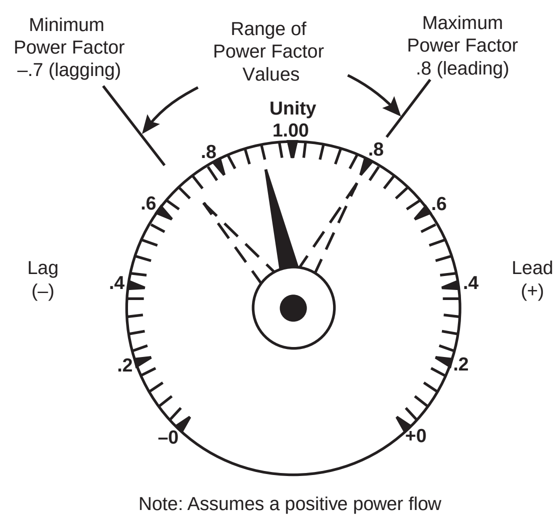


Figure 8–1 Power factor min/max example

An alternate power factor storage method is also available for use with analog outputs and trending. See the footnotes in **Appendix A—Abbreviated Register Listing** on page 181 for the applicable registers.

VAR Sign Conventions

The circuit monitor can be set to one of two VAR sign conventions, the IEEE or the old CM2. Circuit monitors manufactured before March 2000 default to the old CM2 VAR sign convention.The Series 4000 Circuit Monitors defaults to the IEEE VAR sign convention. Figure 8–2 illustrates the VAR sign convention defined by IEEE and the default used by previous model circuit monitors (old CM2). For instructions on changing the VAR sign convention, refer to “Advanced Meter Setup” on page 93.

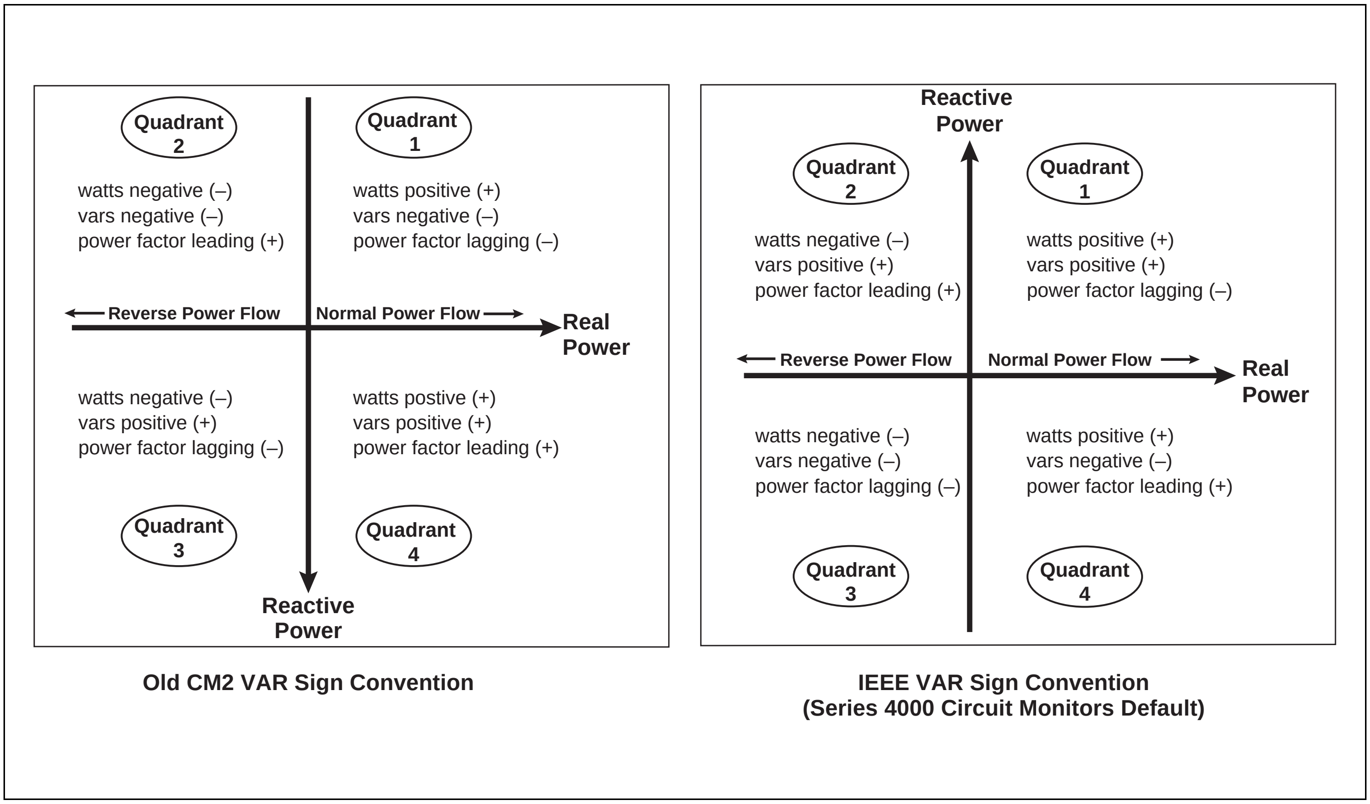


Figure 8–2 Reactive Power—VAR sign convention

DEMAND READINGS

The circuit monitor provides a variety of demand readings, including coincident readings and predicted demands. Table 8–3 lists the available demand readings and their reportable ranges.

Table 8–3: Demand Readings

Demand Readings	Reportable Range
Demand Current, Per-Phase, 3Ø Average, Neutral	
Last Complete Interval	0 to 32,767 A
Peak	0 to 32,767 A
Demand Voltage, L–N, L–L, Per-phase, Average, N-G	
Last Complete Interval	0 to 1200 kV
Minimum	0 to 1200 kV
Peak	0 to 1200 kV
Average Power Factor (True), 3Ø Total	
Last Complete Interval	–0.010 to 1.000 to +0.010
Coincident with kW Peak	–0.010 to 1.000 to +0.010
Coincident with kVAR Peak	–0.010 to 1.000 to +0.010
Coincident with kVA Peak	–0.010 to 1.000 to +0.010
Demand Real Power, 3Ø Total	
Last Complete Interval	0 to +/–3276.70 MW
Predicted	0 to +/–3276.70 MW
Peak	0 to +/–3276.70 MW
Coincident kVA Demand	0 to +/–3276.70 MVA
Coincident kVAR Demand	0 to +/–3276.70 MVAR
Demand Reactive Power, 3Ø Total	
Last Complete Interval	0 to +/–3276.70 MVAR
Predicted	0 to +/–3276.70 MVAR
Peak	0 to +/–3276.70 MVAR
Coincident kVA Demand	0 to +/–3276.70 MVA
Coincident kW Demand	0 to +/–3276.70 MW
Demand Apparent Power, 3Ø Total	
Last Complete Interval	0 to +/–3276.70 MVA
Predicted	0 to +/–3276.70 MVA
Peak	0 to +/–3276.70 MVA
Coincident kW Demand	0 to +/–3276.70 MW
Coincident kVAR Demand	0 to +/–3276.70 MVAR

Demand Power Calculation Methods

Demand power is the energy accumulated during a specified period divided by the length of that period. How the circuit monitor performs this calculation depends on the method you select. To be compatible with electric utility billing practices, the circuit monitor provides the following types of demand power calculations:

- Thermal Demand
- Block Interval Demand
- Synchronized Demand

The default demand calculation is set to sliding block with a 15 minute interval. You can set up any of the demand power calculation methods from the display or from SMS. For instructions on how to setup the demand calculation from the display, see "Setting Up the Metering Functions of the Circuit Monitor" on page 79. See the SMS online help to perform the set up using the software.

Thermal Demand

The thermal demand method calculates the demand based on a thermal response, which mimics the old thermal demand meters. The demand calculation updates at the end of each interval. You select the demand interval from 1 to 60 minutes (in 1-minute increments). In Figure 8–3 the interval is set to 15 minutes for illustration purposes.

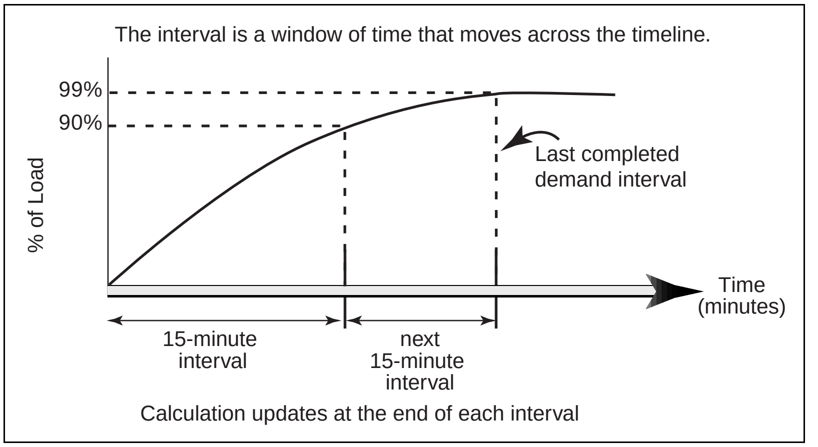


Figure 8–3 Thermal Demand Example

Block Interval Demand

In the block interval demand method, you select a "block" of time that the circuit monitor uses for the demand calculation. You choose how the circuit monitor handles that block of time (interval). Three different modes are possible:

- **Sliding Block**. In the sliding block interval, you select an interval from 1 to 60 minutes (in 1-minute increments). If the interval is between 1 and 15 minutes, the demand calculation *updates every 15 seconds*. If the interval is between 16 and 60 minutes, the demand calculation *updates every 60 seconds*. The circuit monitor displays the demand value for the last completed interval.
- **Fixed Block**. In the fixed block interval, you select an interval from 1 to 60 minutes (in 1-minute increments). The circuit monitor *calculates and updates the demand at the end of each interval*.

- **Rolling Block**. In the rolling block interval, you select an interval and a subinterval. The subinterval must divide evenly into the interval. For example, you might set three 5-minute subintervals for a 15-minute interval. Demand is *updated at each subinterval*. The circuit monitor displays the demand value for the last completed interval.

Figure 8–4 below illustrates the three ways to calculate demand power using the block method. For illustration purposes, the interval is set to 15 minutes.

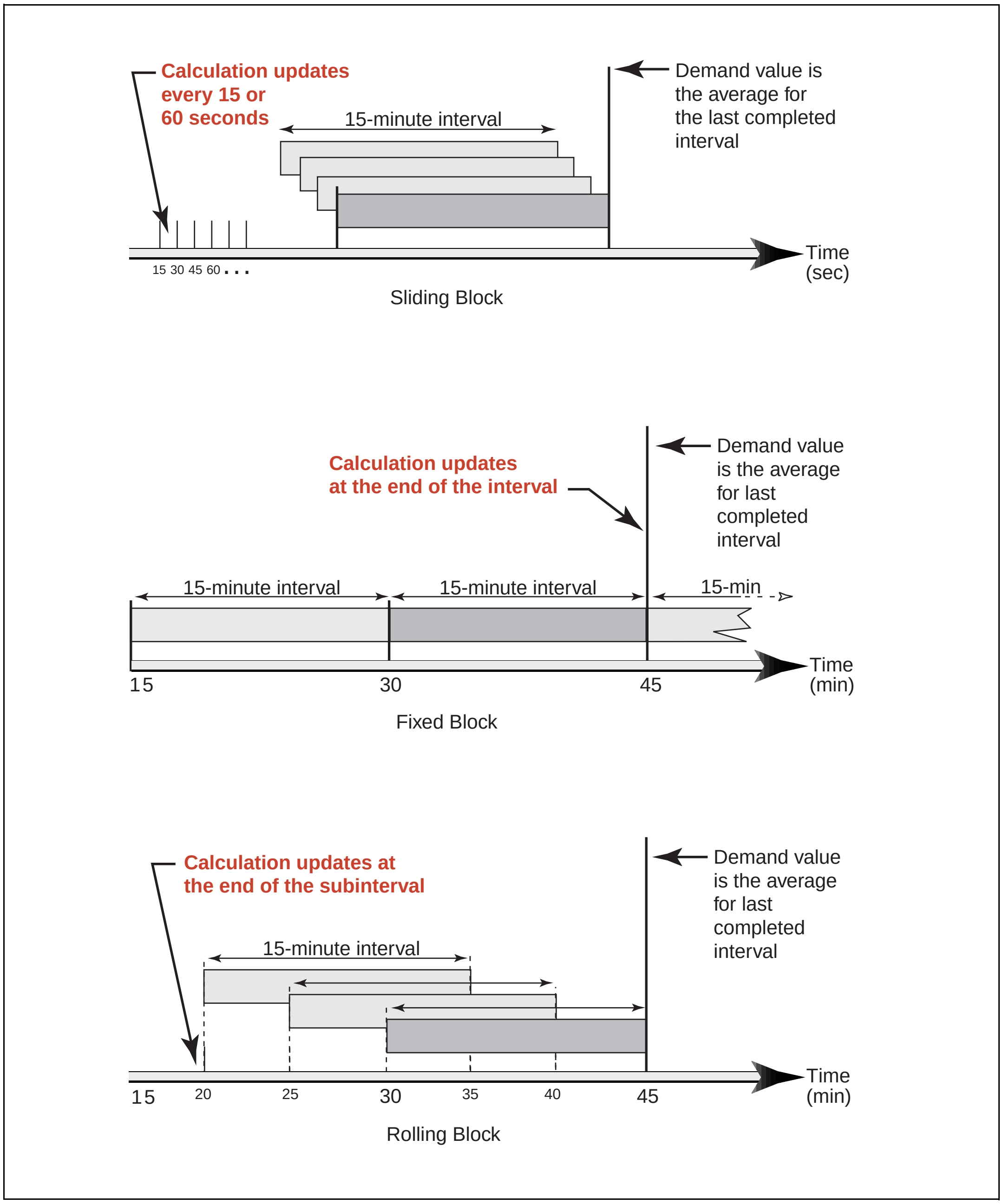


Figure 8–4 Block Interval Demand Examples

Synchronized Demand

The demand calculations can be synchronized to an external pulse, to a command sent over communications, or to the internal real-time clock.

- **Input Synchronized Demand.** You can set up the circuit monitor to accept an input such as a demand synch pulse from another meter. The circuit monitor then uses the same time interval as the other meter for each demand calculation. You can use any digital input installed on the meter to receive the synch pulse. When setting up this type of demand, you select whether it will be input-synchronized block or input-synchronized rolling block demand. The rolling block demand requires that you choose a subinterval.
- **Command Synchronized Demand**. Using command synchronized demand, you can synchronize the demand intervals of multiple meters on a communications network. For example, if a PLC input is monitoring a pulse at the end of a demand interval on a utility revenue meter, you could program the PLC to issue a command to multiple meters whenever the utility meter starts a new demand interval. Each time the command is issued, the demand readings of each meter are calculated for the same interval. When setting up this type of demand, you select whether it will be command-synchronized block or command-synchronized rolling block demand. The rolling block demand requires that you choose a subinterval. See **Appendix C—Using the Command Interface** on page 235 for more information.
- **Clock Synchronized Demand**. You can synchronize the demand interval to the internal real-time clock in the circuit monitor. This enables you to synchronize the demand to a particular time, typically on the hour. The default time is 12:00 am. If you select another time of day when the demand intervals are to be synchronized, the time must be in minutes from midnight. For example, to synchronize at 8:00 am, select 480 minutes. When setting up this type of demand, you select whether it will be clock-synchronized block or clock-synchronized rolling block demand. The rolling block demand requires that you choose a subinterval.

Demand Current

The circuit monitor calculates demand current using the thermal demand method. The default interval is 15 minutes, but you can set the demand current interval between 1 and 60 minutes in 1-minute increments.

Demand Voltage

The circuit monitor calculates demand voltage. The default demand mode is thermal demand with a 15-minute demand interval. You can also set the demand voltage to any of the block interval demand modes described in “Block Interval Demand” on page 111.

Predicted Demand

The circuit monitor calculates predicted demand for the end of the present interval for kW, kVAR, and kVA demand. This prediction takes into account the energy consumption thus far within the present (partial) interval and the present rate of consumption. The prediction is updated every second.

Figure 8–5 illustrates how a change in load can affect predicted demand for the interval.

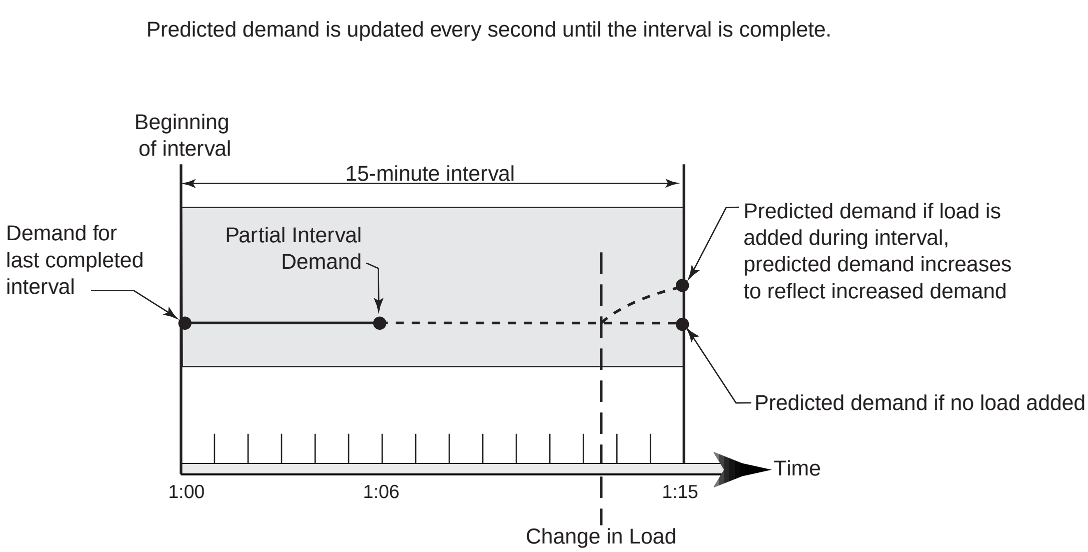


Figure 8–5 Predicted Demand

Peak Demand

In nonvolatile memory, the circuit monitor maintains a running maximum for power demand values, called “peak demand.” The peak is the highest average for each of these readings: kWD, kVARD, and kVAD since the last reset. The circuit monitor also stores the date and time when the peak demand occurred. In addition to the peak demand, the circuit monitor also stores the coinciding average 3-phase power factor. The average 3-phase power factor is defined as “demand kW/demand kVA” for the peak demand interval. Table 8–3 on page 110 lists the available peak demand readings from the circuit monitor.

You can reset peak demand values from the circuit monitor display. From the Main Menu, select Resets > Demand. You can also reset the values over the communications link by using SMS. See the SMS online help for instructions.

The circuit monitor also stores the peak demand during the last incremental energy interval. See “Energy Readings” on page 117 for more about incremental energy readings.

Generic Demand

The circuit monitor can perform any of the demand calculation methods, described earlier in this chapter, on up to 20 quantities that you choose. In SMS the quantities are divided into two groups of 10, so you can set up two different demand "profiles." For each profile, you do the following in SMS:

- **Select the demand calculation method** (thermal, block interval, or synchronized).
- **Select the demand interval** (from 1–60 minutes in 1–minute increments) and select the demand subinterval (if applicable).
- **Select the quantities** on which to perform the demand calculation. You must also select the units and scale factor for each quantity.

Use the Device Setup > Basic Setup tab in SMS to create the generic demand profiles. For example, you might set up a profile to calculate the 15-minute average value of an analog input. To do this, select a fixed-block demand interval with a 15-minute interval for the analog input.

For each quantity in the demand profile, the circuit monitor stores four values:

- Partial interval demand value
- Last completed demand interval value
- Minimum values (date and time for each is also stored)
- Peak demand value (date and time for each is also stored)

You can reset the minimum and peak values of the quantities in a generic demand profile by using one of two methods:

- Use SMS (see the SMS online help file), or
- Use the command interface.
  Command 5115 resets the generic demand profile 1.
  Command 5116 resets the generic demand profile 2.
  See **Appendix C—Using the Command Interface** on page 235 for more about the command interface.

Input Pulse Demand Metering

The circuit monitor has ten input pulse demand channels. Each channel counts pulses received from one or more digital inputs assigned to that channel and multiplies the pulses by the pulse weight that you select. For example, if each incoming pulse represented 100 kWh, then the pulse weight would be 100. The circuit monitor counts each ON-to-OFF and OFF-to-ON transition as a pulse. For each channel, the circuit monitor maintains the following information:

- Last completed interval demand—calculated demand for the last completed interval.
- Partial interval demand—demand calculation up to the present point during the interval.
- Peak demand—highest demand value since the last reset of the input pulse demand. The date and time of the peak demand is also saved.
- Minimum demand—lowest demand value since the last reset of the input pulse demand. The date and time of the minimum demand is also saved.

For example, you can use channels to verify utility charges. In Figure 8–6, Channel 1 is adding demand from two utility feeders to track total demand for the building. This information could be viewed in SMS and compared against the utility charges.

To use the channels feature, first set up the digital inputs from the display or from SMS. See “Setting Up I/Os” on page 85 in **Chapter 7—Operation** for instructions. Then using SMS, you must set the I/O operating mode to Normal and set up the channels. The demand method and interval that you select applies to all channels. See the SMS online help for instructions on device set up of the CM4000 Circuit Monitor.

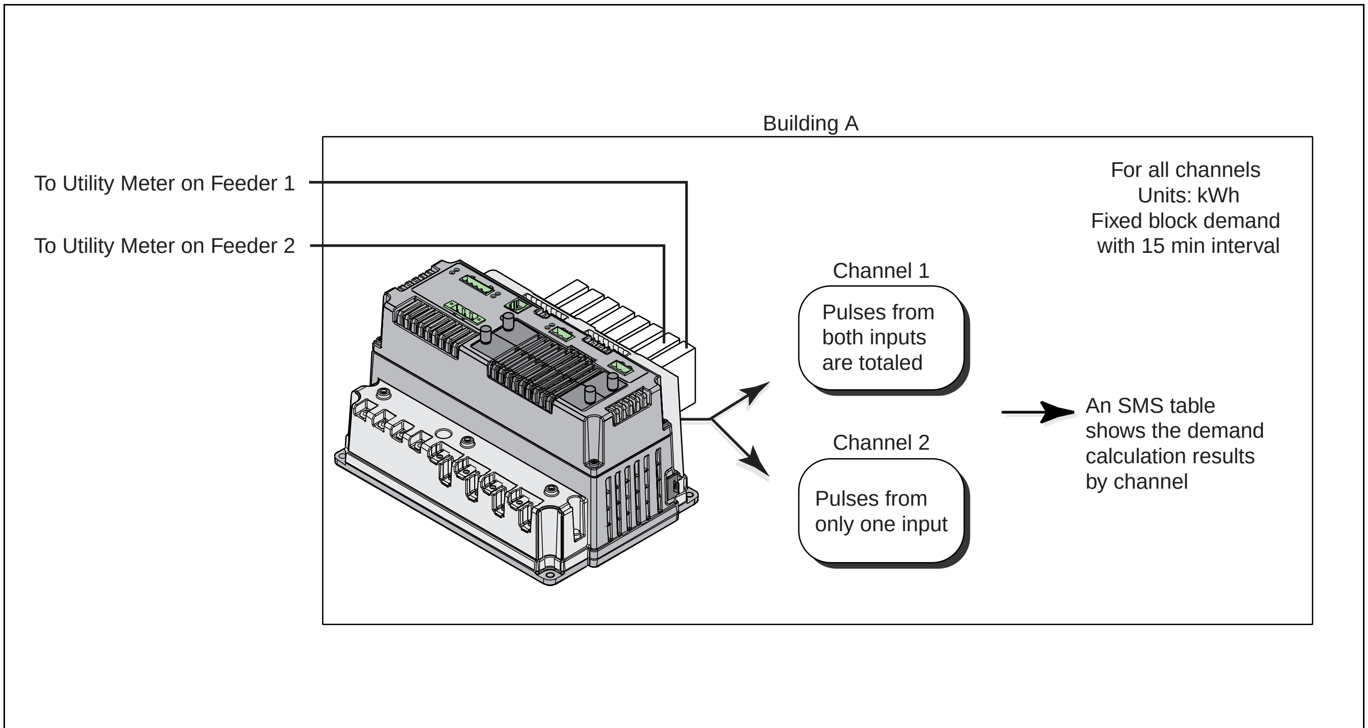


Figure 8–6 Channel pulse demand metering example

ENERGY READINGS

The circuit monitor calculates and stores accumulated energy values for real and reactive energy (kWh and kVARh) both into and out of the load, and also accumulates absolute apparent power. Table 8–4 lists the energy values the circuit monitor can accumulate.

Table 8–4: Energy Readings

Energy Reading, 3-Phase	Reportable Range	Shown on the Display
Accumulated Energy		
Real (Signed/Absolute)	-9,999,999,999,999,999 to 9,999,999,999,999,999 Wh	0000.000 kWh to 99,999.99 MWh and 0000.000 to 99,999.99 kVARh
Reactive (Signed/Absolute)	-9,999,999,999,999,999 to 9,999,999,999,999,999 VARh	
Real (In)	0 to 9,999,999,999,999,999 Wh	0000.000 kWh to 99,999.99 MWh and 0000.000 to 99,999.99 kVARh
Real (Out)	0 to 9,999,999,999,999,999 Wh	
Reactive (In)	0 to 9,999,999,999,999,999 VARh	
Reactive (Out)	0 to 9,999,999,999,999,999 VARh	
Apparent	0 to 9,999,999,999,999,999 VAh	
Accumulated Energy, Conditional		Not shown on the display. Readings are obtained only through the communications link.
Real (In)	0 to 9,999,999,999,999,999 Wh	
Real (Out)	0 to 9,999,999,999,999,999 Wh	
Reactive (In)	0 to 9,999,999,999,999,999 VARh	
Reactive (Out)	0 to 9,999,999,999,999,999 VARh	
Apparent	0 to 9,999,999,999,999,999 VAh	
Accumulated Energy, Incremental ①		0000.000 kWh to 99,999.99 MWh and 0000.000 to 99,999.99 kVARh
Real (In)	0 to 999,999,999,999 Wh	
Real (Out)	0 to 999,999,999,999 Wh	
Reactive (In)	0 to 999,999,999,999 VARh	
Reactive (Out)	0 to 999,999,999,999 VARh	
Apparent	0 to 999,999,999,999 VAh	
Reactive Energy ①		Not shown on the display. Readings are obtained only through the communications link.
Quadrant 1	0 to 999,999,999,999 VARh	
Quadrant 2	0 to 999,999,999,999 VARh	
Quadrant 3	0 to 999,999,999,999 VARh	
Quadrant 4	0 to 999,999,999,999 VARh	

The circuit monitor can accumulate the energy values shown in Table 8–4 in one of two modes: signed or unsigned (absolute). In signed mode, the circuit monitor considers the direction of power flow, allowing the magnitude of accumulated energy to increase and decrease. In unsigned mode, the circuit monitor accumulates energy as a positive value, regardless of the direction of power flow. In other words, the energy value increases, even during reverse power flow. The default accumulation mode is unsigned.

You can view accumulated energy from the display. The resolution of the energy value will automatically change through the range of 000.000 kWh to 000,000 MWh (000.000 to 000,000 kVARh), or it can be fixed. See **Appendix A—Abbreviated Register Listing** on page 181 for the contents of the registers.

For conditional accumulated energy readings, you can set the real, reactive, and apparent energy accumulation to OFF or ON when a particular condition occurs. You can do this over the communications link, from a command, or from a digital input change. For example, you may want to track accumulated energy values during a particular process that is controlled by a PLC. The circuit monitor stores the date and time of the last reset of conditional energy in nonvolatile memory.

Also, the circuit monitor provides additional energy readings that are only available over the communications link:

- **Incremental accumulated energy readings**. You can define when an increment starts and how long the interval should last. At the end of this increment of time, the circuit monitor will log into its memory accumulated values for real, reactive, and apparent energy. Incremental energy values can be used for load-profile analysis. For example, you may want to record the amount of energy consumed in the past hour, every hour on the hour for 90 days.
- **Reactive accumulated energy readings**. The circuit monitor can accumulate reactive energy (kVARh) in four quadrants as shown in Figure 8–7. The registers operate in unsigned (absolute) mode in which the circuit monitor accumulates energy as positive.

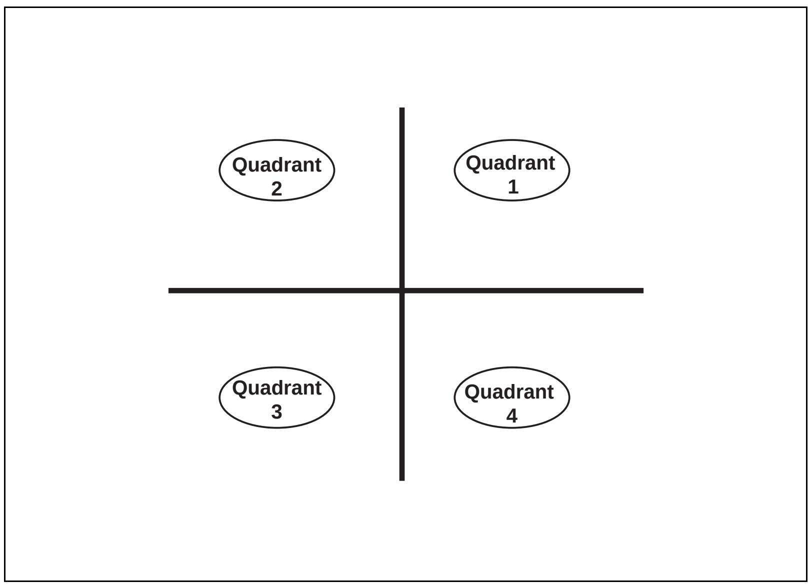


Figure 8–7 Reactive energy accumulates in four quadrants

POWER ANALYSIS VALUES

The circuit monitor provides a number of power analysis values that can be used to detect power quality problems, diagnose wiring problems, and more. Table 8–5 on page 120 summarizes the power analysis values.

- **THD**. Total Harmonic Distortion (THD) is a quick measure of the total distortion present in a waveform and is the ratio of harmonic content to the fundamental. It provides a general indication of the “quality” of a waveform. THD is calculated for both voltage and current. The circuit monitor uses the following equation to calculate THD:

$$THD = \frac{\sqrt{H_2^2 + H_3^2 + H_4^2 + \cdots}}{H_1} \times 100\%$$

- **thd**. An alternate method for calculating Total Harmonic Distortion, used widely in Europe. It considers the total harmonic current and the total rms content rather than fundamental content in the calculation. The circuit monitor calculates thd for both voltage and current. The following equation is used to calculate thd:

$$thd = \frac{\sqrt{H_2^2 + H_3^2 + H_4^2 + \cdots}}{\text{Total rms}} \times 100\%$$

- **K-factor**. K-factor is a simple numerical rating used to specify transformers for nonlinear loads. The rating describes a transformer’s ability to serve nonlinear loads without exceeding rated temperature rise limits. The higher the K-factor rating, the better the transformer’s ability to handle the harmonics. The circuit monitor uses the following formula to calculate K-factor:

$$K = \frac{\text{SUM } (I_h)^2 \; h^2}{I_{rms}^2}$$

- **Displacement Power Factor**. *Power factor (PF)* represents the degree to which voltage and current coming into a load are out of phase. When true power factor is calculated (kW/kVA), it uses total real and apparent power including harmonics. On the other hand, the calculation for displacement power factor assumes that the load is purely sinusoidal, with no harmonics present. The displacement power factor calculation kW/kVA is equal to the cosine of the angle between the current and voltage waveforms. The displacement power factor is based on the angle between the fundamental components of current and voltage. When only the fundamental components of real and apparent power are considered, the result is *displacement power factor (dPF)*.
- **Harmonic Values**. Harmonics reduce the capacity of the power system. The circuit monitor determines the individual per-phase harmonic magnitudes and angles through the 63rd harmonic for all currents and voltages. The harmonic magnitudes can be formatted as either a percentage of the fundamental (default) or a percentage of the rms value. Refer to “Setting Up Individual Harmonic Calculations” on page 244 in **Appendix C—Using the Command Interface** for information on how to configure harmonic calculations.

Table 8–5: Power Analysis Values

Value	Reportable Range
THD—Voltage, Current 3-phase, per-phase, neutral	 0 to 3,276.7%
thd—Voltage, Current 3-phase, per-phase, neutral	 0 to 3,276.7%
K-Factor (per phase)②	0.0 to 100.0
K-Factor Demand (per phase)①②	0.0 to 100.0
Crest Factor (per phase) ①	0.0 to 100.0
Displacement P.F. (per phase, 3-phase) ①	–0.010 to 1.000 to +0.010
Fundamental Voltages (per phase) Magnitude Angle	 0 to 3,276,700 V 0.0 to 359.9°
Fundamental Currents (per phase) Magnitude Angle	 0 to 32,767 A 0.0 to 359.9°
Fundamental Real Power (per phase, 3-phase) ①	0 to 327,670 kW
Fundamental Reactive Power (per phase) ①	0 to 327,670 kVAR
Harmonic Power (per phase, 3-phase) ①	0 to 327,670 kW
Phase Rotation	ABC or CBA
Unbalance (current and voltage) ①	0.0 to 100.0%
Individual Harmonic Magnitudes ①③	0 to 327.67%
Individual Harmonic Angles①③	0.0° to 359.9°

① Readings are obtained only through communications.
② K-Factor not available at 400Hz.
③ Harmonic magnitudes and angles through the 63rd harmonic at 50Hz and 60Hz; harmonic magnitudes and angles through the 15th harmonic at 400Hz.

CHAPTER 9—INPUT/OUTPUT CAPABILITIES

This chapter explains the input and output (I/O) capabilities of the circuit monitor and its optional I/O accessories. For module installation instructions and detailed technical specifications, refer to the individual instruction bulletins that ship with the product. For a list of these publications, see Table 1–2 on page 3 of this bulletin.

CHAPTER CONTENTS

I/O OPTIONS

The circuit monitor supports a variety of input and output options including:

- Digital Inputs
- Analog Inputs
- Mechanical Relay Outputs
- Solid State KYZ Pulse Outputs
- Analog Outputs

The circuit monitor has one KYZ output as standard. You can expand the I/O capabilities by adding the optional I/O Extender (IOX) and the digital I/O option card (IOC-44). Table 9–1 lists the many available I/O options. The I/O options are explained in detail in the sections that follow.

Table 9–1: I/O Options

I/O Extender Options	Part Number
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, 3 relay (10 A) outputs, and 1 pulse output (KYZ)	IOC44
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 digital inputs and 4 analog inputs (4–20 mA)	IOX0404
with 8 digital inputs (120 Vac)	IOX08
Individual I/O Modules①	**Part Number**
Digital I/Os	
120 Vac input	DI120AC
240 Vac input	DI240AC
32 Vdc input (0.2ms turn on) polarized	DI32DC
120 Vac output	DO120AC
200 Vdc output	DO200DC
240 Vac output	DO240AC
60 Vdc output	DO60DC
Analog I/Os	
0 to 5 Vdc analog input	AI05
4 to 20 mA analog input	AI420
4 to 20 mA analog output	AO420

① The circuit monitor must be equipped with the I/O Extender (IOX) to install the modules.

DIGITAL INPUTS

The circuit monitor can accept up to 16 digital inputs depending on the I/O accessories you select. Digital inputs are used to detect digital signals. For example, the digital input can be used to determine circuit breaker status, count pulses, or count motor starts. Digital inputs can also be associated with an external relay, which can trigger a waveform capture in the circuit monitor. You can log digital input transitions as events in the circuit monitor's on-board event log. The event is date and time stamped with resolution to the millisecond, for sequence of events recording. The circuit monitor counts OFF-to-ON transitions for each input, and you can reset this value using the command interface.

Digital inputs have four operating modes:

- Normal—Use the normal mode for simple on/off digital inputs. In normal mode, digital inputs can be used to count KYZ pulses for demand and energy calculation. Using the input pulse demand feature, you can map multiple inputs to the same channel where the circuit monitor can total pulses from multiple inputs (see“Input Pulse Demand Metering” on page 116 in **Chapter 8—Metering Capabilities** for more information). To accurately count pulses, set the time between transitions from OFF to ON and ON to OFF to at least 20 milliseconds.
- Demand Interval Synch Pulse—you can configure any digital input to accept a demand synch pulse from a utility demand meter (see “Demand Synch Pulse Input” on page 124 of this chapter for more about this topic). For each demand profile, you can designate only one input as a demand synch input.
- Time Synch—you can configure one digital input to receive a signal from a Modicon GPS receiver to synchronize the internal clock of the circuit monitor.
- Conditional Energy Control—you can configure one digital input to control conditional energy (see “Energy Readings” on page 117 in **Chapter 8—Metering Capabilities** for more about conditional energy).

To set up a digital input, you must first define it from the display. From the main menu, select Setup > I/O. Select the appropriate digital input option. For example, if you are using IOX-2411 option of the I/O Extender, select IOX-2411. For detailed instructions, see “Setting Up I/Os” on page 85 in **Chapter 7—Operation**. Then using SMS, define the name and operating mode of the digital input. The name is a 14-character label that identifies the digital input. The operating mode is one of those listed above. See the SMS online help for instructions on device set up of the circuit monitor.

DEMAND SYNCH PULSE INPUT

You can configure the circuit monitor to accept a demand synch pulse from another demand meter. By accepting demand synch pulses through a digital input, the circuit monitor can make its demand interval “window” match the other meter’s demand interval “window.” The circuit monitor does this by “watching” the digital input for a pulse from the other demand meter. When it sees a pulse, it starts a new demand interval and calculates the demand for the preceding interval. The circuit monitor then uses the same time interval as the other meter for each demand calculation. Figure 9–2 illustrates this point. See “Synchronized Demand” on page 113 in **Chapter 8—Metering Capabilities** for more about demand calculations.

When in demand synch pulse operating mode, the circuit monitor will not start or stop a demand interval without a pulse. The maximum allowable time between pulses is 60 minutes. If 61 minutes pass before a synch pulse is received, the circuit monitor throws out the demand calculations and begins a new calculation when the next pulse is received. Once in synch with the billing meter, the circuit monitor can be used to verify peak demand charges.

Important facts about the circuit monitor’s demand synch feature are listed below:

- Any installed digital input can be set to accept a demand synch pulse.
- You can have up to five separate demand synch pulses, one each for voltage demand, power demand, generic demand profile1, generic demand profile 2, and digital input pulse demand metering.
- The demand synch feature can be set up from SMS. See the SMS online help for instructions on device set up of the circuit monitor.

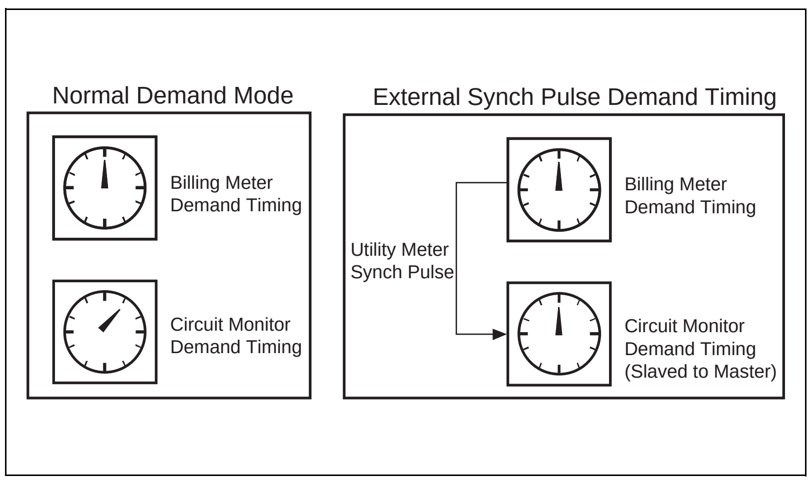


Figure 9–2: Demand synch pulse timing

ANALOG INPUTS

Depending on the I/O modules you select, the circuit monitor can accept either voltage or current signals through its analog inputs. See Table 9–1 on page 122 for a list of I/O options. The circuit monitor stores a minimum and a maximum value for each analog input.

For technical specifications and instructions on installing I/O modules, refer to the instruction bulletin that ships with the I/O (see Table 1–2 on page 3 for a list of these publications). To set up analog inputs, you must first set it up from the display. From the main menu, select Setup > I/O, then select the appropriate analog input option. For example, if you are using the IOX-0404 option of the I/O Extender, select IOX-0404. For detailed instructions, see "Setting Up I/Os" on page 85 in **Chapter 7—Operation**. Then, in SMS define the following values for each analog input:

- Name—a 14-character label used to identify the analog input.
- Units—the units of the monitored analog value (for example, "psi").
- Scale factor—multiplies the units by this value (such as tenths or hundreths).
- Report Range Lower Limit—the value the circuit monitor reports when the input current reaches a minimum value. When the input current is below the lowest valid reading, the circuit monitor reports the lower limit.
- Report Range Upper Limit—the value the circuit monitor reports when the input current reaches the maximum value. When the input current is above highest valid reading, the circuit monitor reports the upper limit.

For instructions on setting up analog inputs in SMS, see device set up of the circuit monitor in the SMS online help.

Analog Input Example

Figure 9–4 shows an analog input example. In this example, the analog input has been configured as follows:

Upper Limit: 500

Lower Limit: 100

Units: psi

Table 9–3 shows circuit monitor readings at various input currents.

Table 9–3: Sample register readings for analog inputs

Input Current (mA)	Circuit Monitor Reading (psi)
3 (invalid)	100
4	100
8	200
10	250
20	500
21	500

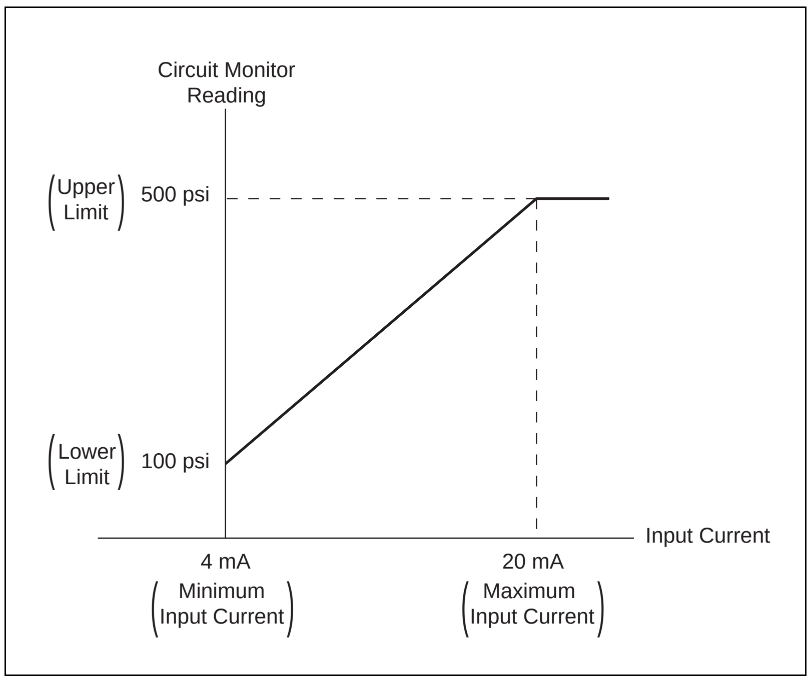


Figure 9–4: Analog input example

In addition, you can use the report range of an analog input to detect a broken wire. To do this, set the lower limit of the report range to a negative value. In the example illustrated in Figure 9–5, the lower limit is set to -40 psi. If the circuit monitor detects a value less than 5 mA, it will report a negative value (-40 in this case). A negative value indicates a problem with the connection to the analog input.

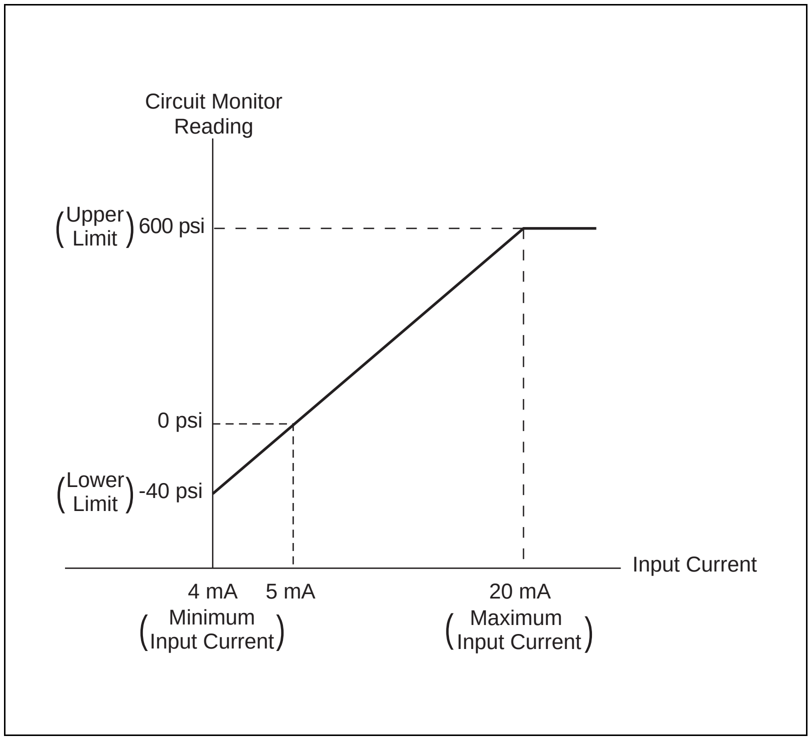


Figure 9–5: Broken wire detection example

RELAY OUTPUT OPERATING MODES

Before we describe the 11 available relay operating modes, it is important to understand the difference between a relay configured for remote (external) control and a relay configured for circuit monitor (internal) control.

Each mechanical relay output defaults to internal control, but you can choose whether the relay is set to external or internal control:

- **Remote (external) control**—the relay is controlled either from a PC using SMS or a programmable controller.
- **Circuit monitor (internal) control**—the relay is controlled by the circuit monitor in response to a set-point controlled alarm condition, or as a pulse initiator output. Once you've set up a relay for circuit monitor control, you can no longer operate the relay remotely. However, you can temporarily override the relay, using SMS.

The 11 relay operating modes are as follows:

- **Normal**
  - — *Remotely Controlled:* Energize the relay by issuing a command from a remote PC or programmable controller. The relay remains energized until a command to de-energize is issued from the remote PC or programmable controller, or until the circuit monitor loses control power. When control power is restored, the relay will be re-energized.
  - — *Circuit Monitor Controlled:* When an alarm condition assigned to the relay occurs, the relay is energized. The relay is not de-energized until *all* alarm conditions assigned to the relay have dropped out, or until the circuit monitor loses control power. If the alarm condition is still true when the circuit monitor regains control power, the relay will be re-energized.
- **Latched**
  - — *Remotely Controlled:* You energize the relay by issuing a command from a remote PC or programmable controller. The relay remains energized until a command to de-energize is issued from a remote PC or programmable controller, or until the circuit monitor loses control power. When control power is restored, the relay will be re-energized.
  - — *Circuit Monitor Controlled:* When an alarm condition assigned to the relay occurs, the relay is energized. The relay remains energized—even after all alarm conditions assigned to the relay have dropped out—until a command to de-energize is issued from a remote PC or programmable controller, until the high priority alarm log is cleared from the display, or until the circuit monitor loses control power. When control power is restored, the relay will be re-energized.

- **Timed**
  - — *Remotely Controlled:* You energize the relay by issuing a command from a remote PC or programmable controller. The relay remains energized until the timer expires, or until the circuit monitor loses control power. If a new command to energize the relay is issued before the timer expires, the timer restarts. If the circuit monitor loses control power, the relay will be re-energized when control power is restored and the timer will reset to zero.
  - — *Circuit Monitor Controlled:* When an alarm condition assigned to the relay occurs, the relay is energized. The relay remains energized for the duration of the timer. When the timer expires, if the alarm has dropped out, the relay will de-energize and remain de-energized. However, if the alarm is still active when the relay timer expires, the relay will remain energized until the alarm condition drops out. If the circuit monitor loses control power, the relay will be re-energized when control power is restored and the timer will reset to zero.
- **End of power demand interval**

  This mode assigns the relay to operate as a synch pulse to another device. The output operates in timed mode using the timer setting and turns on at the end of a power demand interval. It turns off when the timer expires.
- **Absolute kWh Pulse**

  This mode assigns the relay to operate as a pulse initiator with a user-defined number of kWh per pulse. In this mode, both forward and reverse real energy are treated as additive (as in a tie circuit breaker).
- **Absolute kVARh Pulse**

  This mode assigns the relay to operate as a pulse initiator with a user-defined number of kVARh per pulse. In this mode, both forward and reverse reactive energy are treated as additive (as in a tie circuit breaker).
- **kVAh Pulse**

  This mode assigns the relay to operate as a pulse initiator with a user-defined number of kVAh per pulse. Since kVA has no sign, the kVAh pulse has only one mode.
- **kWh In Pulse**

  This mode assigns the relay to operate as a pulse initiator with a user-defined number of kWh per pulse. In this mode, only the kWh flowing into the load is considered.
- **kVARh In Pulse**

  This mode assigns the relay to operate as a pulse initiator with a user-defined number of kVARh per pulse. In this mode, only the kVARh flowing into the load is considered.
- **kWh Out Pulse**

  This mode assigns the relay to operate as a pulse initiator with a user-defined number of kWh per pulse. In this mode, only the kWh flowing out of the load is considered.
- **kVAR Out Pulse**

  This mode assigns the relay to operate as a pulse initiator with a user-defined number of kVARh per pulse. In this mode, only the kVARh flowing out of the load is considered.

MECHANICAL RELAY OUTPUTS

The optional Input/Output Card IOC-44 provides three Form-C, 10 A mechanical relays that can be used to open or close circuit breakers, annunciate alarms, and more.

The mechanical output relays of the circuit monitor can be configured to operate in one of 11 operating modes:

- Normal
- Latched (electrically held)
- Timed
- End of power demand interval
- Absolute kWh pulse
- Absolute kVARh pulse
- kVAh pulse
- kWh in pulse
- kVARh in pulse
- kWh out pulse
- kVAR out pulse

See the previous section “Relay Output Operating Modes” on page 128 for a description of the modes.

The last seven modes in the list above are for pulse initiator applications. All CM4000 Circuit Monitors are equipped with one solid-state KYZ pulse output rated at 96 mA and an additional KYZ pulse output is available on the IOC-44 card. The solid-state KYZ output provides the long life—billions of operations—required for pulse initiator applications. The mechanical relay outputs have limited lives: 10 million operations under no load; 100,000 under load. For maximum life, use the solid-state KYZ pulse output for pulse initiation, except when a rating higher than 96 mA is required. See“Solid-State KYZ Pulse Output” on page 131 in this chapter for a description of the solid-state KYZ pulse output.

To set up a mechanical relay output, you must first define it from the display. From the main menu, select Setup > I/O. Select input option IOC-44. For detailed instructions, see “Setting Up I/Os” on page 85 in **Chapter 7—Operation**. Then using SMS, you must define the following values for each mechanical relay output:

- Name—A 14-character label used to identify the analog output.
- Mode—Select one of the operating modes listed above.
- Pulse Weight—You must set the pulse weight, the multiplier of the unit being measured, if you select any of the pulse modes (last 7 listed above).
- Timer—You must set the timer if you select the timed mode or end of power demand interval mode (in seconds).
- Control—You must set the relay to be controlled either remotely or internally (from the circuit monitor) if you select the normal, latched, or timed mode.

For instructions on setting up analog I/Os in SMS, see the SMS online help on device set up of the circuit monitor.

Setpoint-controlled Relay Functions

The circuit monitor can detect over 100 alarm conditions, including over/under conditions, digital input changes, phase unbalance conditions, and more (see **Chapter 10—Alarms** on page 137 for more about alarms). Using SMS, you can configure a relay to operate when an alarm condition is true. For example, you could set up the three relays on the IOC-44 card to operate at each occurrence of “Undervoltage Phase A.” Then, each time the alarm condition occurs—that is, each time the setpoints and time delays assigned to Undervoltage Phase A are satisfied—the circuit monitor automatically operates relays R1, R2, and R3 according to their configured mode of operation. See “Relay Output Operating Modes” on page 128 of this chapter for a description of the operating modes.

Also, you can assign multiple alarm conditions to a relay. For example, relay AR1 on the IOC-44 card could have “Undervoltage Phase A” and “Undervoltage Phase B” assigned to it. The relay would operate whenever either condition occurred.

NOTE: Setpoint-controlled relay operation can be used for some types of non-time-critical relaying. For more information, see “Setpoint-Controlled Relay Functions” on page 142 in **Chapter 10—Alarms**.

SOLID-STATE KYZ PULSE OUTPUT

This section describes the pulse output capabilities of the circuit monitor. For instructions on wiring the KYZ pulse output, see “Wiring the Solid-State KYZ Output” on page 50 in **Chapter 5—Wiring**.

The circuit monitor is equipped with one solid-state KYZ pulse output on the top of the circuit monitor. An additional KYZ output is available on the IOC-44 option card. This solid-state relay provides the extremely long life—billions of operations—required for pulse initiator applications.

The KYZ output is a Form-C contact with a maximum rating of 96 mA. Because most pulse initiator applications feed solid-state receivers with low burdens, this 96 mA rating is adequate for most applications. For applications where a higher rating is required, the IOC-44 card provides 3 relays with 10 ampere ratings. You can use SMS to configure any of the 10 ampere relays as a pulse initiator output. Keep in mind that the 10 ampere relays are mechanical relays with limited life—10 million operations under no load; 100,000 under load.

Use SMS to set the watthour-per-pulse value. When setting the kWh/pulse value, set the value based on a 3-wire pulse output. For instructions on calculating the correct value, see “Calculating the Watthour-Per-Pulse Value” on page 133 in this chapter.

The circuit monitor can be used in 2-wire or 3-wire pulse initiator applications. Each of these applications is described the sections that follow.

The KYZ pulse output can be configured to operate in one of 11 operating modes. See “Relay Output Operating Modes” on page 128 for a description of the modes.

The setup in SMS is the same as a mechanical relay. See the previous section “Mechanical Relay Outputs” on page 130, for the values you must set up in SMS.

2-Wire Pulse Initiator

Most digital inputs in energy management systems use only two of the three wires provided with a KYZ pulse initiator. This is called a 2-wire pulse initiator application. Figure 9–7 shows a pulse train from a 2-wire pulse initiator application.

In a 2-wire application, the pulse train looks like the alternating open and closed states of a Form-A contact. Most 2-wire pulse initiator applications use a Form-C contact, but tie into only one side of the Form-C contact where the pulse is the transition from OFF to ON of that side of the Form-C relay. In Figure 9–6, the transitions are marked as 1 and 2. Each transition represents the time when the relay flips from KZ to KY. Each time the relay flips, the receiver counts a pulse. The circuit monitor can deliver up to 25 pulses per second in a 2-wire application.

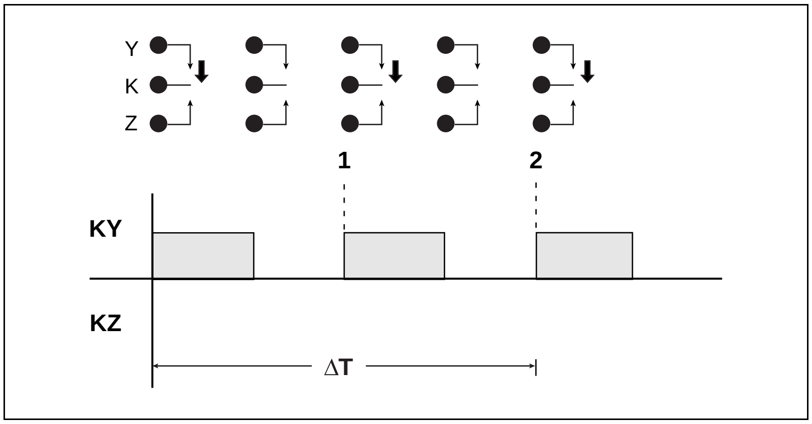


Figure 9–6: Two-wire pulse train

3-Wire Pulse Initiator

Some applications require the use of all three wires provided with the KYZ pulse initiator. This is called a 3-wire pulse initiator application. Figure 9–7 shows a pulse train for a 3-wire pulse initiator application.

Three-wire KYZ pulses are the transitions between KY and KZ. These transitions are the alternate contact closures of a Form-C contact. In Figure 9–7, the transitions are marked as 1, 2, 3, and 4. The receiver counts a pulse at each transition. That is, each time the Form-C contact flips from KY to KZ, or from KZ to KY, the receiver counts a pulse.The circuit monitor can deliver up to 50 pulses per second in a 3-wire application.

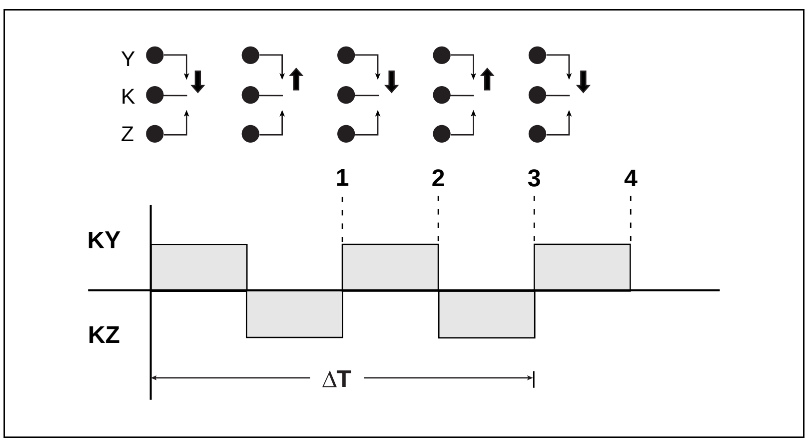


Figure 9–7: Three-wire pulse train

CALCULATING THE WATTHOUR-PER-PULSE VALUE

This section shows an example of how to calculate watthours per pulse. To calculate this value, first determine the highest kW value you can expect and the required pulse rate. In this example, the following assumptions are made:

- The metered load should not exceed 1600 kW.
- About two KYZ pulses per second should occur at full scale.

Step 1: Translate 1600 kW load into kWh/second.

$$(1600\text{ kW})\ (1\text{ Hr}) = 1600\text{ kWh}$$

$$\frac{(1600\text{ kWh})}{1\text{ hour}} = \frac{\text{“X” kWh}}{1\text{ second}}$$

$$\frac{(1600\text{ kWh})}{3600\text{ seconds}} = \frac{\text{“X” kWh}}{1\text{ second}}$$

$$X = 1600/3600 = 0.4444\text{ kWh/second}$$

Step 2: Calculate the kWh required per pulse.

$$\frac{0.4444\text{ kWh/second}}{2\text{ pulses/second}} = 0.2222\text{ kWh/pulse}$$

Step 3: Round to nearest hundreth, since the circuit monitor only accepts 0.01 kWh increments.

$$\text{Ke} = 0.22\text{ kWh/pulse}$$

Summary:

- 3-wire application—**0.22** kWh/pulse provides approximately 2 pulses per second at full scale.
- 2-wire application—**0.11** kWh/pulse provides approximately 2 pulses per second at full scale. (To convert to the kWh/pulse required for a 2-wire application, divide Ke by 2. This is necessary because the circuit monitor Form C relay generates two pulses—KY and KZ—for every pulse that is counted.)

ANALOG OUTPUTS

This section describes the circuit monitor's analog output capabilities. For technical specifications and instructions on installing the I/O Extender or analog output modules, refer to the instruction bulletin that ships with the I/O (see Table 1–2 on page 3 for a list of these publications).

To set up analog outputs, you must first define it from the display. From the main menu, select Setup > I/O. Select the appropriate analog input option. For example, if you are using the IOX-0404 option of the I/O Extender, select IOX-0404. For detailed instructions, see "Setting Up I/Os" on page 85 in **Chapter 7—Operation**. Then using SMS, you must define the following values for each analog input:

- Name—A 14-character label used to identify the output.
- Output register**—**The circuit monitor register assigned to the analog output.
- Lower Limit—The value equivalent to the minimum output current. When the register value is below the lower limit, the circuit monitor outputs the minimum output current.
- Upper Limit—The value equivalent to the maximum output current. When the register value is above the upper limit, the circuit monitor outputs the maximum output current.

For instructions on setting up an analog outputs in SMS, see the SMS online help on device set up of the circuit monitor.

CAUTION
HAZARD OF EQUIPMENT DAMAGE Each analog output represents an individual 2-wire current loop; therefore, use an isolated receiver for *each* individual analog output on the I/O Extender (IOX). **Failure to observe this instruction can result in equipment damage.**

Analog Output Example

Figure 9–9 illustrates the relationship between the output range of current (in milliamperes) and the upper and lower limit of power usage (real power in kW). In this example, the analog output has been configured as follows:

Register Number: 1143 (Real Power, 3-Phase Total)

Lower Limit: 100 kW

Upper Limit: 500 kW

Table 9–8 shows the output current at various register readings.

Table 9–8: Sample register readings for analog output

Register Reading (kW)	Output Current (mA)
50	4
100	4
200	8
250	10
500	20
550	20

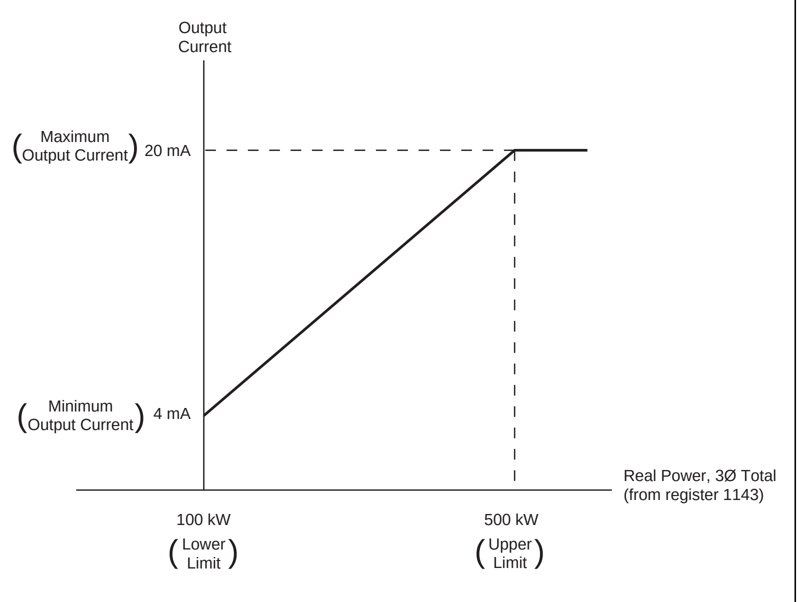


Figure 9–9: Analog output example

CHAPTER 10—ALARMS

This chapter provides a detailed discussion of the alarm capabilities of the circuit monitor.

CHAPTER CONTENTS

ABOUT ALARMS

The circuit monitor can detect over 100 alarm conditions, including over or under conditions, digital input changes, phase unbalance conditions, and more. It also maintains a counter for each alarm to keep track of the total number of occurrences. A complete list of default alarm conditions are described in Table 10–2 on page 148. In addition, you can set up your own custom alarms and set up relays to operate on alarm conditions.

When one or more alarm conditions are true, the circuit monitor will execute a task automatically. Using SMS, you can set up each alarm condition to perform these tasks:

- Force data log entries in up to 14 user-defined data log files. See **Chapter 11—Logging** on page 153 for more about data logging.
- Perform event captures. See **Chapter 12—Waveform and Event Capture** on page 161 for more about event recording.
- Operate relays. Using SMS you can assign one or more relays to operate when an alarm condition is true. See the SMS online help for more about this topic.

Alarms Groups

Whether you are using a default alarm or creating a custom alarm, you first choose the alarm group that is appropriate for the situation. Each alarm condition is assigned to one of these alarm groups:

- **Standard** —Standard alarms have a detection rate of 1 second and are useful for detecting conditions such as over current and under voltage. Up to 80 alarms can be set up in this alarm group
- **High Speed**—High speed alarms have a detection rate of 100 milliseconds and are useful for detecting voltage sags and swells lasting only a few cycles. Up to 20 alarms can be set up in this group.
- **Disturbance** — Disturbance alarms have a detection rate of less than ½ cycle and are useful for detecting voltage sags and swells. Up to 20 alarms can be set up in this group. See **Chapter 13—Disturbance Monitoring** on page 167 for more about disturbance monitoring.
- **Digital**—Digital alarms are triggered by an exception such as the transition of a digital input or the end of an incremental energy interval. Up to 40 alarms can be set up in this group.
- **Boolean**—Boolean alarms use Boolean logic to combine up to four enabled alarms. You can choose from the Boolean logic operands: AND, NAND, OR, NOR, or XOR to combine your alarms.

Use either SMS or the display to set up standard, high speed, disturbance, and digital alarms. Use SMS to set up Boolean alarms.

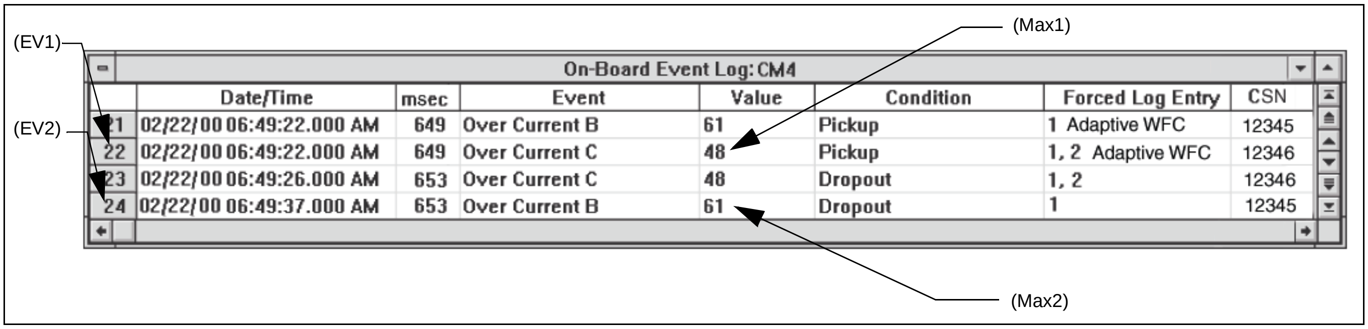
Setpoint-Driven Alarms

Many of the alarm conditions require that you define setpoints. This includes all alarms for over, under, and phase unbalance alarm conditions. Other alarm conditions such as digital input transitions and phase reversals do not require setpoints. For those alarm conditions that require setpoints, you must define the following information:

- Pickup Setpoint
- Pickup Delay (depending on the alarm group, you choose the time to be in seconds, 100 ms increments, or cycles)
- Dropout Setpoint
- Dropout Delay (depending on the alarm group, you choose the time to be in seconds, 100 ms increments, or cycles)

To understand how the circuit monitor handles setpoint-driven alarms, see Figure 10–2 on page 140. Figure 10–1 shows what the actual event log entries for Figure 10–2 might look like, as displayed by SMS.

NOTE: The software does not actually display the codes in parentheses—EV1, EV2, Max1, Max2. These are references to the codes in Figure 10–2.



	Date/Time	msec	Event	Value	Condition	Forced Log Entry	CSN
21	02/22/00 06:49:22.000 AM	649	Over Current B	61	Pickup	1 Adaptive WFC	12345
22	02/22/00 06:49:22.000 AM	649	Over Current C	48	Pickup	1, 2 Adaptive WFC	12346
23	02/22/00 06:49:26.000 AM	653	Over Current C	48	Dropout	1, 2	12346
24	02/22/00 06:49:37.000 AM	653	Over Current B	61	Dropout	1	12345

Figure 10–1 Sample event log entry

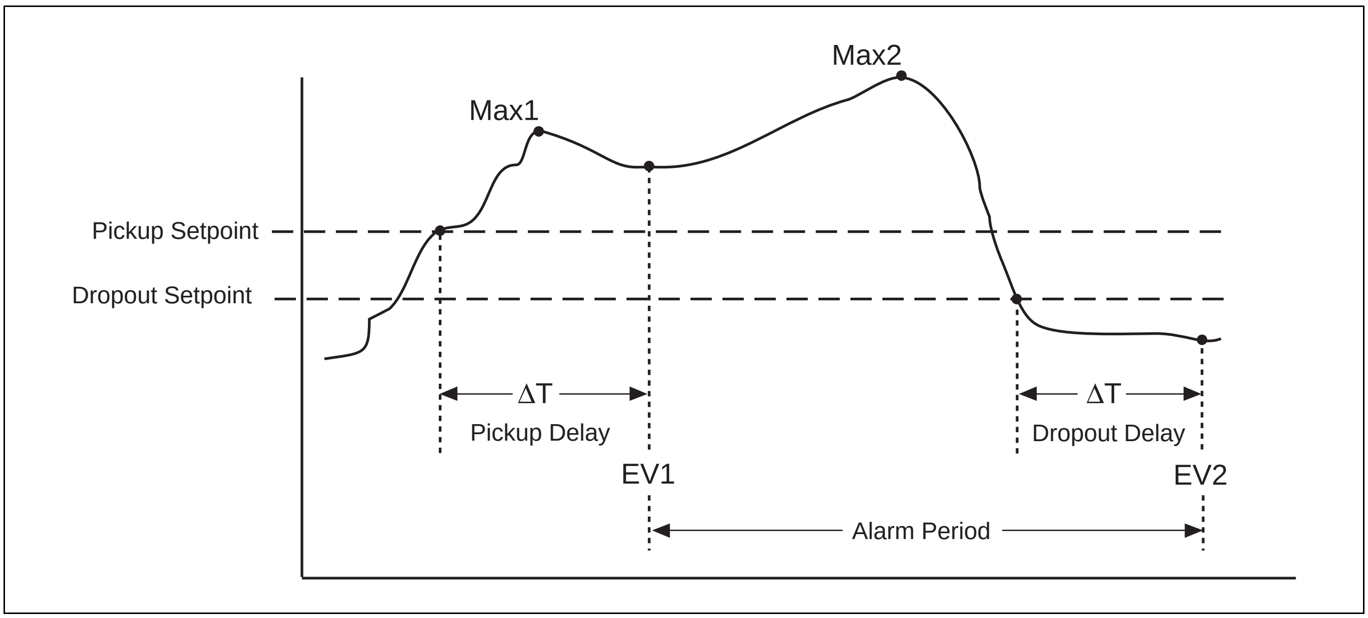


Figure 10–2 How the circuit monitor handles setpoint-driven alarms

EV1—The circuit monitor records the date and time that the pickup setpoint and time delay were satisfied, and the maximum value reached (Max1) during the pickup delay period (ΔT). Also, the circuit monitor performs any tasks assigned to the event such as event waveform captures or forced data log entries.

EV2—The circuit monitor records the date and time that the dropout setpoint and time delay were satisfied, and the maximum value reached (Max2) during the alarm period.

The circuit monitor also stores a correlation sequence number (CSN) for each event (such as *Under Voltage Phase A Pickup, Under Voltage Phase A Dropout*). The CSN lets you relate pickups and dropouts in the event log. You can sort pickups and dropouts by CSN to correlate the pickups and dropouts of a particular alarm. The pickup and dropout entries of an alarm will have the same CSN. You can also calculate the duration of an event by looking at pickups and dropouts with the same CSN.

Priorities

Each alarm also has a priority level. Use the priorities to distinguish between events that require immediate action and those that do not require action.

- **High priority**—if a high priority alarm occurs, the display informs you in two ways: the LED on the display flashes until you acknowledge the alarm and a message flashes while the alarm is active.
- **Medium priority**—if a medium priority alarm occurs, the LED and message flashes on the display only while the alarm is active. Once the alarm becomes inactive, the LED and flashing message stop.
- **Low priority**—if a low priority alarm occurs, the LED on the display flashes only while the alarm is active. No alarm message is displayed.
- **No priority**—if an alarm is setup with no priority, no visible representation will appear on the display.

If multiple alarms with different priorities are active at the same time, the display shows the alarm message for the highest priority alarm. For instructions on setting up alarms from the circuit monitor display, see “Setting Up and Editing Alarms” on page 83.

Alarm Levels

From the display or SMS, multiple alarms can be set up for one particular quantity (parameter) to create alarm “levels”. You can take different actions depending on the severity of the alarm.

For example, you could set up two alarms for kW Demand. A default alarm already exists for kW Demand (no. 26 in the alarm list), but you could create another custom alarm for kW Demand, selecting different pickup points for it. The custom kW Demand alarm, once created, will appear in the standard alarm list. For illustration purposes, let’s set the default kW Demand alarm to 120 kW and the new custom alarm to 150 kW. One alarm named *kW Demand 120 kW*; the other *kW Dmd 150kW* as shown in Figure 10–3. Note that if you choose to set up two alarms for the same quantity, use slightly different names to distinguish which alarm is active. The display can hold up to 15 characters for each name. You can create up to 10 alarm levels for each quantity.

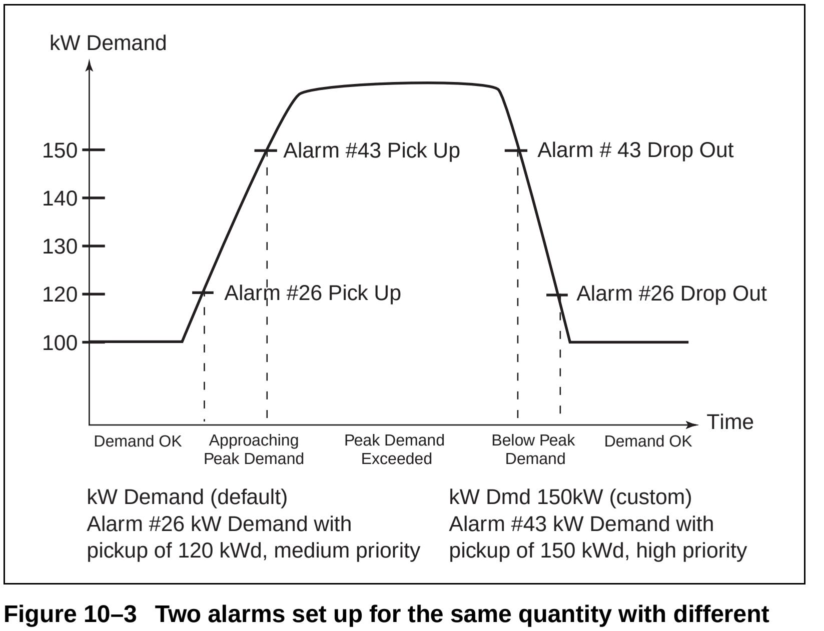


Figure 10–3 Two alarms set up for the same quantity with different pickup and dropout set points

CUSTOM ALARMS

The circuit monitor has many pre-defined alarms, but you can also set up your own custom alarms. For example, you may need to alarm on the transition of a digital input. To create this type of custom alarm:

1. Select the appropriate alarm group (digital in this case).
2. Select the type of alarm (described in Table 10–3 on page 150).
3. Give the alarm a name.

After creating a custom alarm, you can configure it by applying priorities, setting pickups and dropouts (if applicable), and so forth. For instructions on creating custom alarms, see “Creating a New Custom Alarm” on page 82 in **Chapter 7—Operation**.

SETPOINT-CONTROLLED RELAY FUNCTIONS

A circuit monitor can mimic the functions of certain motor management devices to detect and respond to conditions such as phase loss, undervoltage, or reverse phase relays. While the circuit monitor is not a primary protective device, it can detect abnormal conditions and respond by operating one or more Form-C output contacts. These outputs can be used to operate an alarm horn or bell to annunciate the alarm condition.

NOTE: The circuit monitor is not designed for use as a primary protective relay. While its setpoint-controlled functions may be acceptable for certain applications, it should not be considered a substitute for proper circuit protection.

If you determine that the circuit monitor’s performance is acceptable for the application, the output contacts can be used to mimic some functions of a motor management device. When deciding if the circuit monitor is acceptable for these applications, keep the following points in mind:

- Circuit monitors require control power to operate properly.
- Circuit monitors may take up to 5 seconds after control power is applied before setpoint-controlled functions are activated. If this is too long, a reliable source of control power is required.
- When control power is interrupted for more than approximately 100 milliseconds, the circuit monitor releases all energized output contacts.
- Standard setpoint-controlled functions may take 1–2 seconds to operate, in addition to the intended delay.
- A password is required to program the circuit monitor’s setpoint controlled relay functions.

For instructions on configuring setpoint-controlled alarms or relays from the circuit monitor’s display, see “Setting Up and Editing Alarms” on page 83. The types of available alarms are described later in this chapter in Table 10–2 on page 148.

Types of Setpoint-Controlled Relay Functions

This section describes some common motor management functions to which the following information applies:

- Values that are too large to fit into the display may require scale factors. For more information on scale factors, refer to “Changing Scale Factors” on page 245 in **Appendix C—Using the Command Interface**.
- Relays can be configured as normal, latched, or timed. See “Relay Output Operating Modes” on page 128 in **Chapter 9—Input/Output Capabilities** for more information.
- When the alarm occurs, the circuit monitor operates any specified relays and the relay remains closed until the alarm clears. There are two ways to to release relays that are in latched mode:
  - — Issue a command to de-energize a relay. See **Appendix C—Using the Command Interface** on page 235 for instructions on using the command interface, or
  - — Acknowledge the alarm in the high priority log to release the relays from latched mode. From the main menu of the display, select Alarms > High Priority Alarms to view and acknowledge unacknowledged alarms. See “Viewing Alarms” on page 99 for detailed instructions.

The list that follows shows the types of alarms available for some common motor management functions:

Undervoltage:

Pickup and dropout setpoints are entered in volts. The per-phase undervoltage alarm occurs when the per-phase voltage is equal to or below the pickup setpoint long enough to satisfy the specified pickup delay (in seconds). The undervoltage alarm clears when the phase voltage remains above the dropout setpoint for the specified dropout delay period.

Overvoltage:

Pickup and dropout setpoints are entered in volts. The per-phase overvoltage alarm occurs when the per-phase voltage is equal to or above the pickup setpoint long enough to satisfy the specified pickup delay (in seconds). The overvoltage alarm clears when the phase voltage remains below the dropout setpoint for the specified dropout delay period.

Unbalance Current:

Pickup and dropout setpoints are entered in tenths of percent, based on the percentage difference between each phase current with respect to the average of all phase currents. For example, enter an unbalance of 16.0% as 160. The unbalance current alarm occurs when the phase current deviates from the average of the phase currents, by the percentage pickup setpoint, for the specified pickup delay. The alarm clears when the percentage difference between the phase current and the average of all phases remains below the dropout setpoint for the specified dropout delay period.

Unbalance Voltage:

Pickup and dropout setpoints are entered in tenths of percent, based on the percentage difference between each phase voltage with respect to the average of all phase voltages. For example, enter an unbalance of 16.0% as 160. The unbalance voltage alarm occurs when the phase voltage deviates from the average of the phase voltages, by the percentage pickup setpoint, for the specified pickup delay. The alarm clears when the percentage difference between the phase voltage and the average of all phases remains below the dropout setpoint for the specified dropout delay (in seconds).

Phase Loss—Current:

NOTE: The alarm for Phase Loss Current is not a standard alarm. You must set it up as a custom alarm.

Pickup and dropout setpoints are entered in amperes. The phase loss current alarm occurs when any current value (but not all current values) is equal to or below the pickup setpoint for the specified pickup delay (in seconds). The alarm clears when one of the following is true:

- All of the phases remain above the dropout setpoint for the specified dropout delay, or
- All of the phases drop below the phase loss pickup setpoint.

If all of the phase currents are equal to or below the pickup setpoint, during the pickup delay, the phase loss alarm will not activate. This is considered an under current condition. It should be handled by configuring the under current protective functions.

Phase Loss—Voltage:

Pickup and dropout setpoints are entered in volts. The phase loss voltage alarm occurs when any voltage value (but not all voltage values) is equal to or below the pickup setpoint for the specified pickup delay (in seconds). The alarm clears when one of the following is true:

- All of the phases remain above the dropout setpoint for the specified dropout delay (in seconds), OR
- All of the phases drop below the phase loss pickup setpoint.

If all of the phase voltages are equal to or below the pickup setpoint, during the pickup delay, the phase loss alarm will not activate. This is considered an under voltage condition. It should be handled by configuring the under voltage protective functions.

Reverse Power:

Pickup and dropout setpoints are entered in kilowatts or kVARs. The reverse power alarm occurs when the power flows in a negative direction and remains at or below the negative pickup value for the specified pickup delay (in seconds). The alarm clears when the power reading remains above the dropout setpoint for the specified dropout delay (in seconds).

Phase Reversal:

Pickup and dropout setpoints and delays do not apply to phase reversal. The phase reversal alarm occurs when the phase voltage rotation differs from the default phase rotation. The circuit monitor assumes that an ABC phase rotation is normal. If a CBA phase rotation is normal, the user must change the circuit monitor’s phase rotation from ABC (default) to CBA. To change the phase rotation from the display, from the main menu select Setup > Meter > Advanced. For more information about changing the phase rotation setting of the circuit monitor, refer to “Advanced Meter Setup” on page 93.

SCALE FACTORS

Scale factors are simply multipliers that the circuit monitor uses to make values fit into the register where it stores the information. Normally, you do not need change scale factors for alarms. If you are creating custom alarms, you need to understand how scale factors work so that you do not overflow the register with a number larger than what the register can hold. When SMS is used to set up alarms, it automatically handles the scaling of pickup and dropout setpoints. When creating a custom alarm using the circuit monitor's display, do the following:

- Determine how the corresponding metering value is scaled, and
- Take the scale factor into account when entering alarm pickup and dropout settings.

Pickup and dropout settings must be integer values in the range of -32,767 to +32,767. For example, to set up an under voltage alarm for a 138 kV nominal system, decide upon a setpoint value and then convert it into an integer between -32,767 and +32,767. If the under voltage setpoint were 125,000 V, this would typically be converted to 12500 x 10 and entered as a setpoint of 12500.

Six scale groups are defined (A through F). The scale factor is preset for all factory-configured alarms. Table 10–1 lists the available scale factors for each of the scale groups. The factory default for each scale group is zero. If you need either an extended range or more resolution, select any of the available scale factors to suit your need.

Table 10–1: Scale Groups

Scale Group	Measurement Range	Scale Factor
Scale Group A—Phase Current	Amperes	
	0–327.67 A	–2
	0–3,276.7 A	–1
	0–32,767 A	0 (default)
	0–327.67 kA	1
Scale Group B—Neutral Current	Amperes	
	0–327.67 A	–2
	0–3,276.7 A	–1
	0–32,767 A	0 (default)
	0–327.67 kA	1
Scale Group C—Ground Current	Amperes	
	0–327.67 A	–2
	0–3,276.7 A	–1
	0–32,767 A	0 (default)
	0–327.67 kA	1
Scale Group D—Voltage, L–L	Voltage	
	0–3,276.7 V	–1
	0–32,767 V	0 (default)
	0–327.67 kV	1
	0–3,276.7 kV	2
Scale Group E—Neutral Voltage, L–N, N–G	Voltage	
	0–3,276.7 V	–1
	0–32,767 V	0 (default)
	0–327.67 kV	1

Table 10–1: Scale Groups

	0–3,276.7 kV	2
Scale Group F—Power kW, kVAR, kVA	Power	
	0–32.767 kW, kVAR, kVA	–3
	0–327.67 kW, kVAR, kVA	–2
	0–3276.7 kW, kVAR, kVA	–1
	0–32767 kW, kVAR, kVA	0 (default)
	0–327.67 MW, MVAR, MVA	1
	0–3276.7 MW, MVAR, MVA	2
	0–32767 MW, MVAR, MVA	3

SCALING ALARM SETPOINTS

This section is for users who do not have SMS and must set up alarms from the circuit monitor display. It explains how to scale alarm setpoints.

When the circuit monitor is equipped with a display, the display area is 4 x 20 characters, which limits the displaying of most metered quantities to five characters (plus a positive or negative sign). The display may also show the engineering units applied to that quantity as either *K* (kilowatts, kilovolts, etc.) or *M* (megawatts, megavolts, etc.).

When determining the proper scaling of an alarm setpoint, first view the corresponding metering value. For example, for an *Over Current Phase A* alarm, view the Phase A Current. Observe the location of the decimal point in the displayed value and see if a unit is also associated with the value. This reading can be used to determine the scaling required for alarm setpoints.

The location of the decimal point in the displayed quantity indicates the resolution that is available on this metering quantity. The quantity is displayed with up to three digits to the right of the decimal point, indicating whether the quantity is stored in a register as thousandths, hundredths, tenths, or units. The alarm setpoint value must use the same resolution as shown in the display.

For example, consider a power factor alarm. If the 3-phase average power factor is 1.000—meaning that the power factor is stored in thousandths—enter the alarm setpoints as numeric values in thousandths. Therefore, to define a power factor setpoint of 0.85 leading, enter 850.

For another example, consider a *Phase A-B Undervoltage* alarm. If the Voltage Phase A–B (VA-B) reading is displayed as *138.00 K*, then enter the setpoints in hundredths of kilovolts. Therefore, to define a setpoint of 125,000 volts, enter 12,500 (hundredths of kV). To arrive at this value, first convert 125,000 volts to 125.00 kilovolts; then multiply by 100.

ALARM CONDITIONS AND ALARM NUMBERS

This section lists the circuit monitor's predefined alarm conditions. For each alarm condition, the following information is provided.

- Alarm No.—a position number indicating where an alarm falls in the list.
- Alarm Description—a brief description of the alarm condition
- Abbreviated Display Name—an abbreviated name that describes the alarm condition, but is limited to 15 characters that fit in the window of the circuit monitor's display.
- Test Register—the register number that contains the value (where applicable) that is used as the basis for a comparison to alarm pickup and dropout settings.
- Units—the unit that applies to the pickup and dropout settings.
- Scale Group—the scale group that applies to the test register's metering value (A–F). For a description of scale groups, see "Scale Factors" on page 145**.**
- Alarm Type—a reference to a definition that provides details on the operation and configuration of the alarm. For a description of alarm types, refer to Table 10–3 on page 150.

Table 10–2 on page 148 lists the preconfigured alarms by alarm number.

Table 10–2: List of Default Alarms by Alarm Number

Alarm Number	Alarm Description	Abbreviated Display Name	Test Register	Units	Scale Group	Alarm Type ①
Standard Speed Alarms (1 Second)						
01	Over Current Phase A	Over Ia	1100	Amperes	A	010
02	Over Current Phase B	Over Ib	1101	Amperes	A	010
03	Over Current Phase C	Over Ic	1102	Amperes	A	010
04	Over Current Neutral	Over In	1103	Amperes	B	010
05	Over Current Ground	Over Ig	1104	Amperes	C	010
06	Under Current Phase A	Under Ia	1100	Amperes	A	020
07	Under Current Phase B	Under Ib	1101	Amperes	A	020
08	Under Current Phase C	Under Ic	1102	Amperes	A	020
09	Current Unbalance, Max	I Unbal Max	1110	Tenths %	—	010
10	Over Voltage Phase A–N	Over Van	1124	Volts	D	010
11	Over Voltage Phase B–N	Over Vbn	1125	Volts	D	010
12	Over Voltage Phase C–N	Over Vcn	1126	Volts	D	010
13	Over Voltage Phase A–B	Over Vab	1120	Volts	D	010
14	Over Voltage Phase B–C	Over Vbc	1121	Volts	D	010
15	Over Voltage Phase C–A	Over Vca	1122	Volts	D	010
16	Under Voltage Phase A	Under Van	1124	Volts	D	020
17	Under Voltage Phase B	Under Vbn	1125	Volts	D	020
18	Under Voltage Phase C	Under Vcn	1126	Volts	D	020
19	Under Voltage Phase A–B	Under Vab	1120	Volts	D	020
20	Under Voltage Phase B–C	Under Vbc	1121	Volts	D	020
21	Under Voltage Phase C–A	Under Vca	1122	Volts	D	020
22	Voltage Unbalance L–N, Max	V Unbal L-N Max	1136	Tenths %	—	010
23	Voltage Unbalance L–L, Max	V Unbal L-L Max	1132	Tenths %	—	010
24	Voltage Loss (loss of A,B,C, but not all)	Voltage Loss	—	—	—	052
25	Over kVA Demand	Over kVA Dmd	2180	kVA	F	011
26	Over kW Demand	Over kW Dmd	2150	kW	F	011
27	Over kVAR Demand	Over kVAR Dmd	2165	kVAR	F	011
28	Over Frequency	Over Freq.	1180	Hundredths of Hertz	—	010
29	Under Frequency	Under Freq.	1180	Hundredths of Hertz	—	020
30	Lagging true power factor	Lag True PF	1163	Thousandths	—	055
31	Leading true power factor	Lead True PF	1163	Thousandths	—	054
32	Lagging displacement power factor	Lag Disp PF	1171	Thousandths	—	055
33	Leading displacement power factor	Lead Disp PF	1171	Thousandths	—	054
34	Over Current Demand Phase A	Over Ia Dmd	1960	Amperes	A	010
35	Over Current Demand Phase B	Over Ib Dmd	1970	Amperes	A	010
36	Over Current Demand Phase C	Over Ic Dmd	1980	Amperes	A	010
37	Over THD Voltage A–N	Over THD Van	1207	Tenths %	—	010
38	Over THD Voltage B–N	Over THD Vbn	1208	Tenths %	—	010
39	Over THD Voltage C–N	Over THD Vcn	1209	Tenths %	—	010
40	Over THD Voltage A–B	Over THD Vab	1211	Tenths %	—	010
41	Over THD Voltage B–C	Over THD Vbc	1212	Tenths %	—	010
42	Over THD Voltage C–A	Over THD Vca	1213	Tenths %	—	010

① Alarm Types are described in Table 10–3 on page 150.

Table 10–2: List of Default Alarms by Alarm Number

Alarm Number	Alarm Description	Abbreviated Display Name	Test Register	Units	Scale Group	Alarm Type ①
High Speed Alarms (100 ms)						
01	Over Current A	Over Ia	1000	Amperes	A	010
02	Over Current B	Over Ib	1001	Amperes	A	010
03	Over Current C	Over Ic	1002	Amperes	A	010
04	Over Current N	Over In	1003	Amperes	B	010
05	Over Current G	Over Ig	1004	Amperes	C	010
06	Over Voltage A–N	Over Van	1024	Volts	D	010
07	Over Voltage B–N	Over Vbn	1025	Volts	D	010
08	Over Voltage C–N	Over Vcn	1026	Volts	D	010
09	Over Voltage A-B	Over Vab	1020	Volts	D	010
10	Over Voltage B-C	Over Vbc	1021	Volts	D	010
11	Over Voltage C-A	Over Vca	1022	Volts	D	010
12	Over Voltage N-G	Over Vng	1027	Volts	E	010
13	Under Voltage A–N	Under Van	1024	Volts	D	020
14	Under Voltage B–N	Under Vbn	1025	Volts	D	020
15	Under Voltage C–N	Under Vcn	1026	Volts	D	020
16	Under Voltage A-B	Under Vab	1020	Volts	D	020
17	Under Voltage B-C	Under Vbc	1021	Volts	D	020
18	Under Voltage C-A	Under Vca	1022	Volts	D	020
Disturbance Monitoring (½ Cycle)						
01	Voltage Swell A	Swell Van/Vab	N/A	Volts	D	080
02	Voltage Swell B	Swell Vbn	N/A	Volts	D	080
03	Voltage Swell C/C–A	Swell Vcn/Vca	N/A	Volts	D	080
04	Voltage Sag A/A–B	Sag Van/Vab	N/A	Volts	D	090
05	Voltage Sag B	Sag Vbn	N/A	Volts	D	090
06	Voltage Sag C/C–A	Sag Vcn/Vca	N/A	Volts	D	090
07	Current Swell A	Swell Ia	N/A	Volts	D	080
08	Current Swell B	Swell Ib	N/A	Amperes	A	080
09	Current Swell C	Swell Ic	N/A	Amperes	A	080
10	Current Sag A	Sag Ia	N/A	Amperes	A	090
11	Current Sag B	Sag Ib	N/A	Amperes	A	090
12	Current Sag C	Sag Ic	N/A	Amperes	A	090
Digital						
01	End of incremental energy interval	End Inc Enr Int	N/A	—	—	070
02	End of power demand interval	End Power Dmd Int	N/A	—	—	070
03	End of 1-second update cycle	End 1s Cyc	N/A	—	—	070
04	End of 100ms update cycle	End 100ms Cyc	N/A	—	—	070
05	Power up/Reset	Pwr. Up/Reset	N/A	—	—	070

① Alarm Types are described in Table 10–3 on page 150.

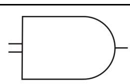
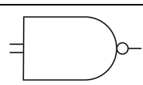
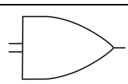
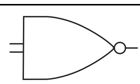
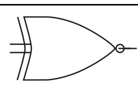
Table 10–3: Alarm Types

Type	Description	Operation
Standard Speed		
010	Over Value Alarm	If the test register value exceeds the setpoint long enough to satisfy the pickup delay period, the alarm condition will be true. When the value in the test register falls below the dropout setpoint long enough to satisfy the dropout delay period, the alarm will dropout. Pickup and dropout setpoints are positive, delays are in seconds.
011	Over Power Alarm	If the absolute value in the test register exceeds the setpoint long enough to satisfy the pickup delay period, the alarm condition will be true. When the value in the test register falls below the dropout setpoint long enough to satisfy the dropout delay period, the alarm will dropout. Pickup and dropout setpoints are positive, delays are in seconds.
012	Over Reverse Power Alarm	If the absolute value in the test register exceeds the setpoint long enough to satisfy the pickup delay period, the alarm condition will be true. When the value in the test register falls below the dropout setpoint long enough to satisfy the dropout delay period, the alarm will dropout. This alarm will only hold true for reverse power conditions. Positive power values will not cause the alarm to occur. Pickup and dropout setpoints are positive, delays are in seconds.
020	Under Value Alarm	If the test register value is below the setpoint long enough to satisfy the pickup delay period, the alarm condition will be true. When the value in the test register rises above the dropout setpoint long enough to satisfy the dropout delay period, the alarm will dropout. Pickup and dropout setpoints are positive, delays are in seconds.
021	Under Power Alarm	If the absolute value in the test register is below the setpoint long enough to satisfy the pickup delay period, the alarm condition will be true. When the value in the test register rises above the dropout setpoint long enough to satisfy the dropout delay period, the alarm will dropout. Pickup and dropout setpoints are positive, delays are in seconds.
051	Phase Reversal	The phase reversal alarm will occur whenever the phase voltage waveform rotation differs from the default phase rotation. The ABC phase rotation is assumed to be normal. If a CBA phase rotation is normal, the user should reprogram the circuit monitor’s phase rotation ABC to CBA phase rotation. The pickup and dropout setpoints and delays for phase reversal do not apply.
052	Phase Loss, Voltage	The phase loss voltage alarm will occur when any one or two phase voltages (but not all) fall to the pickup value and remain at or below the pickup value long enough to satisfy the specified pickup delay. When all of the phases remain at or above the dropout value for the dropout delay period, or when all of the phases drop below the specified phase loss pickup value, the alarm will dropout. Pickup and dropout setpoints are positive, delays are in seconds.
053	Phase Loss, Current	The phase loss current alarm will occur when any one or two phase currents (but not all) fall to the pickup value and remain at or below the pickup value long enough to satisfy the specified pickup delay. When all of the phases remain at or above the dropout value for the dropout delay period, or when all of the phases drop below the specified phase loss pickup value, the alarm will dropout. Pickup and dropout setpoints are positive, delays are in seconds.
054	Leading Power Factor	The leading power factor alarm will occur when the test register value becomes more leading than the pickup setpoint (such as closer to -0.010) and remains more leading long enough to satisfy the pickup delay period. When the value becomes equal to or less leading than the dropout setpoint, that is 1.000, and remains less leading for the dropout delay period, the alarm will dropout. Both the pickup setpoint and the dropout setpoint must be positive values representing leading power factor. Enter setpoints as integer values representing power factor in thousandths. For example, to define a dropout setpoint of 0.5, enter 500. Delays are in seconds.
055	Lagging Power Factor	The lagging power factor alarm will occur when the test register value becomes more lagging than the pickup setpoint (such as closer to 0.010) and remains more lagging long enough to satisfy the pickup delay period. When the value becomes equal to or less lagging than the dropout setpoint, that is 1.000, and remains less lagging for the dropout delay period, the alarm will dropout. Both the pickup setpoint and the dropout setpoint must be positive values representing lagging power factor. Enter setpoints as integer values representing power factor in thousandths. For example, to define a dropout setpoint of -0.5, enter –500. Delays are in seconds.

Table 10–3: Alarm Types

Type	Description	Operation
High Speed		
010	Over Value Alarm	If the test register value exceeds the setpoint long enough to satisfy the pickup delay period, the alarm condition will be true. When the value in the test register falls below the dropout setpoint long enough to satisfy the dropout delay period, the alarm will dropout. Pickup and dropout setpoints are positive, delays are in hundreds of milliseconds.
011	Over Power Alarm	If the absolute value in the test register exceeds the setpoint long enough to satisfy the pickup delay period, the alarm condition will be true. When the value in the test register falls below the dropout setpoint long enough to satisfy the dropout delay period, the alarm will dropout. Pickup and dropout setpoints are positive, delays are in hundreds of milliseconds.
012	Over Reverse Power Alarm	If the absolute value in the test register exceeds the setpoint long enough to satisfy the pickup delay period, the alarm condition will be true. When the value in the test register falls below the dropout setpoint long enough to satisfy the dropout delay period, the alarm will dropout. This alarm will only hold true for reverse power conditions. Positive power values will not cause the alarm to occur. Pickup and dropout setpoints are positive, delays are in hundreds of milliseconds.
020	Under Value Alarm	If the test register value is below the setpoint long enough to satisfy the pickup delay period, the alarm condition will be true. When the value in the test register rises above the dropout setpoint long enough to satisfy the dropout delay period, the alarm will dropout. Pickup and dropout setpoints are positive, delays are in hundreds of milliseconds.
021	Under Power Alarm	If the absolute value in the test register is below the setpoint long enough to satisfy the pickup delay period, the alarm condition will be true. When the value in the test register rises above the dropout setpoint long enough to satisfy the dropout delay period, the alarm will dropout. Pickup and dropout setpoints are positive, delays are in hundreds of milliseconds.
051	Phase Reversal	The phase reversal alarm will occur when ever the phase voltage waveform rotation differs from the default phase rotation. The ABC phase rotation is assumed to be normal. If a CBA normal phase rotation is normal, the user should reprogram the circuit monitor’s phase rotation ABC to CBA phase rotation. The pickup and dropout setpoints and delays for phase reversal do no apply.
052	Phase Loss, Voltage	The phase loss voltage alarm will occur when any one or two phase voltages (but not all) fall to the pickup value and remain at or below the pickup value long enough to satisfy the specified pickup delay. When all of the phases remain at or above the dropout value for the dropout delay period, or when all of the phases drop below the specified phase loss pickup value, the alarm will dropout. Pickup and dropout setpoints are positive, delays are in seconds.
053	Phase Loss, Current	The phase loss current alarm will occur when any one or two phase currents (but not all) fall to the pickup value and remain at or below the pickup value long enough to satisfy the specified pickup delay. When all of the phases remain at or above the dropout value for the dropout delay period, or when all of the phases drop below the specified phase loss pickup value, the alarm will dropout. Pickup and dropout setpoints are positive, delays are in hundreds of milliseconds.
054	Leading Power Factor	The leading power factor alarm will occur when the test register value becomes more leading than the pickup setpoint (closer to -0.010) and remains more leading long enough to satisfy the pickup delay period. When the value becomes equal to or less leading than the dropout setpoint, that is 1.000, and remains less leading for the dropout delay period, the alarm will dropout.Both the pickup setpoint and the dropout setpoint must be positive values representing leading power factor. Enter setpoints as integer values representing power factor in thousandths. For example, to define a dropout setpoint of -0.5, enter –500. Delays are in hundreds of milliseconds.
055	Lagging Power Factor	The lagging power factor alarm will occur when the test register value becomes more lagging than the pickup setpoint (closer to 0.010) and remains more lagging long enough to satisfy the pickup delay period. When the value becomes equal to or less lagging than the dropout setpoint, that is. 1.000 and remains less lagging for the dropout delay period, the alarm will dropout. Both the pickup setpoint and the dropout setpoint must be positive values representing lagging power factor. Enter setpoints as integer values representing power factor in thousandths. For example, to define a dropout setpoint of -0.5, enter –500. Delays arein hundreds of milliseconds.

Table 10–3: Alarm Types

Type	Description	Operation
Disturbance		
080	Voltage/Current Swell	The voltage and current swell alarms will occur whenever the continuous rms calculation is above the pickup setpoint and remains above the pickup setpoint for the specified number of cycles. When the continuous rms calculations fall below the dropout setpoint and remain below the setpoint for the specified number of cycles, the alarm will dropout. Pickup and dropout setpoints are positive and delays are in cycles.
090	Voltage/Current Sag	The voltage and current sag alarms will occur whenever the continuous rms calculation is below the pickup setpoint and remains below the pickup setpoint for the specified number of cycles. When the continuous rms calculations rise above the dropout setpoint and remain above the setpoint for the specified number of cycles, the alarm will drop out. Pickup and dropout setpoints are positive and delays are in cycles.
Digital		
060	Digital Input On	The digital input transition alarms will occur whenever the digital input changes from off to on. The alarm requires no pickup or dropout setpoints or delays. The alarm will dropout when the digital input changes back to off from on. The pickup and dropout setpoints and delays do not apply.
061	Digital Input Off	The digital input transition alarms will occur whenever the digital input changes from on to off. The alarm requires no pickup or dropout setpoints or delays.The alarm will dropout when the digital input changes back to on from off. The pickup and dropout setpoints and delays do not apply.
070	Unary	This is a internal signal from the circuit monitor and can be used, for example, to alarm at the end of an interval or when the circuit monitor is reset. The pickup and dropout delays do not apply.
Boolean		
100	Logic AND 	The AND alarm will occur when *all* of the combined enabled alarms are true (up to 4). The alarm will dropout when *any* of the enabled alarms drops out.
101	Logic NAND 	The NAND alarm will occur when *any, but not all,* or *none* of the combined enabled alarms are true. The alarm will dropout when *all* of the enabled alarms drops out.
102	Logic OR 	The OR alarm will occur when *any* of the combined enabled alarms are true (up to 4). The alarm will dropout when *all* of the enabled alarms are *false*.
103	Logic NOR 	The NOR alarm will occur when *none* of the combined enabled alarms are true (up to 4). The alarm will dropout when *any* of the enabled alarms are *true*.
104	Logic XOR 	The XOR alarm will occur when *only one* of the combined enabled alarms is true (up to 4). The alarm will dropout when *the enabled alarm drops out* or when more than one alarm becomes *true*.

CHAPTER 11—LOGGING

This chapter briefly describes the following logs of the circuit monitor:

- Event log
- User-defined data logs
- Min/Max log and Interval Min/Max/Average log
- Maintenance log

Logs are files stored in the nonvolatile memory of circuit monitor and are referred to as “onboard logs.” Use SMS to set up and view all the logs. See the SMS online help for information about working with circuit monitor’s onboard logs. Waveform captures and the 100-ms rms event recording are not logs, but the information is also saved in the circuit monitor’s memory. See “Memory Allocation” on page 158 for information about shared memory in the circuit monitor.

CHAPTER CONTENTS

EVENT LOG

Using SMS, you can set up the circuit monitor to log the occurrence of any alarm condition as an event. Each time an alarm occurs it becomes an event. The event log in the circuit monitor stores the pickup and dropout points of alarms along with the date and time associated with these events. You select whether the event log saves data as first-in-first-out (FIFO) or fill and hold. You can also view and save the event log to disk, and reset the event log to clear the data out of the circuit monitor's memory.

Event Log Storage

The circuit monitor stores event log data in nonvolatile memory. You define the size of the event log (the maximum number of events). When determining the maximum number of events, consider the circuit monitor's total storage capacity. See "Memory Allocation" on page 158 for additional memory considerations.

DATA LOGS

The circuit monitor records meter readings at regularly scheduled intervals and stores the data in up to 14 independent data log files in its memory. Some data log files are preconfigured at the factory. You can accept the preconfigured data logs or change them to meet your specific needs. See "Factory Defaults" on page 9 for information about preset features of the circuit monitor. You can set up each data log to store the following information:

- Timed Interval—1 second to 24 hours (how often the values are logged)
- First-In-First-Out (FIFO) or Fill and Hold
- Values to be logged—up to 96 quantities along with the date and time of each log entry

Use SMS to clear each data log file, independently of the others, from the circuit monitor's memory. For instructions on setting up and clearing data log files, refer to the SMS online help file.

Alarm-Driven Data Log Entries

The circuit monitor can detect over 100 alarm conditions, including over/under conditions, digital input changes, phase unbalance conditions, and more. (See **Chapter 10—Alarms** on page 137 for more information.) Use SMS to assign each alarm condition one or more tasks, including forcing data log entries into any or all data log files.

For example, assume that you've defined 14 data log files. Using SMS, you could select an alarm condition such as "Overcurrent Phase A" and set up the circuit monitor to force data log entries into any of the 14 log files each time the alarm condition occurs.

Organizing Data Log Files

You can organize data log files in many ways. One possible way is to organize log files according to the logging interval. You might also define a log file for entries forced by alarm conditions. For example, you could set up four data log files as follows:

Data Log 1: Log voltage every minute. Make the file large enough to hold 60 entries so that you could look back over the last hour's voltage readings.

Data Log 2: Log voltage, current, and power hourly for a historical record over a longer period.

Data Log 3: Log energy once every day. Make the file large enough to hold 31 entries so that you could look back over the last month and see daily energy use.

Data Log 4: Report by exception. The report by exception file contains data log entries that are forced by the occurrence of an alarm condition. See the previous sectoin "Alarm-Driven Data Log Entries" for more information.

NOTE: The same data log file can support both scheduled and alarm-driven entries.

Data Log Storage

Each defined data log file stores a date and time and requires some additional overhead. To minimize storage space occupied by dates, times, and file overhead, use a few log files that log many values, as opposed to many log files that store only a few values each.

Consider that storage space is also affected by how many data log files you use (up to 14) and how many quantities are logged in each entry (up to 96) for each data log file. See "Memory Allocation" on page 158 for additional storage considerations.

MIN/MAX LOGS

There are two Min/Max logs:

- Min/Max log
- Interval Min/Max/average log

Min/Max Log

When any real-time reading reaches its highest or lowest value, the circuit monitor saves the value in the Min/Max log.You can use SMS to view and reset this log. For instructions, refer to the SMS online help. You can also view the min/max values from the display. From the main menu, select Min/Max and then select the value you'd like to view, such as amperes, volts, or frequency. See "Viewing Minimum and Maximum Values from the Min/Max Menu" on page 97 in this manual for detailed instructions. The Min/Max log cannot be customized.

Interval Min/Max/Average Log

In addition to the Min/Max log, the circuit monitor has a Min/Max/Average log. The Min/Max/Average log stores 23 quantities, which are listed below. At each interval, the circuit monitor records a minimum, a maximum, and an average value for each quantity. It also records the date and time for each interval along with the date and time for each minimum and maximum value within the interval. For example, every hour the default log will log the minimum voltage for phase A over the last hour, the maximum voltage for phase A over the last hour, and the average voltage for phase A over the last hour. All 23 values are preconfigured with a default interval of 60 minutes, but you can reset the interval from 1 to 1440 minutes. To setup, view, and reset the Min/Max/Average log using SMS, see the SMS online help. The following values are logged into the Min/Max/Average log:

- Voltage Phase A–B
- Voltage Phase B–C
- Voltage Phase C–A
- Voltage N–G
- Current Phase A
- Current Phase B
- Current Phase C
- Current Phase N
- Current Phase G
- kW 3-Phase Average
- kVAR 3-Phase Average
- kVA 3-Phase Average
- kW Demand 3-Phase Average
- kVAR Demand 3-Phase Average
- kVA Demand 3-Phase Average
- THD Voltage A–N
- THD Voltage B–N
- THD Voltage C–N
- THD Voltage A–B
- THD Voltage B–C
- THD Voltage C–A
- True Power Factor 3-Phase Total
- Displacement Power Factor 3-Phase Total

Interval Min/Max/Average Log Storage

When determining storage space among the logs, consider that storage space is affected by how often the circuit monitor is logging min/max/average values and how many entries are stored.

MAINTENANCE LOG

The circuit monitor stores a maintenance log in nonvolatile memory. Table 11–1 describes the values stored in the maintenance log. These values are cumulative over the life of the circuit monitor and cannot be reset.

Use SMS to view the maintenance log. Refer to the SMS online help for instructions.

Table 11–1: Values Stored in Maintenance Log

Value Stored	Description
Number of Demand Resets	Number of times demand values have been reset.
Number of Energy Resets	Number of times energy values have been reset.
Number of Min/Max Resets	Number of times min/max values have been reset.
Number of Output Operations	Number of times digital output has operated. This value is stored for each digital output.
Number of Power Losses	Number of times circuit monitor has lost control power.
Number of Firmware Downloads	Number of times new firmware has been downloaded to the circuit monitor over communications.
Number of I/R Comms Sessions	Number of times the I/R communications port has been used. (Available only with VFD display.)
Highest Temperature Monitored	Highest temperature reached inside the circuit monitor.
Lowest Temperature Monitored	Lowest temperature reached inside the circuit monitor.
Number of GPS time syncs	Number of syncs received from the global positioning satellite transmitter.
Number of option card changes	Number of times the option card has been changed. Stored for both option card slots.
Number of I/O extender changes	Number of times the I/O extender has been changed.
Number of times KYZ pulse output overdriven	Number of times the KYZ pulse output has overdriven
Number of input metering accumulation resets	Number of times input pulse demand metering has been reset.

MEMORY ALLOCATION

The circuit monitor's standard, nonvolatile memory is 8MB and can be upgraded to 16MB, 32MB, and higher. See "Upgrading Memory in the Circuit Monitor" on page 177 for more information about upgrading memory.

When using SMS to set up a circuit monitor, you must allocate the total data storage capacity between the following logs and recorded information:

- Event log
- Harmonic analysis waveform capture
- Short waveform (cycles)
- Adaptive waveform (seconds)
- 100-ms rms event recording
- Up to 14 data logs
- Min/Max/Average log

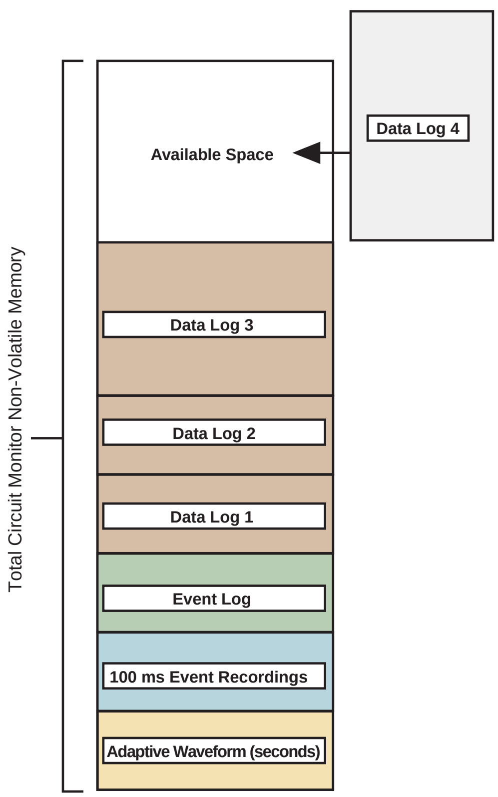
In addition, the choices you make for the items listed below directly affect the amount of memory used:

- The number of data log files (1 to 14)
- The quantities logged in each entry (1 to 96), for each data log file.
- The maximum number of entries in each data log file.
- The maximum number of events in the event log file.
- The maximum number of waveform captures in the each of the waveform capture files. Consider that you set the maximum number for three different waveform captures: steady-state, disturbance waveform (cycles), and adaptive waveforms (seconds) plus a 100 ms rms event recording.

The number you enter for each of the above items depends on the amount of the memory that is still available, and the available memory depends on the numbers you've already assigned to the other items.

With a minimum of 8 MB of memory, it is unlikely that you will use all the circuit monitor's memory, even if you use all 14 data logs and the other recording features. However, it is important to understand that memory is shared by the event logs, data logs, and waveform captures. Figure 11–1 on the left shows how the memory might be allocated.

In Figure 11–1, the user has set up an adaptive waveform (seconds), a 100 ms event recording, an event log, and three data logs (two small logs, and one larger log). Of the total available nonvolatile memory, about 25% is still available. If the user decided to add a fourth data log file, the file could be no larger than the space still available—25% of the circuit monitor's total storage capacity. If the fourth file had to be larger than the space still available, the user would have to reduce the size of one of the other files to free up the needed space.



If you want to add a new log file, but the file is too large for the available space, you must either:
- reduce the size of Data Log 4 or
- reduce the size of one or more of the existing files

Figure 11–1 Memory allocation example

SMS displays the memory allocation statistics in the OnBoard Files dialog box shown in Figure 11–2. Color blocks on the bar show the space devoted to each type of log file, while black indicates memory still available. For instructions on setting up log files using SMS, refer to SMS online help file included with the software.

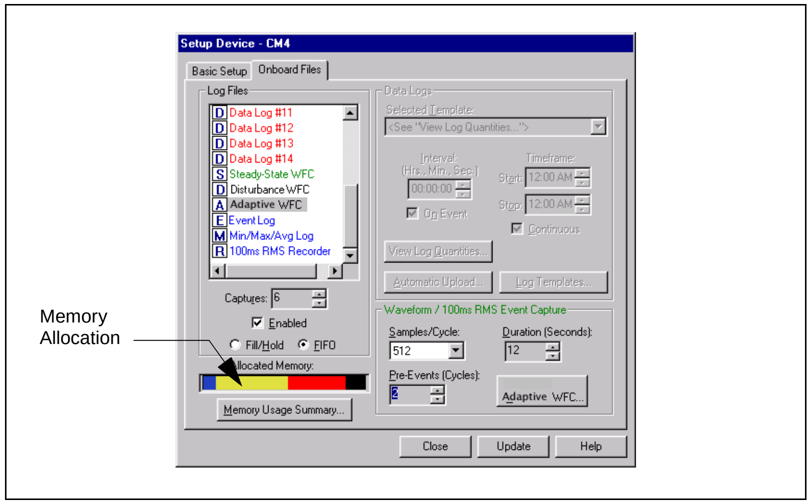


Figure 11–2 Memory allocation in SMS

CHAPTER 12—WAVEFORM AND EVENT CAPTURE

This chapter explains the waveform and event capture capabilities of the circuit monitor.

CHAPTER CONTENTS

TYPES OF WAVEFORM CAPTURES

Using waveform captures you can monitor power sags and swells that may be produced, for example, when an X-ray machine and an elevator are used at the same time, or more commonly, when lightning strikes the distribution system that feeds the facility. The system's alarms can be programmed to detect and record such fluctuations, enabling you to determine an appropriate strategy for corrective action.

Circuit monitors use a sophisticated, high-speed sampling technique to simultaneously sample up to 512 samples per cycle on all current and voltage channels. From this sampling, the circuit monitor saves waveform data into its memory. These waveform captures can be graphically displayed using SMS. The circuit monitor has one type of waveform capture that you initiate manually; the other three event captures are associated with and triggered by an event such as a digital input transition or over/under condition. These event recordings help you understand what happened during an electrical event. Using event captures you can analyze power disturbances in detail, identify potential problems, and take corrective action. See **Chapter 13—Disturbance Monitoring** on page 167 for more about disturbance monitoring. The types of event captures are described in the sections that follow.

Steady-state Waveform Capture

The steady-state waveform capture can be initiated manually to analyze steady-state harmonics. This waveform provides information about individual harmonics, which SMS calculates through the 255th harmonic. It also calculates total harmonic distortion (THD). The waveform capture records one cycle at 512 samples per cycle simultaneously on all metered channels.

Initiating a Steady-state Waveform

Using SMS from a remote PC, initiate a steady-state waveform capture manually by selecting the circuit monitor and issuing the acquire command. Then, use SMS to retrieve the waveform capture from the circuit monitor. You can display the waveform for all three phases, or zoom in on a single waveform, which includes a data block with extensive harmonic data. See the SMS online help for instructions.

Disturbance Waveform Capture

Use the disturbance waveform capture to record events that may occur within a short time span such as multiple sags or swells. Each time a sag or swell is detected, the circuit monitor triggers a waveform capture. The circuit monitor initiates a disturbance waveform capture automatically when an alarm condition occurs (if the alarm is set up to perform the waveform capture). The trigger may be from an external device such as an protective relay trip contact connected to a digital input or voltage sag alarm, or you can also initiate the waveform capture manually at any time.

In SMS, for the disturbance waveform capture, you select the sample rate and how many cycles and pre-event cycles the circuit monitor will capture (see Table 12–1):

Table 12–1: Available Resolutions for Disturbance Waveform Captures

Samples per Cycle (Resolution)	Max Duration
64	96 cycles
128	48 cycles
512	12 cycles

See the SMS online help for instructions on setting up disturbance waveform captures.

Adaptive Waveform Capture

The adaptive waveform capture records up to 64 seconds of an event, making it useful for relatively longer events than can't be recorded with the disturbance waveform capture. For example, using the adaptive waveform capture you could get a detailed view of an entire recloser sequence. Each time a sag or swell is detected, the circuit monitor triggers the waveform capture. The circuit monitor initiates an adaptive waveform capture automatically when an alarm condition occurs, or the waveform capture can also be triggered by an external device such as a protective relay. The unique feature of the adaptive waveform capture is that it can be enabled to stop recording at the dropout of the alarm, which allows you to capture data while the alarm is true. You can also initiate this waveform capture at any time.

In SMS, for the adaptive waveform capture, you select the sample rate, and how many seconds of the event the circuit monitor will capture (see Table 12–2). You can also select how many channels to record. Selecting fewer channels lets you record more seconds.

Table 12–2: Available Resolutions for Adaptive Waveform Captures

Samples per Cycle (Resolution)	Max. Duration (with per-phase current and voltage channels
16	64 seconds
32	32 seconds
64	16 seconds
128	8 seconds
512	2 seconds

Choose fewer samples per cycle when you want to see more total seconds; choose fewer channels to see a longer duration. See the SMS online help for instructions on setting up adaptive waveform captures.

100ms rms Event Recording

The 100ms rms event capture gives you a different view of an event by recording 100ms data for the amount of time you specify. Table 12–3 lists all the quantities captured. This type of event capture is useful for analyzing what happened during a motor start or recloser operation because it shows a long event without using a significant amount of memory. The circuit monitor initiates the event capture automatically when an alarm condition occurs, or an external device can also trigger the event capture. You select the duration of the event recording (up to 300 seconds) and the number of pre-event seconds (1–10) that the circuit monitor will capture.

Table 12–3: 100ms rms Quantities

Current Per-Phase Neutral
Voltage Line-to-Neutral, Per-Phase Line-to-Line, Per-Phase
Real Power Per-Phase (4-wire systems only) 3-Phase Total
Reactive Power Per-Phase (4-wire systems only) 3-Phase Total
Apparent Power 3-Phase Total
Power Factor (True) 3-Phase Total

SETTING UP THE CIRCUIT MONITOR FOR AUTOMATIC EVENT CAPTURE

There are two ways to set up the circuit monitor for automatic event capture:

- Use an alarm to trigger the waveform capture.
- Use an external trigger such as a relay.

This section provides an overview of the steps you perform in SMS to setup these event captures.

Setting Up Alarm-Triggered Event Capture

To set up the circuit monitor for automatic event capture, use SMS to perform the following steps:

NOTE: For detailed instructions, refer to the SMS online help.

1. Select the type of event capture (disturbance, adaptive, or 100ms) and set up the number of samples per cycle, pre-event cycles or seconds, and duration.
2. Select an alarm condition.
3. Define the pick up and dropout setpoints of the alarm, if applicable.
4. Select the automatic waveform capture option (Capture Waveform on Event). Check the pickup-to-dropout box if you want it to use it for an adaptive waveform capture.
5. Repeat these steps for the desired alarm conditions.

Setting Up Relay-Triggered Event Capture

When the circuit monitor is connected to an external device such as a protective relay, the circuit monitor can capture and provide valuable information on short duration events such as voltage sags. The circuit monitor must be equipped with digital inputs on an IOX Extender, or an IOC-44 Digital I/O Card.

To set up the circuit monitor for event capture triggered by a relay, use SMS to perform the following steps:

NOTE: For detailed instructions, refer to the SMS online help.

1. Select the type of event capture (disturbance, adaptive, or 100ms) and set up the number of samples per cycle, pre-event cycles or seconds, and duration.
2. Create a digital alarm for the input.
3. Select the alarm.
4. Choose the type of event recording you would like.

WAVEFORM STORAGE

The circuit monitor can store multiple captured waveforms in its nonvolatile memory. The number of waveforms that can be stored is based on the amount of memory that has been allocated to waveform capture. All stored waveform data is retained on power-loss.

HOW THE CIRCUIT MONITOR CAPTURES AN EVENT

When the circuit monitor senses the trigger—that is, when the digital input transitions from OFF to ON, or an alarm condition is met—the circuit monitor transfers the cycle data from its data buffer into the memory allocated for event captures. The number of cycles or seconds it saves depends on the number of cycles or seconds you selected.

Figure 12–1 shows an event capture. In this example, the circuit monitor was monitoring a constant load when a motor load started causing a current inrush. The circuit monitor was set up to capture 2 pre-event and 10 post-event cycles.

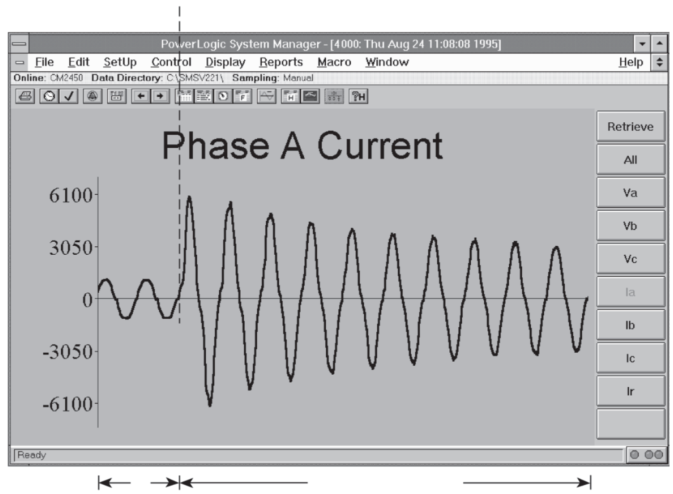


Figure 12–1 Event capture initiated from a high-speed input

CHAPTER 13—DISTURBANCE MONITORING

This chapter gives you background information about disturbance monitoring and describes how to use the circuit monitor to continuously monitor for disturbances on the current and voltage inputs. It also provides an overview of using SMS to gather data when a disturbance event occurs.

CHAPTER CONTENTS

ABOUT DISTURBANCE MONITORING

Momentary voltage disturbances are an increasing concern for industrial plants, hospitals, data centers, and other commercial facilities because modern equipment used in those facilities tends to be more sensitive to voltage sags, swells, and momentary interruptions. The circuit monitor can detect these events by continuously monitoring current and voltage on all metered channels. Using this information, you can diagnose equipment problems resulting from voltage sags or swells and identify areas of vulnerability, enabling you to take corrective action.

The interruption of an industrial process because of an abnormal voltage condition can result in substantial costs, which manifest themselves in many ways:

- labor costs for cleanup and restart
- lost productivity
- damaged product or reduced product quality
- delivery delays and user dissatisfaction

The entire process can depend on the sensitivity of a single piece of equipment. Relays, contactors, adjustable speed drives, programmable controllers, PCs, and data communication networks are all susceptible to transient and short-duration power problems. After the electrical system is interrupted or shut down, determining the cause may be difficult.

Several types of voltage disturbances are possible, each potentially having a different origin and requiring a separate solution. A momentary interruption occurs when a protective device interrupts the circuit that feeds a facility. Swells and overvoltages can damage equipment or cause motors to overheat. Perhaps the biggest power quality problem is the momentary voltage sag caused by faults on remote circuits.

A voltage sag is a brief (1/2 cycle to 1 minute) decrease in rms voltage magnitude. A sag is typically caused by a remote fault somewhere on the power system, often initiated by a lightning strike. In Figure 13–1, the utility circuit breaker cleared the fault near plant D. The fault not only caused an interruption to plant D, but also resulted in voltage sags to plants A, B, and C.

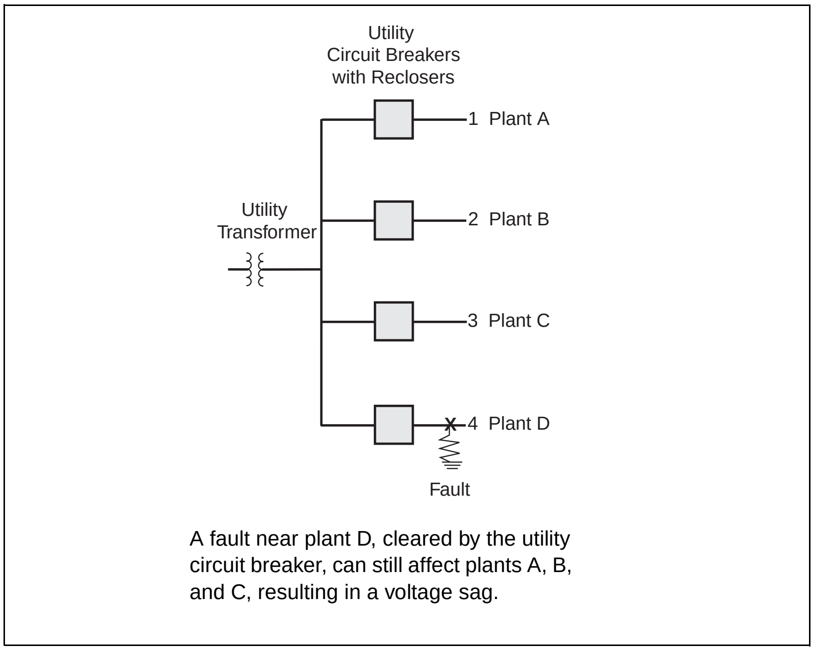


Figure 13–1 A fault can cause voltage sag on the whole system.

System voltage sags are much more numerous than interruptions, since a wider part of the distribution system is affected. And, if reclosers are operating, they may cause repeated sags. The circuit monitor can record recloser sequences, too. The waveform in Figure 13–2 shows the magnitude of a voltage sag, which persists until the remote fault is cleared.

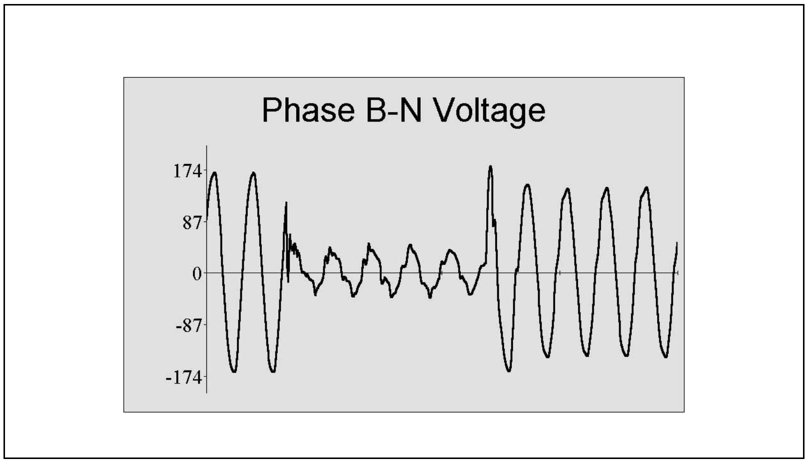


Figure 13–2 Waveform showing voltage sag, which was caused by a remote fault and lasted five cycles.

With the information obtained from the circuit monitor during a disturbance, you can solve disturbance-related problems, including the following:

- Obtain accurate measurement from your power system
  - — Identify the number of sags, swells, or interruptions for evaluation
  - — Determine the source (user or utility) of sags or swells
  - — Accurately distinguish between sags and interruptions, with accurate recording of the time and date of the occurrence
  - — Provide accurate data in equipment specification (ride-through, etc.)
- Determine equipment sensitivity
  - — Compare equipment sensitivity of different brands (contactor dropout, drive sensitivity, etc.)
  - — Diagnose mysterious events such as equipment failure, contactor dropout, computer glitches, etc.
  - — Compare actual sensitivity of equipment to published standards
  - — Use waveform to determine exact disturbance characteristics to compare with equipment sensitivity
  - — Justify purchase of power conditioning equipment
  - — Distinguish between equipment failures and power system related problems
- Develop disturbance prevention methods
  - — Develop solutions to voltage sensitivity-based problems using actual data
- Work with the utility
  - — Discuss protection practices with the serving utility and request changes to shorten the duration of potential sags (reduce interruption time delays on protective devices)
  - — Work with the utility to provide alternate “stiffer” services (alternate design practices)

CAPABILITIES OF THE CIRCUIT MONITOR DURING AN EVENT

The circuit monitor calculates rms magnitudes, based on 128 data points per cycle, every 1/2 cycle. This ensures that even sub-cycle duration rms variations are not missed. Table 13–1 shows the capability of the circuit monitor to measure electromagnetic phenomena in a power system as defined in IEEE Recommended Practice for Monitoring Electric Power Quality (IEEE Standard 1159-95).

Table 13–1: Capability of the circuit monitor to measure electromagnetic phenomena

Categories	CM-4000
Transients ①	
Impulsive	✓①
Oscillatory	✓①
Short Duration Variations	
Instantaneous	✓
Momentary	✓
Temporary	✓
Long Duration Variations	✓
Voltage Imbalance	✓
Waveform Distortion	✓
Voltage Fluctuations	✓
Power Frequency Variations	✓

① Requires the optional Current/Voltage Module with Transient Detection (CVMT).

When the circuit monitor detects a sag or swell, it can perform the following actions:

- **Perform a waveform capture** with a resolution up to 512 samples per cycle on all channels of the metered current and voltage inputs. Three types of automatic event captures are possible: disturbance, adaptive, and 100 ms. See “Types of Waveform Captures” on page 162 in **Chapter 12—Waveform and Event Capture** for more about waveform and event captures. Use SMS to setup the event capture and retrieve the waveform.
- **Record the event in the event log**. When an event occurs, the circuit monitor updates the event log with an event date and time stamp with 1 millisecond resolution for a sag or swell pickup, and an rms magnitude corresponding to the most extreme value of the sag or swell during the event pickup delay. Also, the circuit monitor can record the sag or swell dropout in the event log at the end of the disturbance. Information stored includes: a dropout time stamp with 1 millisecond resolution and a second rms magnitude corresponding to the most extreme value of the sag or swell. Use SMS to view the event log.
- **Force a data log entry** in up to 14 independent data logs. Use SMS to set up and view the data logs.
- **Operate any output relays** when the event is detected.
- **Indicate the alarm** on the display by flashing the alarm LED to show that a sag or swell event has occurred. From the circuit monitor’s display, a list of up to 10 of the previous alarms in the high priority log is available. You can also view the alarms in SMS.

USING THE CIRCUIT MONITOR WITH SMS TO PERFORM DISTURBANCE MONITORING

This section gives you an overview of the steps to set up the circuit monitor for disturbance monitoring. For detailed instructions, see the SMS online help. In SMS under Setup > Devices Routing, the Device Setup dialog box contains the tabs for setting up disturbance monitoring. After you have performed basic set up of the circuit monitor, perform three setup steps:

1. Define the storage space for the event log, waveform capture, and any forced data logs using the Onboard Files tab in SMS. This sets up the amount of circuit monitor memory that the logs and waveform capture will use.

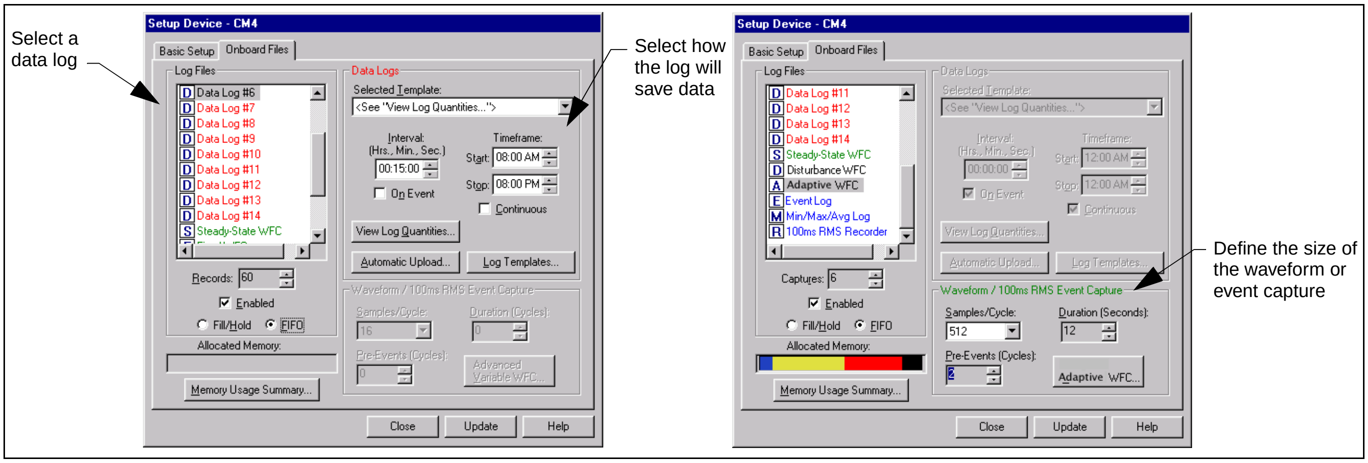


Figure 13–3 Onboard Files tab

2. Associate an alarm with data logs and waveform/event captures using the Onboard Alarms/Events tab.

   NOTE: Voltage sag and swell alarms are available, but you need to create any status transition alarms before you can associate them with logs and event captures. See **Chapter 10—Alarms** *on page 137 for instructions on setting up custom alarms.*

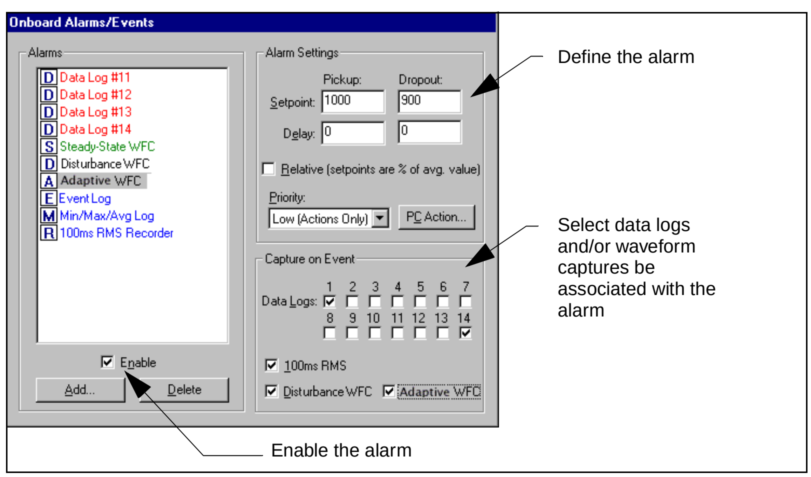


Figure 13–4 Onboard Alarms/Events tab

3. In addition, you can set up a relay to operate upon an event using the I/O tab in SMS.

   NOTE: You must define the relay from the display before SMS can recognize it. See "Setting Up I/Os" on page 85 of this bulletin for instructions.

UNDERSTANDING THE EVENT LOG

Pickups and dropouts of an event are logged into the onboard event log of the circuit monitor as separate entries. Figure 13–5 illustrates an event log entry sequence. In this example, two events are entered into the event log:

- Event Log Entry 1—The value stored in the event log at the end of the pickup delay is the furthest excursion from normal during the pickup delay period *t1*. This is calculated using 128 data point rms calculations.
- Event Log Entry 2—The value stored in the event log at the end of the dropout delay is the furthest excursion from normal during both periods *t1 and t2* from the start of the pickup delay to the end of the dropout delay.

The time stamps for the pickup and dropout reflect the actual duration of these periods.

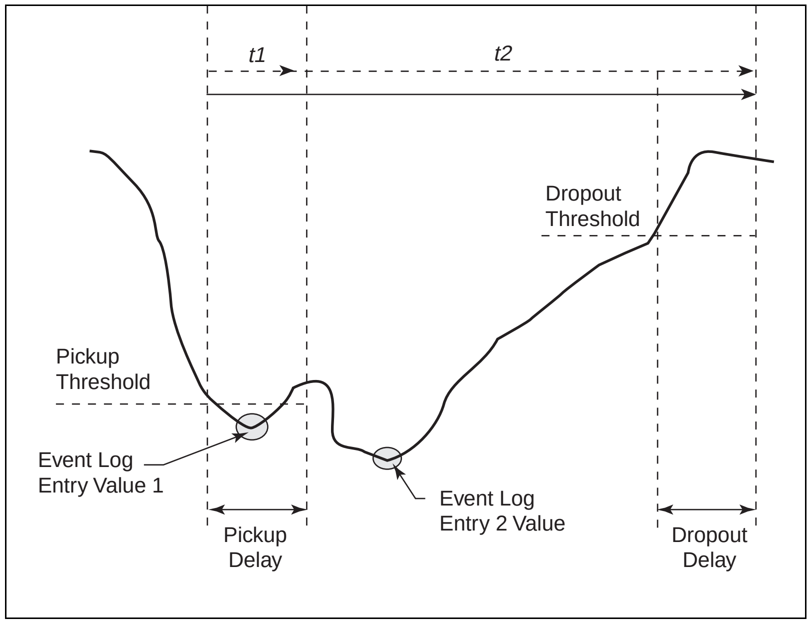
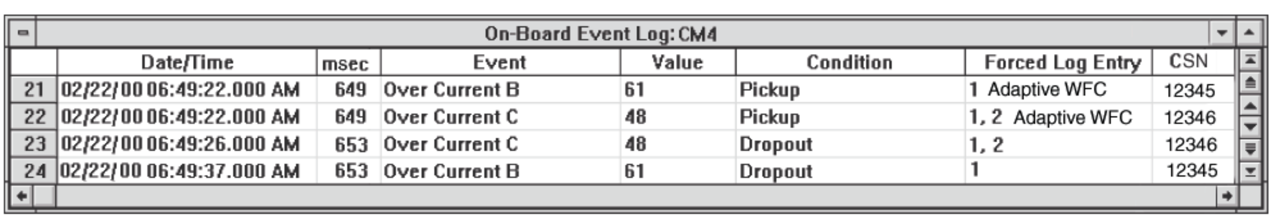


Figure 13–5 Event log entries example

Once the event has been recorded, you can view the event log in SMS. A sample event log entry is shown in Figure 13–6. See SMS online help for instructions on working with the event log.



On-Board Event Log: CM4

	Date/Time	msec	Event	Value	Condition	Forced Log Entry	CSN
21	02/22/00 06:49:22.000 AM	649	Over Current B	61	Pickup	1 Adaptive WFC	12345
22	02/22/00 06:49:22.000 AM	649	Over Current C	48	Pickup	1, 2 Adaptive WFC	12346
23	02/22/00 06:49:26.000 AM	653	Over Current C	48	Dropout	1, 2	12346
24	02/22/00 06:49:37.000 AM	653	Over Current B	61	Dropout	1	12345

Figure 13–6 Sample event log entry

CHAPTER 14—MAINTENANCE AND TROUBLESHOOTING

This chapter describes information related to maintenance of your circuit monitor.

CHAPTER CONTENTS

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, BURN, OR EXPLOSION

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.

CIRCUIT MONITOR MEMORY

The circuit monitor uses its nonvolatile memory (RAM) to retain all data and metering configuration values. Under the operating temperature range specified for the circuit monitor, this nonvolatile memory has an expected life of up to 100 years. The circuit monitor stores its data logs on a memory chip, which has a life expectancy of up to 20 years under the operating temperature range specified for the circuit monitor. The life of the circuit monitor's internal battery-backed clock is over 20 years at 25°C.

NOTE: Life expectancy is a function of operating conditions; this does not constitute any expressed or implied warranty.

Upgrading Memory in the Circuit Monitor

The circuit monitor standard memory is 8MB, but can be easily expanded to 16 MB, 32 MB, and higher without dismantling the meter. Contact your local Square D/Schneider Electric representative for availability of the memory upgrade chips. The memory chip is accessible through the access door on the side of the circuit monitor as illustrated in Figure 14–1. See the instruction bulletin provided with the memory expansion kit for instructions on removal and installation of the memory chip.

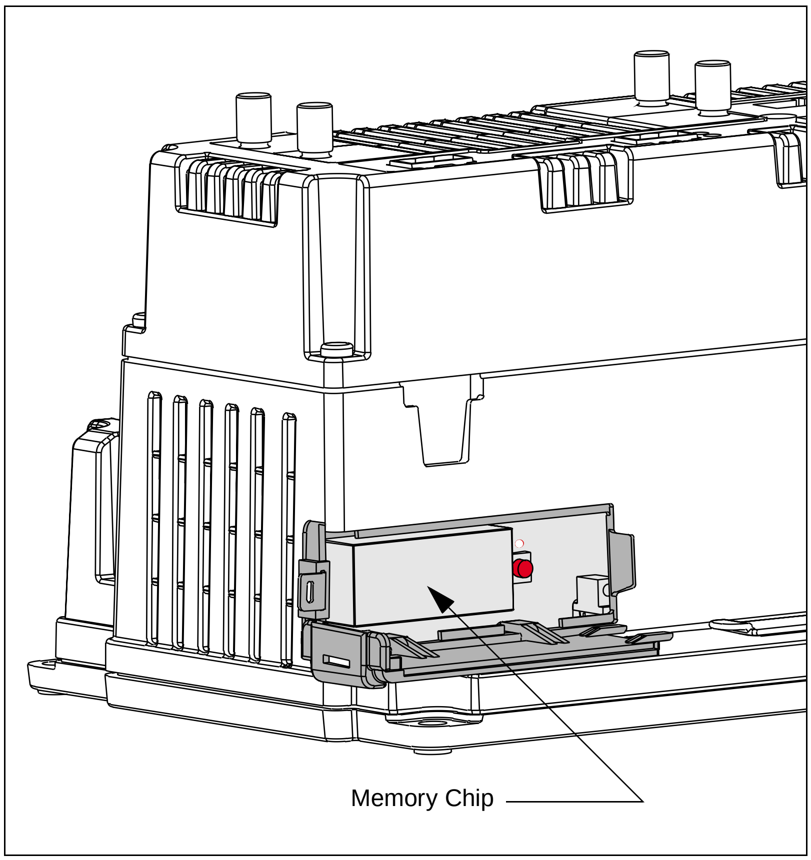


Figure 14–1 Memory chip location in the circuit monitor

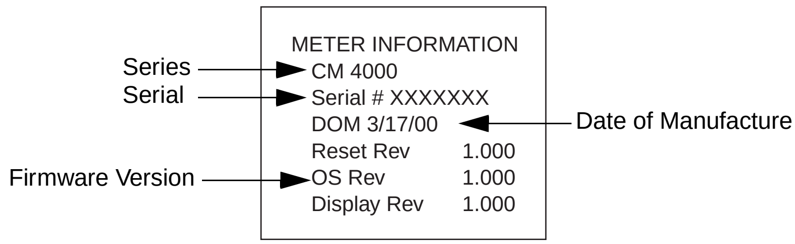
IDENTIFYING THE SERIES AND FIRMWARE VERSION

You can upgrade the circuit monitor's firmware through any of these ports:

- RS-485 port
- RS-232 port
- Infrared ports on the VFD display
- Ethernet communications card

To determine the firmware version of the circuit monitor's operating system from the remote display, do this:

From the main menu, select Diagnostics > Meter Information. The information about your meter displays on the Meter Information screen.



To determine the firmware version over the communication line, use SMS to perform a System Communications Test. The firmware version is listed in the firmware revision (F/W Revision) column.

CALIBRATION OF THE CURRENT/VOLTAGE MODULE (CVM)

Contact your local sales representative for information on calibration of the CVM module on the circuit monitor.

GETTING TECHNICAL SUPPORT

Please refer to the *Technical Support Contacts* provided in the circuit monitor shipping carton for a list of support phone numbers by country.

TROUBLESHOOTING

The information in Table 14–1 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 the your local Square D/Schneider Electric sales representative for assistance.

⚠ DANGER

HAZARD OF ELECTRIC SHOCK, BURN, OR EXPLOSION

- Beware of potential hazards, wear personal protective equipment, 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 this instruction will result in death or serious injury.

Table 14–1: 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.	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 79 for setup instructions.
	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 34 for wiring diagrams. Initiate a wiring check from the circuit monitor display.
	Incorrect voltage inputs.	Check circuit monitor voltage input terminals (9, 10, 11,12) to verify that adequate voltage is present.
	Circuit monitor is grounded incorrectly.	Verify that the circuit monitor is grounded as described in “Grounding the Circuit Monitor” on page 49**.**

Table 14–1: Troubleshooting

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 **Chapter 6—Communications Connections** 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 63 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—ABBREVIATED REGISTER LISTING

This appendix contains information about the registers of the circuit monitor.

CONTENTS

ABOUT REGISTERS

The four tables in this appendix contain an abbreviated listing of circuit monitor registers:

- Table A–1, beginning on page 183, identifies registers for these values:
  - Real-Time Metered Values including 100 ms and 1 second
  - Power Quality
  - Minimum Real-Time Meter Values
  - Maximum Real-Time Meter Values
  - Accumulated Energy Values
  - Demand Values
  - System Configuration
  - Current and Voltage Module (CVM) Configuration
  - Metering Configuration
  - Communications
- Table A–2 on page 204 lists the register numbers related to the set up of inputs and outputs.
- Table A–3 on page 210 identifies the alarm position register numbers.
- Table A–4 on page 212 lists the registers used for the individual per-phase harmonic magnitudes and angles through the 63rd harmonic for all currents and voltages.

For registers defined in bits, the rightmost bit is referred to as bit 00. Figure A–1 shows how bits are organized in a register.

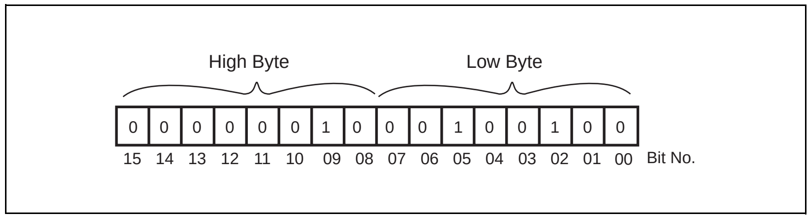


Figure A–1 Bits in a register

The circuit monitor registers can be used with MODBUS or JBUS protocols. Although the MODBUS protocol uses a one-based register addressing convention and JBUS protocol uses a zero-based register addressing convention, the circuit monitor automatically compensates for the MODBUS offset of one. Regard all registers as holding registers where a 30,000 or 40,000 offset can be used. For example, Current Phase A will reside in register 31,000 or 41,000 instead of 1000 as listed in Table A–1.

HOW POWER FACTOR IS STORED IN THE REGISTER

Each power factor value occupies one register. Power factor values are stored using signed magnitude notation (see Figure A–2 below). Bit number 15, the sign bit, indicates leading/lagging. A positive value (bit 15=0) always indicates leading. A negative value (bit 15=1) always indicates lagging. Bits 0–9 store a value in the range 0–1000 decimal. For example the circuit monitor would return a leading power factor of 0.5 as 500. Divide by 1000 to get a power factor in the range 0 to 1.000.

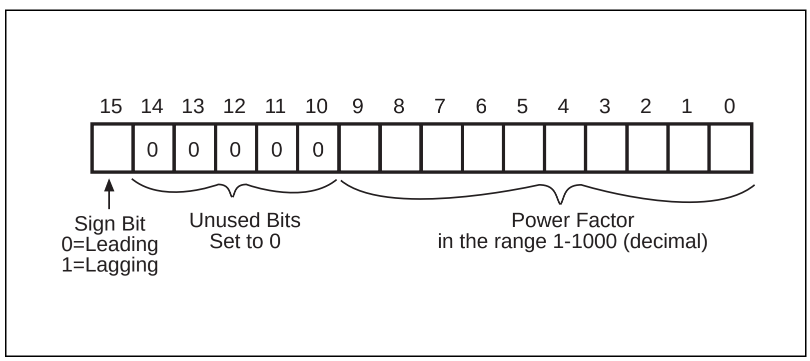


Figure A–2 Power factor register format

When the power factor is lagging, the circuit monitor returns a high negative value—for example, -31,794. This happens because bit 15=1 (for example, the binary equivalent of -31,794 is 1000001111001110). To get a value in the range 0 to 1000, you need to mask bit 15. You do this by adding 32,768 to the value. An example will help clarify.

Assume that you read a power factor value of -31,794. Convert this to a power factor in the range 0 to 1.000, as follows:

-31,794 + 32,768 = 974

974/1000 = .974 lagging power factor

REGISTER LISTING

Table A–1: Abbreviated Register List

Register Number	Description	Scale Factor	Units	Register Range
100 ms Real-Time Readings				
1000	Current, Phase A	A	Amperes	0 – 32,767
1001	Current, Phase B	A	Amperes	0 – 32,767
1002	Current, Phase C	A	Amperes	0 – 32,767
1003	Current, Neutral	B	Amperes	0 – 32,767 (if N/A, -32768)
1004	Current, Ground	C	Amperes	0 – 32,767 (if N/A, -32768)
1005	Current, 3-Phase Average	A	Amperes	0 – 32,767
1006	Current, Apparent rms	A	Amperes	0 – 32,767
1020	Voltage, Phase A to B	D	Volts	0 – 32,767
1021	Voltage, Phase B to C	D	Volts	0 – 32,767
1022	Voltage, Phase C to A	D	Volts	0 – 32,767
1023	Voltage, Line to Line Average	D	Volts	0 – 32,767
1024	Voltage, Phase A to N	D	Volts	0 – 32,767
1025	Voltage, Phase B to N	D	Volts	0 – 32,767
1026	Voltage, Phase C to N	D	Volts	0 – 32,767
1027	Voltage, Neutral to Ground	E	Volts	0 – 32,767
1028	Voltage, Line to Neutral, 3-Phase Average	D	Volts	0 – 32,767
1040	Real Power, Phase A	F	kW	-32,767 – 32,767
1041	Real Power, Phase B	F	kW	-32,767 – 32,767
1042	Real Power, Phase C	F	kW	-32,767 – 32,767
1043	Real Power, 3-Phase Total	F	kW	-32,767 – 32,767
1044	Reactive Power, Phase A	F	kW	-32,767 – 32,767
1045	Reactive Power, Phase B	F	kW	-32,767 – 32,767
1046	Reactive Power, Phase C	F	kW	-32,767 – 32,767
1047	Reactive Power, 3-Phase Total	F	kW	-32,767 – 32,767
1048	Apparent Power, Phase A	F	kW	-32,767 – 32,767
1049	Apparent Power, Phase B	F	kW	-32,767 – 32,767
1050	Apparent Power, Phase C	F	kW	-32,767 – 32,767
1051	Apparent Power, 3-Phase Total	F	kW	-32,767 – 32,767
1060	True Power Factor, Phase A (4-wire systems only)	0.001	—	-100 to 1,000 to +100 ①
1061	True Power Factor, Phase B (4-wire systems only)	0.001	—	-100 to 1,000 to +100 ①
1062	True Power Factor, Phase C (4-wire systems only)	0.001	—	-100 to 1,000 to +100 ①
1063	True Power Factor, Total	0.001	—	-100 to 1,000 to +100 ①
1064	Alternate True Power Factor, Phase A (4-wire systems only)	0.001	—	0 – 2,000 ③
1065	Alternate True Power Factor, Phase B (4-wire systems only)	0.001	—	0 – 2,000 ③
1066	Alternate True Power Factor, Phase C (4-wire systems only)	0.001	—	0 – 2,000 ③
1067	Alternate True Power Factor, Total	0.001	—	0 – 2,000 ③
1-Second Real-Time Readings				
1100	Current, Phase A	A	Amperes	0 – 32,767
1101	Current, Phase B	A	Amperes	0 – 32,767
1102	Current, Phase C	A	Amperes	0 – 32,767
1103	Current, Neutral	B	Amperes	0 – 32,767
1104	Current, Ground	C	Amperes	0 – 32,767

① See “How Power Factor is Stored in the Register” on page 182.

② May be used to meter other inputs when I2, I4, or V2–N is not required. This is possible in all supported system types except type 41.

③ The alternate storage method for power factor (PF) is useful for outputting PF on analog outputs. The PF value is stored as a positive value between 0 and 2, centered around 1 (unity). A value of 0 lagging maps to 0; -0.999 maps to 0.999;0.999 leading maps to 1.001; and 0 leading maps to 2. The alternate PF is also stored with a scale factor 0.001.

④ These configuration registers require that you enter the setup mode to change the register’s contents. Issue command 9020 to enter setup mode and 9021 to exit setup mode. See “Using the Command Interface to Change Configuration Registers” on page 241 for instructions on how to use the setup-mode commands.

Table A–1: Abbreviated Register List

Register Number	Description	Scale Factor	Units	Register Range
1105	Current, 3-Phase Average	A	Amperes	0 – 32,767
1106	Current, Apparent rms	A	Amperes	0 – 32,767
1107	Current, Unbalance, Phase A	0.10	%	-1000 to +1000
1108	Current, Unbalance, Phase B	0.10	%	-1000 to +1000
1109	Current, Unbalance, Phase C	0.10	%	-1000 to +1000
1110	Current, Unbalance, Max	0.10	%	-1000 to +1000
1111	Current, Alternate I2 ②	A	Amperes	0 – 32,767
1112	Current, Alternate I4 ②	A	Amperes	0 – 32,767
1120	Voltage, Phase A to B	D	Volts	0 – 32,767
1121	Voltage, Phase B to C	D	Volts	0 – 32,767
1122	Voltage, Phase C to A	D	Volts	0 – 32,767
1123	Voltage, Line to Line, 3-Phase Average	D	Volts	0 – 32,767
1124	Voltage, Phase A to N	D	Volts	0 – 32,767
1125	Voltage, Phase B to N	D	Volts	0 – 32,767
1126	Voltage, Phase C to N	D	Volts	0 – 32,767
1127	Voltage, Neutral to Ground	E	Volts	0 – 32,767
1128	Voltage, Line to Neutral, 3-Phase Average	D	Volts	0 – 32,767
1129	Voltage, Unbalance, Phase A to B	0.10	%	-1000 to +1000
1130	Voltage, Unbalance, Phase B to C	0.10	%	-1000 to +1000
1131	Voltage, Unbalance, Phase C to A	0.10	%	-1000 to +1000
1132	Voltage, Unbalance, Max Line to Line	0.10	%	-1000 to +1000
1133	Voltage, Unbalance, Phase A to Neutral	0.10	%	-1000 to +1000
1134	Voltage, Unbalance, Phase B to Neutral	0.10	%	-1000 to +1000
1135	Voltage, Unbalance, Phase C to Neutral	0.10	%	-1000 to +1000
1136	Voltage, Unbalance, Max Line to Neutral	0.10	%	-1000 to +1000
1137	Voltage, Alternate V2-N ②	D	Volts	-1000 to +1000
1140	Real Power, Phase A (4-wire systems only)	F	kW	-32,767 – 32,767
1141	Real Power, Phase B (4-wire systems only)	F	kW	-32,767 – 32,767
1142	Real Power, Phase C (4-wire systems only)	F	kW	-32,767 – 32,767
1143	Real Power, Total	F	kW	-32,767 – 32,767
1144	Reactive Power, Phase A (4-wire systems only)	F	kVAR	-32,767 – 32,767
1145	Reactive Power, Phase B (4-wire systems only)	F	kVAR	-32,767 – 32,767
1146	Reactive Power, Phase C (4-wire systems only)	F	kVAR	-32,767 – 32,767
1147	Reactive Power, Total	F	kVAR	-32,767 – 32,767
1148	Apparent Power, Phase A (4-wire systems only)	F	kVA	0 – 32,767
1149	Apparent Power, Phase B (4-wire systems only)	F	kVA	0 – 32,767
1150	Apparent Power, Phase C (4-wire systems only)	F	kVA	0 – 32,767
1151	Apparent Power, Total	F	kVA	0 – 32,767
1160	True Power Factor, Phase A (4-wire systems only)	0.001	—	-100 to 1,000 to +100 ①
1161	True Power Factor, Phase B (4-wire systems only)	0.001	—	-100 to 1,000 to +100 ①
1162	True Power Factor, Phase C (4-wire systems only)	0.001	—	-100 to 1,000 to +100 ①
1163	True Power Factor, Total	0.001	—	-100 to 1,000 to +100 ①
1164	Alternate True Power Factor, Phase A (4-wire systems only)	0.001	—	0 – 2,000 ③
1165	Alternate True Power Factor, Phase B (4-wire systems only)	0.001	—	0 – 2,000 ③
1166	Alternate True Power Factor, Phase C (4-wire systems only)	0.001	—	0 – 2,000 ③
1167	Alternate True Power Factor, Total	0.001	—	0 – 2,000 ③
1168	Displacement Power Factor, Phase A (4-wire systems only)	0.001	—	-100 to 1,000 to +100 ①
1169	Displacement Power Factor, Phase B (4-wire systems only)	0.001	—	-100 to 1,000 to +100 ①

① See “How Power Factor is Stored in the Register” on page 182.

② May be used to meter other inputs when I2, I4, or V2–N is not required. This is possible in all supported system types except type 41.

③ The alternate storage method for power factor (PF) is useful for outputting PF on analog outputs. The PF value is stored as a positive value between 0 and 2, centered around 1 (unity). A value of 0 lagging maps to 0; -0.999 maps to 0.999;0.999 leading maps to 1.001; and 0 leading maps to 2. The alternate PF is also stored with a scale factor 0.001.

④ These configuration registers require that you enter the setup mode to change the register’s contents. Issue command 9020 to enter setup mode and 9021 to exit setup mode. See “Using the Command Interface to Change Configuration Registers” on page 241 for instructions on how to use the setup-mode commands.

Table A–1: Abbreviated Register List

Register Number	Description	Scale Factor	Units	Register Range
1170	Displacement Power Factor, Phase C (4-wire systems only)	0.001	—	-100 to 1,000 to +100 ①
1171	Displacement Power Factor, Total	0.001	—	-100 to 1,000 to +100 ①
1172	Alternate Displacement Power Factor, Phase A (4-wire systems only)	0.001	—	0 – 2,000 ③
1173	Alternate Displacement Power Factor, Phase B (4-wire systems only)	0.001	—	0 – 2,000 ③
1174	Alternate Displacement Power Factor, Phase C (4-wire systems only)	0.001	—	0 – 2,000 ③
1175	Alternate Displacement Power Factor, Total	0.001	—	0 – 2,000 ③
1180	Frequency	.01	Hertz	(50/60) 2300 –6700 (400) 3500 – 4500
1181	Temperature	.1	C°	-1,000 to 1,000
1190	Analog Input 1 Present Value	—	Determined in analog setup	-32,767 – 32,767
1191	Analog Input 2 Present Value	—	Determined in analog setup	-32,767 – 32,767
1192	Analog Input 3 Present Value	—	Determined in analog setup	-32,767 – 32,767
1193	Analog Input 4 Present Value	—	Determined in analog setup	-32,767 – 32,767
Power Quality				
1200	THD/thd Current, Phase A	0.10	%	0 – 32,767
1201	THD/thd Current, Phase B	0.10	%	0 – 32,767
1202	THD/thd Current, Phase C	0.10	%	0 – 32,767
1203	THD/thd Current, Neutral	0.10	%	0 – 32,767
1204	THD/thd Current, Ground	0.10	%	0 – 32,767
1205	THD/thd Current, Alternate I2 ②	0.10	%	0 – 32,767
1206	THD/thd Current, Alternate I4 ②	0.10	%	0 – 32,767
1207	THD/thd Voltage, Phase A to N	0.10	%	0 – 32,767
1208	THD/thd Voltage, Phase B to N	0.10	%	0 – 32,767
1209	THD/thd Voltage, Phase C to N	0.10	%	0 – 32,767
1210	THD/thd Voltage, Phase N to G	0.10	%	0 – 32,767
1211	THD/thd Voltage, Phase A to B	0.10	%	0 – 32,767
1212	THD/thd Voltage, Phase B to C	0.10	%	0 – 32,767
1213	THD/thd Voltage, Phase C to A	0.10	%	0 – 32,767
1214	THD/thd Voltage, Alternate V2-N ②	0.10	%	0 – 32,767
1218	Current K-factor, Phase A	0.10	—	0 – 10,000
1219	Current K-factor, Phase B	0.10	—	0 – 10,000
1220	Current K-factor, Phase C	0.10	—	0 – 10,000
1221	Crest Factor, Phase A	0.01	—	0 – 10,000
1222	Crest Factor, Phase B	0.01	—	0 – 10,000
1223	Crest Factor, Phase C	0.01	—	0 – 10,000
1224	Crest Factor, Neutral	0.01	—	0 – 10,000
1225	Crest Factor, Ground	0.01	—	0 – 10,000
1226	Crest Factor, Alternate I2 ②	0.01	—	0 – 10,000
1227	Crest Factor, Alternate I4 ②	0.01	—	0 – 10,000
1230	Current Fundamental rms Magnitude, Phase A	A	Amperes	0 – 32,767
1231	Current Fundamental Coincident Angle, Phase A	0.1	Degrees (°)	0 – 3,599
1232	Current Fundamental rms Magnitude, Phase B	A	Amperes	0 – 32,767
1233	Current Fundamental Coincident Angle, Phase B	0.1	Degrees (°)	0 – 3,599
1234	Current Fundamental rms Magnitude, Phase C	A	Amperes	0 – 32,767
1235	Current Fundamental Coincident Angle, Phase C	0.1	Degrees (°)	0 – 3,599

① See “How Power Factor is Stored in the Register” on page 182.

② May be used to meter other inputs when I2, I4, or V2–N is not required. This is possible in all supported system types except type 41.

③ The alternate storage method for power factor (PF) is useful for outputting PF on analog outputs. The PF value is stored as a positive value between 0 and 2, centered around 1 (unity). A value of 0 lagging maps to 0; -0.999 maps to 0.999;0.999 leading maps to 1.001; and 0 leading maps to 2. The alternate PF is also stored with a scale factor 0.001.

④ These configuration registers require that you enter the setup mode to change the register’s contents. Issue command 9020 to enter setup mode and 9021 to exit setup mode. See “Using the Command Interface to Change Configuration Registers” on page 241 for instructions on how to use the setup-mode commands.

Table A–1: Abbreviated Register List

Register Number	Description	Scale Factor	Units	Register Range
1236	Current Fundamental rms Magnitude, Neutral	B	Amperes	0 – 32,767
1237	Current Fundamental Coincident Angle, Neutral	0.1	Degrees (°)	0 – 3,599
1238	Current Fundamental rms Magnitude, Ground	C	Amperes	0 – 32,767
1239	Current Fundamental Coincident Angle, Ground	0.1	Degrees (°)	0 – 3,599
1240	Current Fundamental rms Magnitude, Alternate I2 ②	B	Amperes	0 – 32,767
1241	Current Fundamental Coincident Angle, Alternate I2 ②	0.1	Degrees (°)	0 – 3,599
1242	Current Fundamental rms Magnitude, Alternate I4 ②	B	Amperes	0 – 32,767
1243	Current Fundamental Coincident Angle, Alternate I4 ②	0.1	Degrees (°)	0 – 3,599
1244	Voltage Fundamental rms Magnitude, Phase A to N / A to B	D	Volts	0 – 32,767
1245	Voltage Fund. Coincident Angle, Phase A to N / A to B	0.1	Degrees (°)	0 – 3,599
1246	Voltage Fundamental rms Magnitude, Phase B to N / B to C	D	Volts	0 – 32,767
1247	Voltage Fund. Coincident Angle, Phase B to N / B to C	0.1	Degrees (°)	0 – 3,599
1248	Voltage Fundamental rms Magnitude, Phase C to N / C to A	D	Volts	0 – 32,767
1249	Voltage Fund. Coincident Angle, Phase C to N / C to A	0.1	Degrees (°)	0 – 3,599
1250	Voltage Fundamental rms Magnitude, Neutral to Ground	E	Volts	0 – 32,767
1251	Voltage Fund. Coincident Angle, Neutral to Ground	0.1	Degrees (°)	0 – 3,599
1252	Voltage Fundamental RMS Magnitude, Alternate V2 ②	E	Volts	0 – 32,767
1253	Voltage Fund. Coincident Angle, Alternate V2 ②	0.1	Degrees (°)	0 – 3,599
1255	Fundamental Real Power, Phase A (4-wire systems only)	F	kW	-32,767 – 32,767
1256	Fundamental Real Power, Phase B (4-wire systems only)	F	kW	-32,767 – 32,767
1257	Fundamental Real Power, Phase C (4-wire systems only)	F	kW	-32,767 – 32,767
1258	Fundamental Real Power, Total	F	kW	-32,767 – 32,767
1259	Fundamental Reactive Power, Phase A (4-wire systems only)	F	kVAR	-32,767 – 32,767
1260	Fundamental Reactive Power, Phase B (4-wire systems only)	F	kVAR	-32,767 – 32,767
1261	Fundamental Reactive Power, Phase C (4-wire systems only)	F	kVAR	-32,767 – 32,767
1262	Fundamental Reactive Power, Total	F	kVAR	-32,767 – 32,767
1264	Distortion Power, Phase A (4-wire systems only)	F	kW	-32,767 – 32,767
1265	Distortion Power, Phase B (4-wire systems only)	F	kW	-32,767 – 32,767
1266	Distortion Power, Phase C (4-wire systems only)	F	kW	-32,767 – 32,767
1267	Distortion Power, Total	F	kW	-32,767 – 32,767
1268	Distortion Factor, Phase A (4-wire systems only)	0.10	—	0 – 1,000
1269	Distortion Factor, Phase B (4-wire systems only)	0.10	—	0 – 1,000
1270	Distortion Factor, Phase C (4-wire systems only)	0.10	—	0 – 1,000
1271	Distortion Factor, Total	0.10	—	0 – 1,000
1274	Harmonic Current, Phase A	A	Amperes	0 – 32,767
1275	Harmonic Current, Phase B	A	Amperes	0 – 32,767
1276	Harmonic Current, Phase C	A	Amperes	0 – 32,767
1277	Harmonic Current, Neutral	B	Amperes	0 – 32,767
1278	Harmonic Voltage, Phase A to N	D	Volts	0 – 32,767
1279	Harmonic Voltage, Phase B to N	D	Volts	0 – 32,767
1280	Harmonic Voltage, Phase C to N	D	Volts	0 – 32,767
1281	Total Demand Distortion	0.01	—	0 – 10,000
1284	Current, Positive Sequence, Magnitude	A	Amperes	0 – 32,767

① See “How Power Factor is Stored in the Register” on page 182.

② May be used to meter other inputs when I2, I4, or V2–N is not required. This is possible in all supported system types except type 41.

③ The alternate storage method for power factor (PF) is useful for outputting PF on analog outputs. The PF value is stored as a positive value between 0 and 2, centered around 1 (unity). A value of 0 lagging maps to 0; -0.999 maps to 0.999;0.999 leading maps to 1.001; and 0 leading maps to 2. The alternate PF is also stored with a scale factor 0.001.

④ These configuration registers require that you enter the setup mode to change the register’s contents. Issue command 9020 to enter setup mode and 9021 to exit setup mode. See “Using the Command Interface to Change Configuration Registers” on page 241 for instructions on how to use the setup-mode commands.

Table A–1: Abbreviated Register List

Register Number	Description	Scale Factor	Units	Register Range
1285	Current, Positive Sequence, Angle	0.1	Degrees (°)	0 – 3,599
1286	Current, Negative Sequence, Magnitude	A	Amperes	0 – 32,767
1287	Current, Negative Sequence, Angle	0.1	Degrees (°)	0 – 3,599
1288	Current, Zero Sequence, Magnitude	A	Amperes	0 – 32,767
1289	Current, Zero Sequence, Angle	0.1	Degrees (°)	0 – 3,599
1290	Voltage, Positive Sequence, Magnitude	D	Volts	0 – 32,767
1291	Voltage, Positive Sequence, Angle	0.1	Degrees (°)	0 – 3,599
1292	Voltage, Negative Sequence, Magnitude	D	Volts	0 – 32,767
1293	Voltage, Negative Sequence, Angle	0.1	Degrees (°)	0 – 3,599
1294	Voltage, Zero Sequence, Magnitude	D	Volts	0 – 32,767
1295	Voltage, Zero Sequence, Angle	0.1	Degrees (°)	0 – 3,599
1296	Current, Sequence, Unbalance	0.10	%	0 – 32,767
1297	Voltage, Sequence, Unbalance	0.10	%	0 – 32,767
Real-Time Minimum Metered Values				
1300	Minimum Current, Phase A	A	Amperes	0 – 32,767
1301	Minimum Current, Phase B	A	Amperes	0 – 32,767
1302	Minimum Current, Phase C	A	Amperes	0 – 32,767
1303	Minimum Current, Neutral	B	Amperes	0 – 32,767
1304	Minimum Current, Ground	C	Amperes	0 – 32,767
1305	Minimum Current, 3-Phase Average	A	Amperes	0 – 32,767
1306	Minimum Current, Apparent rms	A	Amperes	0 – 32,767
1307	Minimum Current Unbalance, Phase A	0.10	%	-1000 to 1000
1308	Minimum Current Unbalance, Phase B	0.10	%	-1000 to 1000
1309	Minimum Current Unbalance, Phase C	0.10	%	-1000 to 1000
1310	Minimum Current Unbalance, Max	0.10	%	-1000 to 1000
1311	Minimum Current, Alternate I2 ②	A	Amperes	0 – 32,767
1312	Minimum Current, Alternate I4 ②	A	Amperes	0 – 32,767
1320	Minimum Voltage, Phase A to B	D	Volts	0 – 32767
1321	Minimum Voltage, Phase B to C	D	Volts	0 – 32767
1322	Minimum Voltage, Phase C to A	D	Volts	0 – 32767
1323	Minimum Voltage, Line to Line Average	D	Volts	0 – 32767
1324	Minimum Voltage, Phase A to N (4-wire systems only)	D	Volts	0 – 32767
1325	Minimum Voltage, Phase B to N (4-wire systems only)	D	Volts	0 – 32767
1326	Minimum Voltage, Phase C to N (4-wire systems only)	D	Volts	0 – 32767
1327	Minimum Voltage, Phase Neutral to Ground (4-wire systems only)	E	Volts	0 – 32767
1328	Minimum Voltage, Line to Neutral Average (4-wire systems only)	D	Volts	0 – 32767
1329	Minimum Voltage Unbalance, Phase A to B	0.10	%	-1000 to 1000
1330	Minimum Voltage Unbalance, Phase B to C	0.10	%	-1000 to 1000
1331	Minimum Voltage Unbalance, Phase C to A	0.10	%	-1000 to 1000
1332	Minimum Voltage Unbalance, Max Line to Line	0.10	%	-1000 to 1000
1333	Minimum Voltage Unbalance, Phase A to N (4-wire systems only)	0.10	%	-1000 to 1000
1334	Minimum Voltage Unbalance, Phase B to N (4-wire systems only)	0.10	%	-1000 to 1000
1335	Minimum Voltage Unbalance, Phase C to N (4-wire systems only)	0.10	%	-1000 to 1000
1336	Minimum Voltage Unbalance, Max Line to Neutral (4-wire systems only)	0.10	%	-1000 to 1000
1337	Minimum Voltage, Alternate V2-N ② (4-wire systems only)	D	Volts	0 – 32767
1340	Minimum Real Power, Phase A	F	kW	-32,767 – 32,767
1341	Minimum Real Power, Phase B	F	kW	-32,767 – 32,767

① See “How Power Factor is Stored in the Register” on page 182.

② May be used to meter other inputs when I2, I4, or V2–N is not required. This is possible in all supported system types except type 41.

③ The alternate storage method for power factor (PF) is useful for outputting PF on analog outputs. The PF value is stored as a positive value between 0 and 2, centered around 1 (unity). A value of 0 lagging maps to 0; -0.999 maps to 0.999;0.999 leading maps to 1.001; and 0 leading maps to 2. The alternate PF is also stored with a scale factor 0.001.

④ These configuration registers require that you enter the setup mode to change the register’s contents. Issue command 9020 to enter setup mode and 9021 to exit setup mode. See “Using the Command Interface to Change Configuration Registers” on page 241 for instructions on how to use the setup-mode commands.

Table A–1: Abbreviated Register List

Register Number	Description	Scale Factor	Units	Register Range
1342	Minimum Real Power, Phase C	F	kW	-32,767 – 32,767
1343	Minimum Real Power, Total	F	kW	-32,767 – 32,767
1344	Minimum Reactive Power, Phase A (4-wire systems only)	F	kVAR	-32,767 – 32,767
1345	Minimum Reactive Power, Phase B (4-wire systems only)	F	kVAR	-32,767 – 32,767
1346	Minimum Reactive Power, Phase C (4-wire systems only)	F	kVAR	-32,767 – 32,767
1347	Minimum Reactive Power, Total	F	kVAR	-32,767 – 32,767
1348	Minimum Apparent Power, Phase A (4-wire systems only)	F	kVA	-32,767 – 32,767
1349	Minimum Apparent Power, Phase B (4-wire systems only)	F	kVA	-32,767 – 32,767
1350	Minimum Apparent Power, Phase C (4-wire systems only)	F	kVA	-32,767 – 32,767
1351	Minimum Apparent Power, Total	F	kVA	-32,767 – 32,767
1360	Minimum True Power Factor, Phase A (4-wire systems only)	0.001	—	1000 -100 to 100 ①
1361	Minimum True Power Factor, Phase B (4-wire systems only)	0.001	—	1000 -100 to 100 ①
1362	Minimum True Power Factor, Phase C (4-wire systems only)	0.001	—	1000 -100 to 100 ①
1363	Minimum True Power Factor, Total	0.001	—	1000 -100 to 100 ①
1364	Min. Alternate True Power Factor, Phase A (4-wire systems only) ③	0.001	—	0 – 2,000
1365	Min. Alternate True Power Factor, Phase B (4-wire systems only) ③	0.001	—	0 – 2,000
1366	Min. Alternate True Power Factor, Phase C (4-wire systems only) ③	0.001	—	0 – 2,000
1367	Minimum Alternate True Power Factor, Total ③	0.001		0 – 2,000
1368	Minimum Displacement Power Factor, Phase A (4-wire systems only)	0.001	—	-100 to 1000 to +100 ①
1369	Minimum Displacement Power Factor, Phase B (4-wire systems only)	0.001	—	-100 to 1000 to +100 ①
1370	Minimum Displacement Power Factor, Phase C (4-wire systems only)	0.001	—	-100 to 1000 to +100 ①
1371	Minimum Displacement Power Factor, Total	0.001	—	-100 to 1000 to +100 ①
1372	Minimum Alternate Displacement Power Factor, Phase A (4-wire systems only)	0.001	—	0 – 2,000 ①
1373	Minimum Alternate Displacement Power Factor, Phase B (4-wire systems only)	0.001	—	0 – 2,000 ①
1374	Minimum Alternate Displacement Power Factor, Phase C (4-wire systems only)	0.001	—	0 – 2,000 ①
1375	Minimum Alternate Displacement Power Factor, Total	0.001	—	0 – 2,000 ①
1380	Minimum Frequency	0.01	Hertz	(50/60) 2300 – 6700 (400) 3500 – 4500
1381	Minimum Temperature	.1	C°	-1,000 to 1,000
1390	Minimum Analog Input 1 Value	—	Determined in analog setup	-32,767 – 32,767
1391	Minimum Analog Input 2 Value	—	Determined in analog setup	-32,767 – 32,767
1392	Minimum Analog Input 3 Value	—	Determined in analog setup	-32,767 – 32,767
1393	Minimum Analog Input 4 Value	—	Determined in analog setup	-32,767 – 32,767
1400	Minimum THD/thd Current, Phase A	0.10	%	0 – 32,767
1401	Minimum THD/thd Current, Phase B	0.10	%	0 – 32,767
1402	Minimum THD/thd Current, Phase C	0.10	%	0 – 32,767
1403	Minimum THD/thd Current, Phase N (4-wire systems only)	0.10	%	0 – 32,767
1404	Minimum THD/thd Current, Phase G	0.10	%	0 – 32,767
1405	Minimum THD/thd Current, Alternate I2	0.10	%	0 – 32,767
1406	Minimum THD/thd Current, Alternate I4	0.10	%	0 – 32,767
1407	Minimum THD/thd Voltage, Phase A-N (4-wire systems only)	0.10	%	0 – 32,767
1408	Minimum THD/thd Voltage, Phase B-N (4-wire systems only)	0.10	%	0 – 32,767
1409	Minimum THD/thd Voltage, Phase C-N (4-wire systems only)	0.10	%	0 – 32,767

① See “How Power Factor is Stored in the Register” on page 182.

② May be used to meter other inputs when I2, I4, or V2–N is not required. This is possible in all supported system types except type 41.

③ The alternate storage method for power factor (PF) is useful for outputting PF on analog outputs. The PF value is stored as a positive value between 0 and 2, centered around 1 (unity). A value of 0 lagging maps to 0; -0.999 maps to 0.999;0.999 leading maps to 1.001; and 0 leading maps to 2. The alternate PF is also stored with a scale factor 0.001.

④ These configuration registers require that you enter the setup mode to change the register’s contents. Issue command 9020 to enter setup mode and 9021 to exit setup mode. See “Using the Command Interface to Change Configuration Registers” on page 241 for instructions on how to use the setup-mode commands.

Table A–1: Abbreviated Register List

Register Number	Description	Scale Factor	Units	Register Range
1410	Minimum THD/thd Voltage, Phase N-G (4-wire systems only)	0.10	%	0 – 32,767
1411	Minimum THD/thd Voltage, Phase A-B	0.10	%	0 – 32,767
1412	Minimum THD/thd Voltage, Phase B-C	0.10	%	0 – 32,767
1413	Minimum THD/thd Voltage, Phase C-A	0.10	%	0 – 32,767
1414	Minimum THD/thd Voltage, Alternate V2-N	0.10	%	0 – 32,767
1418	Minimum Current K-factor, Phase A	—	0.10	0 – 10,000
1419	Minimum Current K-factor, Phase B	—	0.10	0 – 10,000
1420	Minimum Current K-factor, Phase C	—	0.10	0 – 10,000
1421	Minimum Crest Factor, Phase A	—	0.01	0 – 10,000
1422	Minimum Crest Factor, Phase B	—	0.01	0 – 10,000
1423	Minimum Crest Factor, Phase C	—	0.01	0 – 10,000
1424	Minimum Crest Factor, Phase N	—	0.01	0 – 10,000
1425	Minimum Crest Factor, Ground	—	0.01	0 – 10,000
1426	Minimum Crest Factor, Alternate I2	—	0.01	0 – 10,000
1427	Minimum Crest Factor, Alternate I4	—	0.01	0 – 10,000
1430	Minimum Current Fundamental rms Magnitude, Phase A	A	Amperes	0 – 32,767
1431	Minimum Current Fundamental Coincident Angle, Phase A	0.1	Degrees (°)	0 – 3,599
1432	Minimum Current Fundamental rms Magnitude, Phase B	A	Amperes	0 – 32,767
1433	Minimum Current Fundamental Coincident Angle, Phase B	0.1	Degrees (°)	0 – 3,599
1434	Minimum Current Fundamental rms Magnitude, Phase C	A	Amperes	0 – 32,767
1435	Minimum Current Fundamental Coincident Angle, Phase C	0.1	Degrees (°)	0 – 3,599
1436	Minimum Current Fundamental rms Magnitude, Neutral	B	Amperes	0 – 32,767
1437	Minimum Current Fundamental Coincident Angle, Neutral	0.1	Degrees (°)	0 – 3,599
1438	Minimum Current Fundamental RMS Magnitude, Ground	B	Amperes	0 – 32,767
1439	Minimum Current Fundamental Coincident Angle, Ground	0.1	Degrees (°)	0 – 3,599
1440	Minimum Current Fundamental RMS Magnitude, Alternate I2	B	Amperes	0 – 32,767
1441	Minimum Current Fundamental Coincident Angle, Alternate I2	0.1	Degrees (°)	0 – 3,599
1442	Minimum Current Fundamental RMS Magnitude, Alternate I4	B	Amperes	0 – 32,767
1443	Minimum Current Fundamental Coincident Angle, Alternate I4	0.1	Degrees (°)	0 – 3,599
1444	Minimum Voltage Fundamental rms Magnitude, A-N/A-B	D	Volts	0 – 32,767
1445	Minimum Voltage Fundamental Coincident Angle, A-N/A-B	0.1	Degrees (°)	0 – 3,599
1446	Minimum Voltage Fundamental rms Magnitude, B-N/B-C	D	Volts	0 – 32,767
1447	Minimum Voltage Fundamental Coincident Angle, B-N/B-C	0.1	Degrees (°)	0 – 3,599
1448	Minimum Voltage Fundamental rms Magnitude, C-N/C-A	D	Volts	0 – 32,767
1449	Minimum Voltage Fundamental Coincident Angle, C-N/C-A	0.1	Degrees (°)	0 – 3,599
1450	Minimum Voltage Fundamental rms Magnitude, N-G	E	Volts	0 – 32,767
1451	Minimum Voltage Fund. Coincident Angle, N-G	0.1	Degrees (°)	0 – 3,599
1452	Minimum Voltage Fundamental RMS Magnitude, Alternate V2	E	Volts	0 – 32,767
1453	Minimum Voltage Fund. Coincident Angle, Alternate V2	0.1	Degrees (°)	0 – 3,599
1455	Minimum Fundamental Real Power, Phase A (4-wire systems only)	F	kW	-32,767 – 32,767
1456	Minimum Fundamental Real Power, Phase B (4-wire systems only)	F	kW	-32,767 – 32,767
1457	Minimum Fundamental Real Power, Phase C (4-wire systems only)	F	kW	-32,767 – 32,767
1458	Minimum Fundamental Real Power, Total	F	kW	-32,767 – 32,767
1459	Minimum Fundamental Reactive Power, Phase A (4-wire systems only)	F	kVAR	-32,767 – 32,767
1460	Minimum Fundamental Reactive Power, Phase B (4-wire systems only)	F	kVAR	-32,767 – 32,767
14561	Minimum Fundamental Reactive Power, Phase C (4-wire systems only)	F	kVAR	-32,767 – 32,767
1462	Minimum Fundamental Reactive Power, Total	F	kVAR	-32,767 – 32,767
1464	Minimum Distortion Power, Phase A (4-wire systems only)	F	kW	-32,767 – 32,767

① See “How Power Factor is Stored in the Register” on page 182.

② May be used to meter other inputs when I2, I4, or V2–N is not required. This is possible in all supported system types except type 41.

③ The alternate storage method for power factor (PF) is useful for outputting PF on analog outputs. The PF value is stored as a positive value between 0 and 2, centered around 1 (unity). A value of 0 lagging maps to 0; -0.999 maps to 0.999;0.999 leading maps to 1.001; and 0 leading maps to 2. The alternate PF is also stored with a scale factor 0.001.

④ These configuration registers require that you enter the setup mode to change the register’s contents. Issue command 9020 to enter setup mode and 9021 to exit setup mode. See “Using the Command Interface to Change Configuration Registers” on page 241 for instructions on how to use the setup-mode commands.

Table A–1: Abbreviated Register List

Register Number	Description	Scale Factor	Units	Register Range
1465	Minimum Distortion Power, Phase B (4-wire systems only)	F	kW	-32,767 – 32,767
1466	Minimum Distortion Power, Phase C (4-wire systems only)	F	kW	-32,767 – 32,767
1467	Minimum Distortion Power, Total	F	kW	-32,767 – 32,767
1468	Minimum Distortion Factor, Phase A	—	0.10	0 – 1,000
1469	Minimum Distortion Factor, Phase B	—	0.10	0 – 1,000
1470	Minimum Distortion Factor, Phase C	—	0.10	0 – 1,000
1471	Minimum Distortion Factor, Total	—	0.10	0 – 1,000
1474	Minimum Harmonic Current, Phase A	A	Amperes	0 – 32,767
1475	Minimum Harmonic Current, Phase B	A	Amperes	0 – 32,767
1476	Minimum Harmonic Current, Phase C	A	Amperes	0 – 32,767
1477	Minimum Harmonic Current, Neutral	B	Amperes	0 – 32,767
1478	Minimum Harmonic Voltage, A-N	D	Volts	0 – 32,767
1479	Minimum Harmonic Voltage, B-N	D	Volts	0 – 32,767
1480	Minimum Harmonic Voltage, C-N	D	Volts	0 – 32,767
1481	Minimum Total Demand Distortion	—	0.01	0 – 10,000
1484	Minimum Current, Positive Sequence, Magnitude	A	Amperes	0 – 32,767
1485	Minimum Current, Positive Sequence, Angle	0.1	Degrees (°)	0 – 3,599
1486	Minimum Current, Negative Sequence, Magnitude	A	Amperes	0 – 32,767
1487	Minimum Current, Negative Sequence, Angle	0.1	Degrees (°)	0 – 3,599
1488	Minimum Current, Zero Sequence, Magnitude	A	Amperes	0 – 32,767
1489	Minimum Current, Zero Sequence, Angle	0.1	Degrees (°)	0 – 3,599
1490	Minimum Voltage, Positive Sequence, Magnitude	D	Volts	0 – 32,767
1491	Minimum Voltage, Positive Sequence, Angle	0.1	Degrees (°)	0 – 3,599
1492	Minimum Voltage, Negative Sequence, Magnitude	D	Volts	0 – 32,767
1493	Minimum Voltage, Negative Sequence, Angle	0.1	Degrees (°)	0 – 3,599
1494	Minimum Voltage, Zero Sequence, Magnitude	D	Volts	0 – 32,767
1495	Minimum Voltage, Zero Sequence, Angle	0.1	Degrees (°)	0 – 3,599
1496	Minimum Current, Sequence, Unbalance	0.10	%	0 – 1,000
1497	Minimum Voltage, Sequence, Unbalance	0.10	%	0 – 1,000
Real-Time Metered Values Maximum				
1500	Maximum Current, Phase A	A	Amperes	0 – 32,767
1501	Maximum Current, Phase B	A	Amperes	0 – 32,767
1502	Maximum Current, Phase C	A	Amperes	0 – 32,767
1503	Maximum Current, Neutral	B	Amperes	0 – 32,767
1504	Maximum Current, Ground	C	Amperes	0 – 32,767
1505	Maximum Current, 3-Phase Average	A	Amperes	0 – 32,767
1506	Maximum Current, Apparent rms	A	Amperes	0 – 32,767
1507	Maximum Current Unbalance, Phase A	0.10	%	-1000 to 1000
1508	Maximum Current Unbalance, Phase B	0.10	%	-1000 to 1000
1509	Maximum Current Unbalance, Phase C	0.10	%	-1000 to 1000
1510	Maximum Current Unbalance, Max	0.10	%	-1000 to 1000
1511	Maximum Current, Alternate I2 ②	A	Amperes	0 – 32,767
1512	Maximum Current, Alternate I4 ②	A	Amperes	0 – 32,767
1520	Maximum Voltage, Phase A to B	D	Volts	0 – 32767
1521	Maximum Voltage, Phase B to C	D	Volts	0 – 32767
1522	Maximum Voltage, Phase C to A	D	Volts	0 – 32767
1523	Maximum Voltage, Line to Line Average	D	Volts	0 – 32767
1524	Maximum Voltage, Phase A to N (4-wire systems only)	D	Volts	0 – 32767

① See “How Power Factor is Stored in the Register” on page 182.

② May be used to meter other inputs when I2, I4, or V2–N is not required. This is possible in all supported system types except type 41.

③ The alternate storage method for power factor (PF) is useful for outputting PF on analog outputs. The PF value is stored as a positive value between 0 and 2, centered around 1 (unity). A value of 0 lagging maps to 0; -0.999 maps to 0.999;0.999 leading maps to 1.001; and 0 leading maps to 2. The alternate PF is also stored with a scale factor 0.001.

④ These configuration registers require that you enter the setup mode to change the register’s contents. Issue command 9020 to enter setup mode and 9021 to exit setup mode. See “Using the Command Interface to Change Configuration Registers” on page 241 for instructions on how to use the setup-mode commands.

Table A–1: Abbreviated Register List

Register Number	Description	Scale Factor	Units	Register Range
1525	Maximum Voltage, Phase B to N (4-wire systems only)	D	Volts	0 – 32767
1526	Maximum Voltage, Phase C to N (4-wire systems only)	D	Volts	0 – 32767
1527	Maximum Voltage, Phase Neutral to Ground (4-wire systems only)	E	Volts	0 – 32767
1528	Maximum Voltage, Line to Neutral Average (4-wire systems only)	D	Volts	0 – 32767
1529	Maximum Voltage Unbalance, Phase A to B	0.10	%	-1000 to 1000
1530	Maximum Voltage Unbalance, Phase B to C	0.10	%	-1000 to 1000
1531	Maximum Voltage Unbalance, Phase C to A	0.10	%	-1000 to 1000
1532	Maximum Voltage Unbalance, Max Line to Line	0.10	%	-1000 to 1000
1533	Maximum Voltage Unbalance, Phase A to Neutral	0.10	%	-1000 to 1000
1534	Maximum Voltage Unbalance, Phase B to Neutral	0.10	%	-1000 to 1000
1535	Maximum Voltage Unbalance, C-N	0.10	%	-1000 to 1000
1536	Maximum Voltage Unbalance, Max L-N	0.10	%	-1000 to 1000
1537	Maximum Voltage, Alternate V2-N	D	Volts	0 – 32767
1540	Maximum Real Power, Phase A (4-wire systems only)	F	kW	-32,767 – 32,767
1541	Maximum Real Power, Phase B (4-wire systems only)	F	kW	-32,767 – 32,767
1542	Maximum Real Power, Phase C (4-wire systems only)	F	kW	-32,767 – 32,767
1543	Maximum Real Power, Total	F	kW	-32,767 – 32,767
1544	Maximum Reactive Power, Phase A (4-wire systems only)	F	kVAR	-32,767 – 32,767
1545	Maximum Reactive Power, Phase B (4-wire systems only)	F	kVAR	-32,767 – 32,767
1546	Maximum Reactive Power, Phase C (4-wire systems only)	F	kVAR	-32,767 – 32,767
1547	Maximum Reactive Power, Total	F	kVAR	-32,767 – 32,767
1548	Maximum Apparent Power, Phase A (4-wire systems only)	F	kVA	0 – 32,767
1549	Maximum Apparent Power, Phase B (4-wire systems only)	F	kVA	0 – 32,767
1550	Maximum Apparent Power, Phase C (4-wire systems only)	F	kVA	0 – 32,767
1551	Maximum Apparent Power, Total	F	kVA	0 – 32,767
1560	Maximum True Power Factor, Phase A (4-wire systems only)	0.001	—	-100 to 1000 to +100 ①
1561	Maximum True Power Factor, Phase B (4-wire systems only)	0.001	—	-100 to 1000 to +100 ①
1562	Maximum True Power Factor, Phase C (4-wire systems only)	0.001	—	-100 to 1000 to +100 ①
1563	Maximum True Power Factor, Total	0.001	—	-100 to 1000 to +100 ①
1564	Max. Alternate True Power Factor, Phase A (4-wire systems only) ③	0.001	—	0 – 2,000
1565	Max. Alternate True Power Factor, Phase B (4-wire systems only) ③	0.001	—	0 – 2,000
1566	Max. Alternate True Power Factor, Phase C (4-wire systems only) ③	0.001	—	0 – 2,000
1567	Maximum Alternate True Power Factor, Total ③	0.001	—	0 – 2,000
1568	Maximum Displacement Power Factor, Phase A (4-wire systems only)	0.001	—	1000 -100 to 100 ①
1569	Maximum Displacement Power Factor, Phase B (4-wire systems only)	0.001	—	1000 -100 to 100 ①
1570	Maximum Displacement Power Factor, Phase C (4-wire systems only)	0.001	—	1000 -100 to 100 ①
1571	Maximum Displacement Power Factor, Total	0.001	—	1000 -100 to 100 ①
1572	Maximum Alternate Displacement Power Factor, Phase A (4-wire systems only) ③	0.001	—	0 – 2,000
1573	Maximum Alternate Displacement Power Factor, Phase B (4-wire systems only) ③	0.001	—	0 – 2,000
1574	Maximum Alternate Displacement Power Factor, Phase C (4-wire systems only) ③	0.001	—	0 – 2,000
1575	Maximum Alternate Displacement Power Factor, Total ③	0.001	—	0 – 2,000
1580	Maximum Frequency	0.01	Hertz	(50/60) 2300 – 6700 (400) 3500 – 4500
1581	Maximum Temperature	.1	C°	-1,000 to 1,000
1600	Maximum THD/thd Current, Phase A	0.10	%	0 – 32,767
1601	Maximum THD/thd Current, Phase B	0.10	%	0 – 32,767

① See “How Power Factor is Stored in the Register” on page 182.

② May be used to meter other inputs when I2, I4, or V2–N is not required. This is possible in all supported system types except type 41.

③ The alternate storage method for power factor (PF) is useful for outputting PF on analog outputs. The PF value is stored as a positive value between 0 and 2, centered around 1 (unity). A value of 0 lagging maps to 0; -0.999 maps to 0.999;0.999 leading maps to 1.001; and 0 leading maps to 2. The alternate PF is also stored with a scale factor 0.001.

④ These configuration registers require that you enter the setup mode to change the register’s contents. Issue command 9020 to enter setup mode and 9021 to exit setup mode. See “Using the Command Interface to Change Configuration Registers” on page 241 for instructions on how to use the setup-mode commands.

Table A–1: Abbreviated Register List

Register Number	Description	Scale Factor	Units	Register Range
1602	Maximum THD/thd Current, Phase C	0.10	%	0 – 32,767
1603	Maximum THD/thd Current, Neutral (4-wire systems only)	0.10	%	0 – 32,767
1604	Maximum THD/thd Current, Ground	0.10	%	0 – 32,767
1605	Maximum THD/thd Current, Alternate I2	0.10	%	0 – 32,767
1606	Maximum THD/thd Current, Alternate I4	0.10	%	0 – 32,767
1607	Maximum THD/thd Voltage, Phase A-N (4-wire systems only)	0.10	%	0 – 32,767
1608	Maximum THD/thd Voltage, Phase B-N (4-wire systems only)	0.10	%	0 – 32,767
1609	Maximum THD/thd Voltage, Phase C-N (4-wire systems only)	0.10	%	0 – 32,767
1610	Maximum THD/thd Voltage, Neutral -Ground	0.10	%	0 – 32,767
1611	Maximum THD/thd Voltage, Phase A-B	0.10	%	0 – 32,767
1612	Maximum THD/thd Voltage, Phase B-C	0.10	%	0 – 32,767
1613	Maximum THD/thd Voltage, Phase C-A	0.10	%	0 – 32,767
1614	Maximum THD/thd Voltage, Alternate V2-N	0.10	%	0 – 32,767
1618	Maximum Current K-factor, Phase A	0.01	—	0 – 10,000
1619	Maximum Current K-factor, Phase B	0.01	—	0 – 10,000
1618	Maximum Current K-factor, Phase C	0.1	—	0 – 10,000
1618	Maximum Crest Factor, Phase A	0.1	—	0 – 10,000
1620	Maximum Crest Factor, Phase B	0.1	—	0 – 10,000
1621	Maximum Crest Factor, Phase C	0.01	—	0 – 10,000
1622	Maximum Crest Factor, Phase N	0.01	—	0 – 10,000
1623	Maximum Crest Factor, Alternate I2	0.01	—	0 – 10,000
1624	Maximum Crest Factor, Alternate I4	0.01	—	0 – 10,000
1630	Maximum Current Fundamental rms Magnitude, Phase A	A	Amperes	0 – 32,767
1631	Maximum Current Fundamental Coincident Angle, Phase A	0.1	Degrees (°)	0 – 3,599
1632	Maximum Current Fundamental rms Magnitude, Phase B	A	Amperes	0 – 32,767
1633	Maximum Current Fundamental Coincident Angle, Phase B	0.1	Degrees (°)	0 – 3,599
1634	Maximum Current Fundamental rms Magnitude, Phase C	A	Amperes	0 – 32,767
1635	Maximum Current Fundamental Coincident Angle, Phase C	0.1	Degrees (°)	0 – 3,599
1636	Maximum Current Fundamental rms Magnitude, Neutral	B	Amperes	0 – 32,767
1637	Maximum Current Fundamental Coincident Angle, Neutral	0.1	Degrees (°)	0 – 3,599
1638	Maximum Current Fundamental RMS Magnitude, Ground	C	Amperes	0 – 32,767
1639	Maximum Current Fundamental Coincident Angle, Ground	0.1	Degrees (°)	0 – 3,599
1640	Maximum Current Fundamental RMS Magnitude, Alternate I2	B	Amperes	0 – 32,767
1641	Maximum Current Fundamental Coincident Angle, Alternate I2	0.1	Degrees (°)	0 – 3,599
1642	Maximum Current Fundamental RMS Magnitude, Alternate I4	B	Amperes	0 – 32,767
1643	Maximum Current Fundamental Coincident Angle, Alternate I4	0.1	Degrees (°)	0 – 3,599
1644	Maximum Voltage Fundamental rms Magnitude, Phase A to N/A to B	D	Volts	0 – 32,767
1645	Maximum Voltage Fundamental Coincident Angle, Phase A to Neutral / A to B	0.1	Degrees (°)	0 – 3,599
1646	Maximum Voltage Fundamental rms Magnitude, Phase B to Neutral / B to C	D	Volts	0 – 32,767
1647	Maximum Voltage Fundamental Coincident Angle, Phase B to Neutral / B to C	0.1	Degrees (°)	0 – 3,599
1648	Maximum Voltage Fundamental rms Magnitude, Phase C to Neutral / C to A	D	Volts	0 – 32,767
1649	Maximum Voltage Fundamental Coincident Angle, Phase C to Neutral / C to A	0.1	Degrees (°)	0 – 3,599
1650	Maximum Voltage Fundamental rms Magnitude, Neutral to Ground	E	Volts	0 – 32,767
1651	Maximum Voltage Fund. Coincident Angle, Neutral to Ground	0.1	Degrees (°)	0 – 3,599

① See “How Power Factor is Stored in the Register” on page 182.

② May be used to meter other inputs when I2, I4, or V2–N is not required. This is possible in all supported system types except type 41.

③ The alternate storage method for power factor (PF) is useful for outputting PF on analog outputs. The PF value is stored as a positive value between 0 and 2, centered around 1 (unity). A value of 0 lagging maps to 0; -0.999 maps to 0.999;0.999 leading maps to 1.001; and 0 leading maps to 2. The alternate PF is also stored with a scale factor 0.001.

④ These configuration registers require that you enter the setup mode to change the register’s contents. Issue command 9020 to enter setup mode and 9021 to exit setup mode. See “Using the Command Interface to Change Configuration Registers” on page 241 for instructions on how to use the setup-mode commands.

Table A–1: Abbreviated Register List

Register Number	Description	Scale Factor	Units	Register Range
1652	Maximum Voltage Fundamental RMS Magnitude, Alternate V2	D	Volts	0 – 32,767
1653	Maximum Voltage Fund. Coincident Angle, Alternate V2-N	0.1	Degrees (°)	0 – 3,599
1655	Maximum Fundamental Real Power, Phase A (4-wire systems only)	F	kW	-32,767 – 32,767
1656	Maximum Fundamental Real Power, Phase B (4-wire systems only)	F	kW	-32,767 – 32,767
1657	Maximum Fundamental Real Power, Phase C (4-wire systems only)	F	kW	-32,767 – 32,767
1658	Maximum Fundamental Real Power, Total	F	kW	-32,767 – 32,767
1659	Max. Fundamental Reactive Power, Phase A (4-wire systems only)	F	kVAR	-32,767 – 32,767
1660	Max. Fundamental Reactive Power, Phase B (4-wire systems only)	F	kVAR	-32,767 – 32,767
1661	Max. Fundamental Reactive Power, Phase C (4-wire systems only)	F	kVAR	-32,767 – 32,767
1662	Maximum Fundamental Reactive Power, Total	F	kVAR	-32,767 – 32,767
1664	Maximum Distortion Power, Phase A (4-wire systems only)	F	kW	-32,767 – 32,767
1665	Maximum Distortion Power, Phase B (4-wire systems only)	F	kW	-32,767 – 32,767
1666	Maximum Distortion Power, Phase C (4-wire systems only)	F	kW	-32,767 – 32,767
1667	Maximum Distortion Power, Total	F	kW	-32,767 – 32,767
1668	Maximum Distortion Factor, Phase A (4-wire systems only)	0.10	—	0 – 1,000
1669	Maximum Distortion Factor, Phase B (4-wire systems only)	0.10	—	0 – 1,000
1670	Maximum Distortion Factor, Phase C (4-wire systems only)	0.10	—	0 – 1,000
1671	Maximum Distortion Factor, Total	0.10	—	0 – 1,000
1674	Maximum Harmonic Current, Phase A	A	Amperes	0 – 32,767
1675	Maximum Harmonic Current, Phase B	A	Amperes	0 – 32,767
1676	Maximum Harmonic Current, Phase C	A	Amperes	0 – 32,767
1677	Maximum Harmonic Current, Neutral	B	Amperes	0 – 32,767
1678	Maximum Harmonic Voltage, Phase A to N	D	Volts	0 – 32,767
1679	Maximum Harmonic Voltage, Phase B to N	D	Volts	0 – 32,767
1680	Maximum Harmonic Voltage, Phase C to N	D	Volts	0 – 32,767
1681	Maximum Total Demand Distortion	—	0.01	0 – 10,000
1684	Maximum Current, Positive Sequence, Magnitude	A	Amperes	0 – 32,767
1685	Maximum Current, Positive Sequence, Angle	0.1	Degrees (°)	0 – 3,599
1686	Maximum Current, Negative Sequence, Magnitude	A	Amperes	0 – 32,767
1687	Maximum Current, Negative Sequence, Angle	0.1	Degrees (°)	0 – 3,599
1688	Maximum Current, Zero Sequence, Magnitude	A	Amperes	0 – 32,767
1689	Maximum Current, Zero Sequence, Angle	0.1	Degrees (°)	0 – 3,599
1690	Maximum Voltage, Positive Sequence, Magnitude	D	Volts	0 – 32,767
1691	Maximum Voltage, Positive Sequence, Angle	0.1	Degrees (°)	0 – 3,599
1692	Maximum Voltage, Negative Sequence, Magnitude	D	Volts	0 – 32,767
1693	Minimum Voltage, Negative Sequence, Angle	0.1	Degrees (°)	0 – 3,599
1694	Maximum Voltage, Zero Sequence, Magnitude	D	Volts	0 – 32,767
1695	Maximum Voltage, Zero Sequence, Angle	0.1	Degrees (°)	0 – 3,599
1696	Maximum Current, Sequence, Unbalance	0.10	%	0 – 1,000
1697	Maximum Voltage, Sequence, Unbalance	0.10	%	0 – 1,000
Accumulated Energy				
1700–1703	Energy, Real In	—	WH	0 – 9,999,999,999,999,999
1704–1707	Energy, Reactive In	—	VARh	0 – 9,999,999,999,999,999

① See “How Power Factor is Stored in the Register” on page 182.

② May be used to meter other inputs when I2, I4, or V2–N is not required. This is possible in all supported system types except type 41.

③ The alternate storage method for power factor (PF) is useful for outputting PF on analog outputs. The PF value is stored as a positive value between 0 and 2, centered around 1 (unity). A value of 0 lagging maps to 0; -0.999 maps to 0.999;0.999 leading maps to 1.001; and 0 leading maps to 2. The alternate PF is also stored with a scale factor 0.001.

④ These configuration registers require that you enter the setup mode to change the register’s contents. Issue command 9020 to enter setup mode and 9021 to exit setup mode. See “Using the Command Interface to Change Configuration Registers” on page 241 for instructions on how to use the setup-mode commands.

Table A–1: Abbreviated Register List

Register Number	Description	Scale Factor	Units	Register Range
1708–1711	Energy, Real Out	—	WH	0 – 9,999,999,999,999,999
1712–1715	Energy, Reactive Out	—	VARh	0 – 9,999,999,999,999,999
1716–1719	Energy, Real Total (Signed/Absolute)	—	WH	-9,999,999,999,999,999 – 9,999,999,999,999,999
1720–1723	Energy, Reactive Total (Signed/Absolute)	—	VARh	-9,999,999,999,999,999– 9,999,999,999,999,999
1727–1727	Energy, Apparent	—	VAH	0 – 9,999,999,999,999,999
1728–1731	Energy, Conditional Real In	—	WH	0 – 9,999,999,999,999,999
1732–1735	Energy, Conditional Reactive In	—	VARh	0 – 9,999,999,999,999,999
1736–1739	Energy, Conditional Real Out	—	WH	0 – 9,999,999,999,999,999
1740–1743	Energy, Conditional Reactive Out	—	VARh	0 – 9,999,999,999,999,999
1744–1747	Energy, Conditional Apparent	—	VAH	0 – 9,999,999,999,999,999
1748–1750	Energy, Incremental Real In, Last Completed Interval	—	WH	0 – 999,999,999,999
1751–1753	Energy, Incremental Reactive In, Last Completed Interval	—	VARh	0 – 999,999,999,999
1754–1756	Energy, Incremental Real Out, Last Completed Interval	—	WH	0 – 999,999,999,999
1757–1759	Energy, Incremental Reactive Out, Last Completed Interval	—	VARh	0 – 999,999,999,999
1760–1762	Energy, Incremental Apparent, Last Completed Interval	—	VAH	0 – 999,999,999,999
1763–1766	Last Complete Incremental Energy Interval Date and Time	—	—	—
1767–1769	Energy, Incremental Real In, Present Interval	—	WH	0 – 999,999,999,999
1770–1772	Energy. Incremental Reactive In, Present Interval	—	VARh	0 – 999,999,999,999
1773–1775	Energy, Incremental Real Out, Present Interval	—	WH	0 – 999,999,999,999
1776–1778	Energy, Incremental Reactive Out, Present Interval	—	VARh	0 – 999,999,999,999
1779–1781	Energy, Incremental Apparent, Present Interval	—	VAH	0 – 999,999,999,999
1782–1784	Energy, Reactive, Quadrant 1	—	VARh	0 – 999,999,999,999
1785–1787	Energy, Reactive, Quadrant 2	—	VARh	0 – 999,999,999,999
1788–1790	Energy, Reactive, Quadrant 3	—	VARh	0 – 999,999,999,999
1791–1793	Energy, Reactive, Quadrant 4	—	VARh	0 – 999,999,999,999
Demand				
1800 ④	Demand Calculation Mode, Current 0 = Thermal Demand (default)	—	—	0
1801 ④	Demand Interval, Current	—	Minutes	1 – 60, Default = 15
1802 ④	Demand Subinterval, Current	—	Minutes	1 – 60, Default = 1
1803 ④	Thermal Demand Sensitivity, Current Adjusts the sensitivity of the thermal demand calculation.	—	1%	1 – 99, Default = 90
1805 ④	Running Average Interval, Current Sets the interval for a running average demand calculation of short duration.		Seconds	1 – 60, Default = 15
1806	Time Elapsed in Interval, Current Time elapsed in the present demand interval.	—	Seconds	0 – 3600
1807	Time Elapsed in Subinterval, Current Time elapsed in the present demand subinterval.	—	Seconds	0 – 3600

① See “How Power Factor is Stored in the Register” on page 182.

② May be used to meter other inputs when I2, I4, or V2–N is not required. This is possible in all supported system types except type 41.

③ The alternate storage method for power factor (PF) is useful for outputting PF on analog outputs. The PF value is stored as a positive value between 0 and 2, centered around 1 (unity). A value of 0 lagging maps to 0; -0.999 maps to 0.999;0.999 leading maps to 1.001; and 0 leading maps to 2. The alternate PF is also stored with a scale factor 0.001.

④ These configuration registers require that you enter the setup mode to change the register’s contents. Issue command 9020 to enter setup mode and 9021 to exit setup mode. See “Using the Command Interface to Change Configuration Registers” on page 241 for instructions on how to use the setup-mode commands.

Table A–1: Abbreviated Register List

Register Number	Description	Scale Factor	Units	Register Range
1810–1813	Date/Time of last reset of Current Demand Peak Demands Date format is a 4-register compressed format. (The decimal representation of the year 2001 is 101 in the year byte.) Register 1: Hi Byte = Month (1 - 12); Lo Byte = Day (1 - 31) Register 2: Hi Byte = Year (0 - 199); Lo Byte = Hour (0 - 23) Register 3: Hi Byte = Minute (0 -59); Lo Byte = Second (0 - 59) Register 4 = Millisecond For example, if date were 01/25/00 at 11:06:59.122 the Hex value would be: 0119, 640B, 063B, 007A 0119 => 01 = month, 19 = day 640B => 64 = year, 0B = hour 063B => 06 = minute, 3B = second 007A => 007A = milliseconds	—	—	—
1820 ④	Demand Calculation Mode, Voltage See register 1800 for values.	—	—	0 – 1024
1821 ④	Demand Interval, Voltage	—	Minutes	1 – 60, Default = 15
1822 ④	Demand Subinterval, Voltage	—	Minutes	1 – 60, Default = 1
1823 ④	Thermal Demand Sensitivity, Voltage Adjusts the sensitivity of the thermal demand calculation.	—	1%	1 – 99, Default = 90
1825 ④	Running Average Demand Interval, Voltage Sets the interval for a running average demand calculation of short duration.	—	Seconds	1 – 60, Default = 15
1826	Time Elapsed in present demand Interval, Voltage	—	Seconds	0 – 3600
1827	Time Elapsed in present demand Subinterval, Voltage	—	Seconds	0 – 3600
1830–1833	Date/Time of last reset of Voltage Demand peak demands	—	—	See register 1809–1812 for explanation of date format.
1840 ④	Demand Calculation Mode, Power See register 1800 for values.	—	—	0 – 1024, except 512
1841 ④	Demand Interval, Power	—	Minutes	1 – 60, Default = 15
1842 ④	Demand Subinterval, Power	—	Minutes	1 – 60, Default = 1
1843 ④	Thermal Demand Sensitivity, Power Adjusts the sensitivity of the thermal demand calculation.	—	1%	1 – 99, Default = 90.
1844 ④	Predicted Demand Sensitivity, Power Adjusts sensitivity of predicted demand calculation to recent changes in power consumption.	—	—	1 – 10, Default = 5.
1845 ④	Running Average Demand Interval, Power Sets the interval for a running average demand calculation of short duration.	—	Seconds	1 – 60, Default = 15
1846	Time Elapsed in present demand Interval, Power	—	Seconds	0 – 3600
1847	Time Elapsed in present demand Subinterval, Power	—	Seconds	0 – 3600
1850–1853	Date/Time of last reset of Power Demand Peak Demands	—	—	See register 1810–1813 for explanation of date format.
1854	Min/Max Reset Count Power Count of peak demand resets.	—	—	0 – 32,767 Rolls over at 32, 767.
1860 ④	Demand Calculation Mode, Input Pulse Metering See register 1800 for values.	—	—	0 – 1024
1861 ④	Demand Interval, Input Pulse Metering	—	Minutes	1 – 60, Default = 15
1862 ④	Demand Subinterval, Input Pulse Metering	—	Minutes	1 – 60, Default = 1
1863 ④	Thermal Demand Sensitivity, Input Pulse Metering	—	1%	1 – 99, Default = 90.
1865 ④	Running Average Demand Interval, Input Pulse Metering Sets the interval for a running average demand calculation of short duration.	—	Seconds	1 – 60, Default = 15

① See “How Power Factor is Stored in the Register” on page 182.

② May be used to meter other inputs when I2, I4, or V2–N is not required. This is possible in all supported system types except type 41.

③ The alternate storage method for power factor (PF) is useful for outputting PF on analog outputs. The PF value is stored as a positive value between 0 and 2, centered around 1 (unity). A value of 0 lagging maps to 0; -0.999 maps to 0.999;0.999 leading maps to 1.001; and 0 leading maps to 2. The alternate PF is also stored with a scale factor 0.001.

④ These configuration registers require that you enter the setup mode to change the register’s contents. Issue command 9020 to enter setup mode and 9021 to exit setup mode. See “Using the Command Interface to Change Configuration Registers” on page 241 for instructions on how to use the setup-mode commands.

Table A–1: Abbreviated Register List

Register Number	Description	Scale Factor	Units	Register Range
1866	Time Elapsed in present demand Interval, Input Pulse Metering	—	Seconds	0 – 3600
1867	Time Elapsed in present demand Subinterval, Input Pulse Metering	—	Seconds	0 – 3600
1870–1873	Date/Time of last reset of Current Demand peak demands	—	—	See register 1810–1813 for explanation of date format.
1880 ④	Demand Calculation Mode Generic Profile 1 See register 1800 for values.	—	—	0 – 1024
1881 ④	Demand Interval Generic Profile 1	—	Minutes	1 – 60, Default = 15
1882 ④	Demand Subinterval Generic Profile 1	—	Minutes	1 – 60, Default = 1
1883 ④	Thermal Demand Sensitivity Generic Profile 1 Adjusts the sensitivity of the thermal demand calculation	—	1%	1 – 99, Default = 90.
1885 ④	Running Average Demand Interval, Generic Profile 1 Sets the interval for a running average demand calculation of short duration.	—	Seconds	1 – 60, Default = 15
1886	Time Elapsed in present demand interval Generic Profile 1	—	Seconds	0 – 3600
1887	Time Elapsed in present demand subinterval Generic Profile 1	—	Seconds	0 – 3600
1890–1893	Date/Time of last reset of Generic Profile 1 Peak Demand	—	—	See register 1810–1813 for explanation of date format.
1900 ④	Demand Calculation Mode Generic Profile 2 See register 1800 for values.	—	—	0 – 1024
1901 ④	Demand Interval Generic Profile 2	—	Minutes	1 – 60, Default = 15
1902 ④	Demand Subinterval Generic Profile 2	—	Minutes	1 – 60, Default = 1
1903 ④	Thermal Demand Sensitivity Generic Profile 2 Adjusts the sensitivity of the thermal demand calculation.	—	1%	1 – 99, Default = 90.
1905 ④	Running Average Demand Interval, Generic Profile 2 Sets the interval for a running average demand calculation of short duration.	—	Seconds	1 – 60, Default = 15
1906	Time Elapsed in present demand interval Generic Profile 2	—	Seconds	0 – 3600
1907	Time Elapsed in present demand subinterval Generic Profile 2	—	Seconds	0 – 3600
1908	Interval Count Generic Group 2 Count of demand intervals.	—	1.0	0 – 32,767 Rolls over at 32, 767.
1910–1913	Date/Time of last reset of Generic Profile 2 Peak Demand	—	—	See register 1810–1813 for explanation of date format.
1923 ④	Clock Sync Time of Day (Minutes from Midnight) Time of day, in minutes from midnight, to which the demand interval is to be synchronized. Applies to demand intervals configured as Clock Synchronized.	—	Minutes	0 – 1440
1924	Power Factor Average Over Last Power Demand Interval	0.001	—	-100 to 1,000
1925–1928	Cumulative Demand Reset D/T Date/Time of the last reset of cumulative demand.	—	—	See register 1810–1813 for explanation of date format.
1929–1932	Cumulative Input Pulse Metering Reset D/T Date/Time of last reset of input pulse metering accumulation	—	—	See register 1810–1813 for explanation of date format.
1940	Last Incremental Energy Interval, Real Demand Peak Maximum real 3-phase power demand over the last incremental energy interval	F	kW	-32,767 – 32,767
1941–1944	Last Incremental Energy Interval, Real Demand Peak D/T Date/Time of the Real Power Demand peak during the last completed incremental energy interval	—	—	See register 1810–1813 for explanation of date format.
1945	Last Incremental Energy Interval, Reactive Demand Peak Maximum reactive 3-phase power demand over the last incremental energy interval	F	kVAR	-32,767 – 32,767
1946–1949	Last Incremental Energy Interval, Reactive Demand Peak D/T Date/Time of the Reactive Power Demand peak during the last completed incremental energy interval	—	—	See register 1810–1813 for explanation of date format.

① See “How Power Factor is Stored in the Register” on page 182.

② May be used to meter other inputs when I2, I4, or V2–N is not required. This is possible in all supported system types except type 41.

③ The alternate storage method for power factor (PF) is useful for outputting PF on analog outputs. The PF value is stored as a positive value between 0 and 2, centered around 1 (unity). A value of 0 lagging maps to 0; -0.999 maps to 0.999;0.999 leading maps to 1.001; and 0 leading maps to 2. The alternate PF is also stored with a scale factor 0.001.

④ These configuration registers require that you enter the setup mode to change the register’s contents. Issue command 9020 to enter setup mode and 9021 to exit setup mode. See “Using the Command Interface to Change Configuration Registers” on page 241 for instructions on how to use the setup-mode commands.

Table A–1: Abbreviated Register List

Register Number	Description	Scale Factor	Units	Register Range
1950	Last Incremental Energy Interval, Apparent Demand Peak Maximum apparent 3-phase power demand over the last incremental energy interval	F	kVA	0 – 32,767
1951–1954	Last Incremental Energy Interval, Apparent Demand Peak D/T Date/Time of the Apparent Power Demand peak during the last completed incremental energy interval	—	—	See register r1810–1813 for explanation of date format.
1960	Last Complete Interval, Demand Current, Phase A	A	Amperes	0 – 32,767
1961	Partial Interval Demand Current, Phase A	A	Amperes	0 – 32,767
1962	Running Average Demand Current, Phase A Calculation of short duration, updated every second	A	Amperes	0 – 32,767
1963	Peak Demand Current, Phase A	A	Amperes	0 – 32,767
1964	Date/Time of Peak Current Demand, Phase A	—	—	See register 1810–1813 for explanation of date format.
1970	Last Complete Interval Demand Current, Phase B	A	Amperes	0 – 32,767
1971	Partial Interval Demand Current, Phase B	A	Amperes	0 – 32,767
1972	Running Average Demand Current, Phase B Calculation of short duration, updated every second	A	Amperes	0 – 32,767
1973	Peak Demand Current Phase B	A	Amperes	0 – 32,767
1974–1977	Peak Demand D/T Current Phase B	—	—	See register 1810–1813 for explanation of date format.
1980	Last Complete Interval Demand Current, Phase C	A	Amperes	0 – 32,767
1981	Partial Interval Demand Current, Phase C	A	Amperes	0 – 32,767
1982	Running Average Demand Current, Phase C Calculation of short duration, updated every second	A	Amperes	0 – 32,767
1983	Peak Demand Current Phase C	A	Amperes	0 – 32,767
1984	Date/Time of Peak Current Demand, Phase C	—	—	See register 1810–1813 for explanation of date format.
1990	Last Complete Interval Demand Current, Neutral	A	Amperes	0 – 32,767
1991	Partial Interval Demand Current, Neutral	A	Amperes	0 – 32,767
1992	Running Average Demand Current, Neutral Calculation of short duration, updated every second	A	Amperes	0 – 32,767
1993	Peak Demand Current, Neutral	A	Amperes	0 – 32,767
1994–1997	Date/Time of Peak Current Demand, Neutral	—	—	See register 1810–1813 for explanation of date format.
2000	Last Complete Interval Demand Current, 3-Phase Average	A	Amperes	0 – 32,767
2001	Partial Interval Demand Current, 3-Phase Average	A	Amperes	0 – 32,767
2002	Running Average Demand Current, 3-Phase Average Calculation of short duration, updated every second	A	Amperes	0 – 32,767
2003	Peak Demand Current, 3-Phase Average	A	Amperes	0 – 32,767
2004–2007	Date/Time of Peak Current Demand, 3-Phase Average	—	—	See register 1810–1813 for explanation of date format.
2010	Last Complete Interval Demand Voltage A to B	D	Volts	0 – 32,767
2011	Partial Interval Demand Voltage Phase A to B	D	Volt	0 – 32,767
2022	Running Average Demand Voltage Phase A to B Calculation of short duration, updated every second	D	Volts	0 – 32,767
2013	Maximum Demand Voltage Phase A to B	D	Volts	0 – 32,767
2014–2017	Date/Time of Voltage Phase A to B maximum demand	—	—	See register 1810–1813 for explanation of date format.
2018	Minimum Demand Voltage Phase A to B	D	Volts	0 – 32,767
2019–2022	Date/Time of Voltage Phase A to B minimum demand	—	—	See register 1810–1813 for explanation of date format.
2025	Last Complete Interval Demand Voltage Phase B to C	D	Volt	0 – 32,767

① See “How Power Factor is Stored in the Register” on page 182.

② May be used to meter other inputs when I2, I4, or V2–N is not required. This is possible in all supported system types except type 41.

③ The alternate storage method for power factor (PF) is useful for outputting PF on analog outputs. The PF value is stored as a positive value between 0 and 2, centered around 1 (unity). A value of 0 lagging maps to 0; -0.999 maps to 0.999;0.999 leading maps to 1.001; and 0 leading maps to 2. The alternate PF is also stored with a scale factor 0.001.

④ These configuration registers require that you enter the setup mode to change the register’s contents. Issue command 9020 to enter setup mode and 9021 to exit setup mode. See “Using the Command Interface to Change Configuration Registers” on page 241 for instructions on how to use the setup-mode commands.

Table A–1: Abbreviated Register List

Register Number	Description	Scale Factor	Units	Register Range
2026	Partial Interval Demand Voltage Phase B to C	D	Volts	0 – 32,767
2027	Running Average Demand Voltage Phase B to C Calculation of short duration, updated every second	D	Volts	0 – 32,767
2028	Maximum Demand Voltage Phase B to C	D	Volts	0 – 32,767
2029–2032	Date/Time of Voltage Phase B to C maximum demand	—	—	See register 1810–1813 for explanation of date format.
2033	Minimum Demand Voltage B to C	D	Volts	0 – 32,767
2034–2037	Date/Time of Voltage Phase B to C minimum demand	—	—	See register 1810–1813 for explanation of date format.
2040	Last Complete Interval Demand Voltage C t o A	D	Volts	0 – 32,767
2041	Partial Interval Demand Voltage C to A	D	Volts	0 – 32,767
2042	Running Average Demand Voltage Phase C to A Calculation of short duration, updated every second	D	Volts	0 – 32,767
2043	Maximum Demand Voltage C to A	D	Volts	0 – 32,767
2044–2047	Date/Time of Voltage Phase C to A maximum demand	—	—	See register 1810–1813 for explanation of date format.
2048	Minimum Demand Voltage C to A	D	Volts	0 – 32,767
2049–2052	Date/Time of Voltage Phase C to A minimum demand	—	—	See register 1810–1813 for explanation of date format.
2055	Last Complete Interval Demand Voltage L to L Average	D	Volts	0 – 32,767
2056	Partial Interval Demand Voltage L to L Average	D	Volts	0 – 32,767
2057	Running Average Demand Voltage L to L Average Calculation of short duration, updated every second	D	Volts	0 – 32,767
2058	Maximum Demand Voltage L to L Average	D	Volts	0 – 32,767
2059–2062	Date/Time of Voltage Line to Line Average maximum demand	—	—	See register 1810–1813 for explanation of date format.
2063	Minimum Demand Voltage L to L Average	D	Volts	0 – 32,767
2064–2067	Date/Time of Voltage Line to Line Average minimum demand	—	—	See register 1810–1813 for explanation of date format.
2070	Voltage Phase A to N demand, last complete interval	D	Volts	0 – 32,767
2071	Partial Interval Demand Voltage A to N	D	Volts	0 – 32,767
2072	Running Average Demand Voltage A to N Calculation of short duration, updated every second	D	Volts	0 – 32,767
2073	Maximum Demand Voltage A to N	D	Volts	0 – 32,767
2074–2077	Date/Time of Voltage Phase A to N maximum demand	—	—	See register 1810–1813 for explanation of date format.
2078	Minimum Demand Voltage A to N	D	Volts	0 – 32,767
2079–2082	Date/Time of Voltage Phase A to N minimum demand	—	—	See register 1810–1813 for explanation of date format.
2085	Last Demand Voltage B to N	D	Volts	0 – 32,767
2086	Partial Interval Demand Voltage B to N	D	Volts	0 – 32,767
2087	Running Average Demand Voltage B to N Calculation of short duration, updated every second	D	Volts	0 – 32,767
2088	Maximum Demand Voltage B to N	D	Volts	0 – 32,767
2089–2092	Date/Time of Voltage Phase B to N maximum demand	—	—	See register 1810–1813 for explanation of date format.
2093	Minimum Demand Voltage B-N	D	Volts	0 – 32,767
2094–2097	Date/Time of Voltage Phase B to N minimum demand	—	—	See register 1810–1813 for explanation of date format.
2100	Voltage Phase C to Neutral demand, last complete interval	D	Volts	0 – 32,767
2101	Partial Interval Demand Voltage C to N Voltage Phase C to Neutral demand, Partial Interval	D	Volts	0 – 32,767

① See “How Power Factor is Stored in the Register” on page 182.

② May be used to meter other inputs when I2, I4, or V2–N is not required. This is possible in all supported system types except type 41.

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④ These configuration registers require that you enter the setup mode to change the register’s contents. Issue command 9020 to enter setup mode and 9021 to exit setup mode. See “Using the Command Interface to Change Configuration Registers” on page 241 for instructions on how to use the setup-mode commands.

Table A–1: Abbreviated Register List

Register Number	Description	Scale Factor	Units	Register Range
2102	Running Average Demand Voltage C to N Calculation of short duration, updated every second	D	Volts	0 – 32,767
2103	Maximum Demand Voltage C-N	D	Volts	0 – 32,767
2104–2107	Date/Time of Voltage Phase C to Neutral maximum demand	—	—	See register 1810–1813 for explanation of date format.
2108	Minimum Demand Voltage C to N	D	Volts	0 – 32,767
2109–2112	Date/Time of Voltage Phase C to Neutral minimum demand	—	—	See register 1810–1813 for explanation of date format.
2115	Voltage Neutral to Ground demand, last complete interval	D	Volt	0 – 32,767
2116	Partial Interval Demand Voltage N to G	D	Volts	0 – 32,767
2117	Running Average Demand Voltage Neutral to Ground Calculation of short duration, updated every second	D	Volts	0 – 32,767
2118	Maximum Demand Voltage Neutral to Ground	D	Volts	0 – 32,767
2119–2122	Date/Time of Voltage Neutral to Ground maximum demand	—	—	See register 1810–1813 for explanation of date format.
2123	Minimum Demand Voltage Neutral to Ground	D	Volt	0 – 32,767
2124–2127	Date/Time of Voltage Neutral to Ground minimum demand	—	—	See register 1810–1813 for explanation of date format.
2130	Voltage Line to Neutral Average demand, last complete interval	D	Volts	0 – 32,767
2131	Partial Interval Demand Voltage Line to Neutral Average	D	Volts	0 – 32,767
2132	Running Average Demand Voltage Line to Neutral Average Calculation of short duration, updated every second	D	Volts	0 – 32,767
2133	Maximum Demand Voltage Line to Neutral Average	D	Volts	0 – 32,767
2134–2137	Date/Time of Voltage Line to Neutral Average maximum demand	—	—	See register 1810–1813 for explanation of date format.
2138	Minimum Demand Voltage Line to Neutral Average	D	Volts	0 – 32,767
2139–2142	Date/Time of Voltage Line to Neutral Average minimum demand	—	—	See register 1810–1813 for explanation of date format.
2150	Last Demand Real Power, 3-Phase Total 3-Phase total present real power demand for last completed demand interval—updated every sub-interval	F	kW	-32,767 – 32,767
2151	Partial Interval Demand Real Power, 3-Phase Total 3-Phase total present real power demand for present demand interval —updated every second	F	kW	-32,767 – 32,767
2152	Running Average Demand Real Power, 3-Phase Total Calculation of short duration, updated every second	F	kW	-32,767 – 32,767
2153	Predicted Demand Real Power, 3-Phase Total Predicted real power demand at the end of the present interval	F	kW	-32,767 – 32,767
2154	Peak Demand Real Power, 3-Phase Total	F	kW	-32,767 – 32,767
2155–2158	Date/Time of 3-Phase peak real power demand	—	—	See register 1810–1813 for explanation of date format.
2159	Cumulative Demand Real Power, 3-Phase Total	F	kW	-2147483648 – 2147483647
2161	Average True Power Factor at the time of the Peak Real Demand	.001	—	-100 – 1000
2162	Reactive Power Demand at the time of the Peak Real Demand	F	kVAR	-32,767 – 32,767
2163	Apparent Power Demand at the time of the Peak Real Demand	F	kVA	0 – 32,767
2165	Last Demand Reactive Power, 3-Phase Total 3-Phase total present real power demand for last completed demand interval – updated every sub-interval	F	kW	-32,767 – 32,767
2166	Partial Interval Demand Reactive Power, 3-Phase Total 3-Phase total present real power demand for present demand interval – updated every second	F	kW	-32,767 – 32,767
2167	Running Average Demand Reactive Power, 3-Phase Total Calculation of short duration, updated every second	F	kW	-32,767 – 32,767

① See “How Power Factor is Stored in the Register” on page 182.

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④ These configuration registers require that you enter the setup mode to change the register’s contents. Issue command 9020 to enter setup mode and 9021 to exit setup mode. See “Using the Command Interface to Change Configuration Registers” on page 241 for instructions on how to use the setup-mode commands.

Table A–1: Abbreviated Register List

Register Number	Description	Scale Factor	Units	Register Range
2168	Predicted Demand Reactive Power, 3-Phase Total Predicted real power demand at the end of the present interval	F	kW	-32,767 – 32,767
2169	Peak Demand Reactive Power, 3-Phase Total	F	kW	-32,767 – 32,767
2170–2173	Date/Time of 3-Phase peak real power demand	—	—	See register 1810–1813 for explanation of date format.
2174	Cumulative Demand Reactive Power, 3-Phase Total	F	kW	-2147483648 – 2147483647
2176	Average True Power Factor at the time of the Peak Real Demand	.001	—	-100 – 1000
2177	Real Power Demand at the time of the Peak Real Demand	F	kVAR	-32,767 – 32,767
2178	Apparent Power Demand at the time of the Peak Real Demand	F	kVA	0 – 32,767
2180	Last Demand Apparent Power 3-Phase Total 3-Phase total present real power demand for last completed demand interval—updated every sub-interval	F	kW	-32,767 – 32,767
2181	Partial Interval Demand Apparent Power, 3-Phase Total 3-Phase total present real power demand for present demand interval —updated every second	F	kW	-32,767 – 32,767
2182	Running Average Demand Apparent Power, 3-Phase Total Calculation of short duration, updated every second	F	kW	-32,767 – 32,767
2183	Predicted Demand Apparent Power, 3-Phase Total Predicted real power demand at the end of the present interval	F	kW	-32,767 – 32,767
2184	Peak Demand Apparent Power, 3-Phase Total	F	kW	-32,767 – 32,767
2185–2188	Date/Time of 3-Phase peak real power demand	—	—	See register 1810–1813 for explanation of date format.
2189	Cumulative Demand Apparent Power, 3-Phase Total	F	kW	-2147483648 – +2147483647
2191	Average True Power Factor at the time of the Peak Real Demand	.001	—	-100 – 1000
2192	Reactive Power Demand at the time of the Peak Real Demand	F	kVAR	-32,767 – 32,767
2193	Apparent Power Demand at the time of the Peak Real Demand	F	kVA	0 – 32,767
2201 ④	Input Channel #1 demand scale code	—	—	-3 – 3 Default = 0
2202	Input Channel #1 demand last complete interval	—	—	0 – 32,767 Default = 0
2203	Partial Interval Demand Input Channel #1	—	—	0 – 32,767
2204	Running Average Demand Input Channel #1 Calculation of short duration, updated every second	—	—	0 – 32,767
2205	Peak Demand Input Channel #1 Channel #1 peak demand since last Min/Max demand reset	—	—	0 – 32,767
2206–2209	Peak Demand Date/Time Input Channel #1 Date/Time of peak demand since last peak demand reset	—	—	See register 1810–1813 for explanation of date format.
2210	Minimum Demand Input Channel #1 Channel #1 minimum since last Min/Max demand reset	—	—	0 – 32,767
2211–2214	Minimum Demand Date/Time Input Channel #1 Date/Time of minimum demand since last Min/Max reset	—	—	See register 1810–1813 for explanation of date format.
2215	Cumulative Usage Input Channel #1	—	—	0 – 9,999,999,999,999,999
2220-2239	Input Channel #2 Same as registers 2201 – 2215 except for Channel #2	—	—	0 – 9,999,999,999,999,999
2240-2259	Input Channel #3 Same as registers 2201 – 2215 except for Channel #3	—	—	0 – 9,999,999,999,999,999
2260-2279	Input Channel #4 Same as registers 2201 – 2215 except for Channel #4	—	—	0 – 9,999,999,999,999,999
2280-2299	Input Channel #5 Same as registers 2201 – 2215 except for Channel #5	—	—	0 – 9,999,999,999,999,999
2300-2319	Input Channel #6 Same as registers 2201 – 2215 except for Channel #6	—	—	0 – 9,999,999,999,999,999

① See “How Power Factor is Stored in the Register” on page 182.

② May be used to meter other inputs when I2, I4, or V2–N is not required. This is possible in all supported system types except type 41.

③ The alternate storage method for power factor (PF) is useful for outputting PF on analog outputs. The PF value is stored as a positive value between 0 and 2, centered around 1 (unity). A value of 0 lagging maps to 0; -0.999 maps to 0.999;0.999 leading maps to 1.001; and 0 leading maps to 2. The alternate PF is also stored with a scale factor 0.001.

④ These configuration registers require that you enter the setup mode to change the register’s contents. Issue command 9020 to enter setup mode and 9021 to exit setup mode. See “Using the Command Interface to Change Configuration Registers” on page 241 for instructions on how to use the setup-mode commands.

Table A–1: Abbreviated Register List

Register Number	Description	Scale Factor	Units	Register Range
2320-2339	Input Channel #7 Same as registers 2201 – 2215 except for Channel #7	—	—	0 – 9,999,999,999,999,999
2340-2359	Input Channel #8 Same as registers 2201 – 2215 except for Channel #8	—	—	0 – 9,999,999,999,999,999
2360-2379	Input Channel #9 Same as registers 2201 – 2215 except for Channel #9	—	—	0 – 9,999,999,999,999,999
2380-2399	Input Channel #10 Same as registers 2201 – 2215 except for Channel #10	—	—	0 – 9,999,999,999,999,999
2405	Running Average Demand, Generic Input Channel Calculation of short duration, updated every second	—	—	0 – 32,767
System Configuration				
3000–3001 ④	Circuit Monitor Label	—	—	—
3002–3009 ④	Circuit Monitor Nameplate	—	—	—
3014	Present Metering System Revision Level (operating system)	—	—	0x0 – 0xFFFF
3034–3037	Present Date and Time	—	—	0x0 – 0xFFFF
3061	Installed Log Memory	—	Kilobytes	0 – 8,000K
3062	Free Log Memory	—	Kilobytes	0 – 8,000K
Current and Voltage Module Configuration				
3138	CT Ratio, Phase A Correction Factor, Default = 0	0.00001	—	-20,000 – 20,000
3139	CT Ratio, Phase B Correction Factor, Default = 0	0.00001	—	-20,000 – 20,000
3140	CT Ratio, Phase C Correction Factor, Default = 0	0.00001	—	-20,000 – 20,000
3141	CT Ratio, Neutral Correction Factor, Default = 0	0.00001	—	-20,000 – 20,000
3142	PT Ratio, Phase A Correction Factor, Default = 0	0.00001	—	-20,000 – 20,000
3143	PT Ratio, Phase B Correction Factor, Default = 0	0.00001	—	-20,000 – 20,000
3144	PT Ratio, Phase C Correction Factor, Default = 0	0.00001	—	-20,000 – 20,000
3145	Neutral-Ground Correction Factor, Default = 0	0.00001	—	-20,000 – 20,000
3154 ④	Phase A Current Field Calibration Coefficient, Default = 0	0.00001	—	-20,000 – 20,000
3155 ④	Phase B Current Field Calibration Coefficient, Default = 0	0.00001	—	-20,000 – 20,000
3156 ④	Phase C Current Field Calibration Coefficient, Default = 0	0.00001	—	-20,000 – 20,000
3157 ④	Neutral Current Field Calibration Coefficient, Default = 0	0.00001	—	-20,000 – 20,000
3158 ④	Phase A Voltage Field Calibration Coefficient, Default = 0	0.00001	—	-20,000 – 20,000
3159 ④	Phase B Voltage Field Calibration Coefficient, Default = 0	0.00001	—	-20,000 – 20,000
3160 ④	Phase C Voltage Field Calibration Coefficient, Default = 0	0.00001	—	-20,000 – 20,000
3161 ④	Neutral-Ground Voltage Field Calibration Coefficient, Default = 0	0.00001	—	-20,000 – 20,000
3170 ④	CT Phase Shift Correction at 1 ampere, Default = 1000 CT phase shift correction, for user instrumentation, in the range of –10º to +10º. A negative shifts in the lag direction.	—	—	-1000 – 1000
3171 ④	CT Phase Shift Correction at 5 amperes, Default = 1000 CT phase shift correction, for user instrumentation, in the range of –10º to +10º. A negative shifts in the lag direction.	—	—	-1000 – 1000
Metering Configuration				
3200 ④	Metering System Type	—	—	30,31,40,41,42
3201 ④	CT Ratio, 3-Phase Primary	—	—	1 – 32767
3202 ④	CT Ratio, 3-Phase Secondary	—	—	1 – 5
3203 ④	CT Ratio, Neutral Primary	—	—	1 – 32767
3204 ④	CT Ratio, Neutral Secondary	—	—	1 – 5
3205 ④	PT Ratio, 3-Phase Primary	—	—	1 – 32767
3206 ④	PT Ratio, 3-Phase Primary Scale Factor	—	—	0 – 2 (-1 is direct connect)
3207 ④	PT Ratio, 3-Phase Secondary	—	—	1 – 600
3208 ④	Nominal System Frequency	0.01	Hertz	50,60,400

① See “How Power Factor is Stored in the Register” on page 182.

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④ These configuration registers require that you enter the setup mode to change the register’s contents. Issue command 9020 to enter setup mode and 9021 to exit setup mode. See “Using the Command Interface to Change Configuration Registers” on page 241 for instructions on how to use the setup-mode commands.

Table A–1: Abbreviated Register List

Register Number	Description	Scale Factor	Units	Register Range
3209 ④	Scale A – 3-Phase Amperes	—	—	-2 – 1
3210 ④	Scale B – Neutral Amperes	—	—	-2 – 1
3211 ④	Scale C – Ground Amperes	—	—	-2 – 1
3212 ④	Scale D – 3-Phase Volts	—	—	-1 – 2
3213 ④	Scale E – Neutral Volts	—	—	-1 – 2
3214 ④	Scale F – Power	—	—	-3 – 3
3227 ④	Operating Mode Parameters, Mode Control Bits Bit 00 = Real & Reactive Energy Accumulation 0 = Absolute; 1 = Signed Bit 01 = Reactive Energy & Demand Accumulation 0 = Fund. Only; 1 = Harmonics Included Bit 02 = VAR/PF Sign Convention 0 = Standard IEEE Convention 1 = Old CM2 Convention Bit 04 & Bit 05 = Demand Sync Source 00 = Input1; 01 = Command; 10 = Clock Bit 06 = Conditional Energy Accumulation Control 0 = Inputs; 1 = Command Bit 07 = Conditional Energy Accumulation Status 0 = Off; 1 = On Bit 08 = Display Setup 0 = Enabled; 1 = Disabled Bit 09 = Normal Phase Rotation 0 = ABC; 1 = CBA Bit 10 = Large or Small THD 0 = THD; 1 = thd Bit 11 = Generate Phase Loss Voltage 0 = Disabled; 1 = Enabled	—	Boolean	Default = 0
3228	Phase Rotation Direction 0 = A-B-C; 1 = C-B-A	—	1.0	0 to 1
3229 ④	Incremental Energy Interval Default = 15 0 = Continuous Accumulation	—	Minutes	0 – 1440
3230 ④	Incremental Energy Interval Start Time Value is time represented in minutes from midnight Default = 0	—	Minutes	0 – 1440
3231 ④	Incremental Energy Interval End Time Value is time represented in minutes from midnight Default = 1440	—	Minutes	0 – 1440
3270	Minimum/Maximum Reset Date/Time	—	—	See register 1810–1813 for explanation of date format.
3274	Accumulated Energy Reset Date/Time	—	—	See register 1810–1813 for explanation of date format.
3278	Conditional Energy Reset Date/Time Date/Time of the last reset of Conditional Energy	—	—	See register 1810–1813 for explanation of date format.
3282	Incremental Energy Reset Date/Time Date/Time of the last reset of Incremental Energy	—	—	See register 1810–1813 for explanation of date format.
3286	Input Metering Accumulation Reset Date/Time Date/Time of the last reset of Input Metering Accumulation	—	—	See register 1810–1813 for explanation of date format.
3300 ④	Average/Min/Max Log interval Must be evenly divisible into 1440. Default = 60	—	Minutes	0 – 1440

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Table A–1: Abbreviated Register List

Register Number	Description	Scale Factor	Units	Register Range
Communications				
3401 ④	RS-485 Comm Port #1 Address Default = 1, Modbus: 0 – 247, Jbus: 0 – 255	—	—	0 – 255
3402 ④	RS-485 Comm Port #1 Baud Rate 0 = 1200 1 = 2400 2 = 4800 3 = 9600 (default) 4 = 19200 5 = 38400	—	—	0 – 5
3403 ④	RS-485 Comm Port #1 Parity 0 = Even (default) 1 = Odd 2 = None	—	—	0 – 2
3431 ④	RS-232 Comms Port #2 Address Default = 1, Modbus: 0 – 247, Jbus: 0 – 255	—	—	0 – 255
3432 ④	RS-232 Comm Port #2 Baud Rate 0 = 1200 1 = 2400 2 = 4800 3 = 9600 (default) 4 = 19200 5 = 38400	—	—	0 – 5
3433 ④	RS-232 Comm Port #2 Parity 0 = Even (default) 1 = Odd 2 = None	—	—	0 – 2

① See “How Power Factor is Stored in the Register” on page 182.

② May be used to meter other inputs when I2, I4, or V2–N is not required. This is possible in all supported system types except type 41.

③ The alternate storage method for power factor (PF) is useful for outputting PF on analog outputs. The PF value is stored as a positive value between 0 and 2, centered around 1 (unity). A value of 0 lagging maps to 0; -0.999 maps to 0.999;0.999 leading maps to 1.001; and 0 leading maps to 2. The alternate PF is also stored with a scale factor 0.001.

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Table A–2: Abbreviated Register List for I/O Status

Register Number	Name	Scale Factor	Units	Range	Description
4001	Digital Input Status Option Card A	—	—	0 – F	Bitmap of On/Off status for the digital inputs in Option Card A: 0 = Off, 1 = On In the following list, AS1 to AS4 refers to a location code of the I/O see “I/O Position Numbers” on page 240 for more information. Use the integer 3–6 that corresponds to the appropriate I/O. Bit 00 = On/Off Status of I/O Point 3 (AS1) Bit 01 = On/Off Status of I/O Point 4 (AS2) Bit 02 = On/Off Status of I/O Point 5 (AS3) Bit 03 = On/Off Status of I/O Point 6 (AS4)
4002	Digital Input Status Option Card B	—	—	0 – F	Bitmap of On/Off status for the digital inputs in Option Card B: 0 = Off, 1 = On In the following list, Bs1 to BS4 refers to a location code of the I/O see “I/O Position Numbers” on page 240 for more information. Use the integer 19–22 that corresponds to the appropriate I/O. Bit 00 = On/Off Status of I/O Point 19 (BS1) Bit 01 = On/Off Status of I/O Point 20 (BS2) Bit 02 = On/Off Status of I/O Point 21 (BS3) Bit 03 = On/Off Status of I/O Point 22 (BS4)
4003	Digital Input Status I/O Extender	—	—	0 – FF	Bitmap of On/Off status for the digital inputs in I/O Extender: 0 = Off, 1 = On In the following list, C1 to C8 refers to a location code of the I/O see “I/O Position Numbers” on page 240 for more information. Use the integer 35–42 that corresponds to the appropriate I/O. Bit 00 = On/Off Status of I/O Point 35 (C1) Bit 01 = On/Off Status of I/O Point 36 (C2) Bit 02 = On/Off Status of I/O Point 37 (C3) Bit 03 = On/Off Status of I/O Point 38 (C4) Bit 04 = On/Off Status of I/O Point 39 (C5) Bit 05 = On/Off Status of I/O Point 40 (C6) Bit 06 = On/Off Status of I/O Point 41 (C7) Bit 07 = On/Off Status of I/O Point 42 (C8)
4005	Standard KYZ Output Status	—	—	0 – 1	Bitmap of On/Off status for the standard KYZ output: 0 = Off, 1 = On Bit 00 = Standard KYZ output (KYZ) Remaining bits not used.
4006	Digital Output Status Option Card A	—	—	0 – OF	Bitmap of On/Off status for the digital outputs in Option Card A: 0 = Off, 1 = On In the following list, AR0 to AR3 refers to a location code of the I/O see “I/O Position Numbers” on page 240 for more information. Use the integer 7–10 that corresponds to the appropriate I/O. Bit 00 = On/Off Status of I/O Point 7 (AR0) Bit 01 = On/Off Status of I/O Point 8 (AR1) Bit 02 = On/Off Status of I/O Point 9 (AR2) Bit 03 = On/Off Status of I/O Point 10 (AR3)
4007	Digital Output Status Option Card B	—	—	0 – oF	Bitmap of On/Off status for the digital outputs in Option Card B: 0 = Off, 1 = On In the following list, BR0 to BR3 refers to a location code of the I/O see “I/O Position Numbers” on page 240 for more information. Use the integer 23–26 that corresponds to the appropriate I/O. Bit 00 = On/Off Status of I/O Point 23 (BR0) Bit 01 = On/Off Status of I/O Point 24 (BR1) Bit 02 = On/Off Status of I/O Point 25 (BR2) Bit 03 = On/Off Status of I/O Point 26 (BR3)

① These configuration registers require that you enter the setup mode to change the register’s contents. Issue command 9010 to enter setup mode and 9020 to exit setup mode. See “Using the Command Interface to Change Configuration Registers” on page 241 for instructions on how to use the setup-mode commands.

Table A–2: Abbreviated Register List for I/O Status

Register Number	Name	Scale Factor	Units	Range	Description
4008	Digital Input Status I/O Extender	—	—	0 – FF	Bitmap of On/Off status for the digital outputs in I/O Extender: 0 = Off, 1 = On In the following list, C1 to C8 refers to a location code of the I/O see “I/O Position Numbers” on page 240 for more information. Use the integer 35–42 that corresponds to the appropriate I/O. Bit 00 = On/Off Status of I/O Point 35 (C1) Bit 01 = On/Off Status of I/O Point 36 (C2) Bit 02 = On/Off Status of I/O Point 37 (C3) Bit 03 = On/Off Status of I/O Point 38 (C4) Bit 04 = On/Off Status of I/O Point 39 (C5) Bit 05 = On/Off Status of I/O Point 40 (C6) Bit 06 = On/Off Status of I/O Point 41 (C7) Bit 07 = On/Off Status of I/O Point 42 (C8)
4021	Present Module Type Option Card A	—	—	0, 1, 6	Indicates the type of Option Module present in Option Card A. 0 = Not Installed 1 = I/OC44 6 = Ethernet Communications Card
4022	Present Module Type Option Card B	—	—	0, 1, 6	Indicates the type of Option Module present in Option Card B. 0 = Not Installed 1 = I/OC44 6 = Ethernet Communications Card
4023	Present Module Type I/O Extender	—	—	0, 5	Indicates the presence of the I/O Extender rack. 0 = No module present 5 = I/O Extender rack present
4300–4329	I/O Point Number 1, Standard KYZ Output (KYZ)				Refer to KYZ Output template below.
4360–4389	I/O Point Number 3 (AS1)				See digital *input* template that follows for register contents.
4390–4419	I/O Point Number 4 (AS2)				
4420–4449	I/O Point Number 5 (AS3)				
4450–4479	I/O Point Number 6 (AS4)				
4480–4509	I/O Point Number 7 (AR0)				See digital *output* template that follows for register contents.
4510–4539	I/O Point Number 8 (AR1)				
4540–4569	I/O Point Number 9 (AR2)				
4570–4599	I/O Point Number 10 (AR3)				
4840–4869	I/O Point Number 19 (BS1)				See digital *input* template that follows for register contents.
4870–4899	I/O Point Number 20 (BS2)				
4900–4929	I/O Point Number 21 (BS3)				
4930–4959	I/O Point Number 22 (BS4)				
4960–4989	I/O Point Number 23 (BR0)				See digital *output* template that follows for register contents.
4990–5019	I/O Point Number 24 (BR1)				
5020–5049	I/O Point Number 25 (BR2)				
5050–5079	I/O Point Number 26 (BR3)				
5320–5349	I/O Point Number 35 (C1)				Register contents depends on I/O type. Refer to the templates that follow.
5350–5379	I/O Point Number 36 (C2)				
5380–5409	I/O Point Number 37 (C3)				
5410–5439	I/O Point Number 38 (C4)				
5440–5469	I/O Point Number 39 (C5)				
5470–5499	I/O Point Number 40 (C6)				
5500–5529	I/O Point Number 41 (C7)				
5530–5559	I/O Point Number 42 (C08)				

① These configuration registers require that you enter the setup mode to change the register’s contents. Issue command 9010 to enter setup mode and 9020 to exit setup mode. See “Using the Command Interface to Change Configuration Registers” on page 241 for instructions on how to use the setup-mode commands.

Table A–2: Abbreviated Register List for I/O Status

Register Number	Name	Scale Factor	Units	Range	Description
Digital Input Template					
Base ①	Digital Input Type	—	—	100 – 199	I/O Point Type—Digital Input First digit (1) indicates point is digital input. Second digit indicates module type: 1=DI120AC 2=DI240AC 3=DI32DC Third digit indicates input type: 1=AC 2=DC
Base + 1– Base + 8 ①	I/O Point Label	—	Alpha-numeric	—	16–character label
Base + 9 ①	Mode	—	—	0 – 3	Digital Input Operating Mode 0 = Normal (default) 1 = Demand Interval Sync Pulse 2 = Time Sync 3 = Conditional Energy Control Only one Time Sync input and one Conditional Energy Control are allowed. If you try to configure more than one of each of these modes, the lowest I/O Point Number will take precedence. The modes of the other points will be set to default. Time sync input signal must be pulse duration method (PDM) from the Modicon GPS Receiver.
Base + 10 ①	Demand Interval Sync System Assignments	—	—	0x0000 – 0x003F	Bitmap indicting Demand System(s) to which input is assigned. All demand systems assigned to input by default. Bit 00 = Power Demand Bit 01 = Current Demand Bit 02 = Voltage Demand Bit 03 = Input Metering Demand Bit 04 = Generic Demand 1 Bit 05 = Generic Demand 2 Only one Demand Sync Pulse per Demand System is allowed. If you try to configure more than one input for each system, the lowest I/O Point Number will take precedence. The corresponding bits of the other points will be set to 0.
Base + 11 ①	Digital Input Options	—	—	—	Bitmap of Digital Input Options. Default = 0 Bit 00 = Debounce time (0 = 5msec, 1 = 50msec)
Base + 14 ①	Metering Pulse Channel Assignments	—	——	0 – 3FF	Bitmap indicting metering pulse channel(s) to which input is assigned. Default = 0. Bit 00 = Channel 1 Bit 01 = Channel 2 Bit 02 = Channel 3 Bit 03 = Channel 4 Bit 04 = Channel 5 Bit 05 = Channel 6 Bit 06 = Channel 7 Bit 07 = Channel 8 Bit 08 = Channel 9 Bit 09 = Channel 10
Base + 15 ①	Metering Pulse Weight	—	1	1– 32,767	Pulse weight associated with the change of state of the input. Default = 1.
Base+ 16 ①	Metering Pulse Scale Factor	—	—	-3 – 3	Pulse weight scale factor (power of 10) to apply to metering pulse weight. Default = 0.
Base + 25 ①	Digital Input On/Off Status	—	—	0 – 1	Digital input Off/On status: 0 = Off, 1 = On
Base + 26– Base + 27 ①	Count of Transitions from OFF to ON	—	—	0 – 99,999,999	Number of times input has transitioned from OFF to ON.
Base + 28 Base + 29 ①	Duration that Digital Input has been ON	—	Second s	0 – 99,999,999	Duration that digital input has been ON.

① These configuration registers require that you enter the setup mode to change the register's contents. Issue command 9010 to enter setup mode and 9020 to exit setup mode. See "Using the Command Interface to Change Configuration Registers" on page 241 for instructions on how to use the setup-mode commands.

Table A–2: Abbreviated Register List for I/O Status

Register Number	Name	Scale Factor	Units	Range	Description
Digital Output Template					
Base ①	Digital Output Type	—	—	200 – 299	First digit (2) indicates point is digital output. Second digit indicates module type: 1 = DO120AC 2 = DO200DC 3 = DO240AC 4 = DO60DC Third digit indicates output type 1 = solid state relay 2 = electromechanical relay
Base + 1– Base + 8 ①	Digital Output Label	—	Alpha–numeric	—	16–character label
Base + 9 ①	Digital Output Operating Mode	—	—	0 – 11	0 = Normal (default) 1 = Latched 2 = Timed 3 = Absolute kWh pulse 4 = Absolute kVARh pulse 5 = kVAh pulse 6 = kWh In pulse 7 = kVARh In pulse 8 = kWh out pulse 9 = kVAR out pulse 11 = End of power demand interval
Base + 10 ①	ON Time for Timed Mode	—	Seconds	1 – 32,767	The time for the output to remain energized (only when the output is in timed mode or end of power demand interval). Default = 1.
Base + 11 ①	Pulse Weight	—	—	0 – 32,767	Specifies the kWh, kVARh and kVAh per pulse for output when in these modes. Units are in 10ths: kWh/Pulse kVARh/Pulse kVAh/Pulse
Base + 12 ①	Internal/External Control	—	—	0 – 1	Indicates active output state. 0 = Internal Control (default) 1 = External Control
Base + 13 ①	Normal/Override Control	—	—	0 – 1	Indicates active output state. 0 = Normal Control (default) 1 = Override Control
Base + 25 ①	Digital Output On/Off Status	—	—	0 – 1	On/Off status of digital output: 0 = Off, 1 = On
Base + 26 ①	Count of Off to On Transitions	—	—	0 – 99,999,999	Number of times output has transitioned from Off to On
Base + 28 ①	Duration that Digital Output has been On	—	Seconds	0 – 99,999,999	Duration that digital output has been On

① These configuration registers require that you enter the setup mode to change the register's contents. Issue command 9010 to enter setup mode and 9020 to exit setup mode. See "Using the Command Interface to Change Configuration Registers" on page 241 for instructions on how to use the setup-mode commands.

Table A–2: Abbreviated Register List for I/O Status

Register Number	Name	Scale Factor	Units	Range	Description
Analog Input Template					
Base ①	Analog Input Type	—	—	300 – 352	First digit (3) indicates point is analog input Second digit indicates the range of analog I/O values (used without units) 1 = 0 - 5 5 = 4 - 20 Third digit indicates the digital resolution of the I/O hardware. 2 = 12-Bit, unipolar
Base + 1– Base + 8 ①	Analog Input Label	—	Alpha–numeric	—	16–character label
Base + 14 ①	Lower Limit Analog Value	—	—	0 – ±32,767	Lower limit of the analog input value. Default value based on I/O Point Type.
Base + 15 ①	Upper Limit Analog Value	—	—	0 – ±32,767	Upper limit of the analog input value. Default value based on I/O Point Type.
Base + 16 ①	Lower Limit Report Range	—	—	0 – ±32,767	Value that the circuit monitor reports when the input reaches a minimum value.
Base + 17 ①	Upper Limit Report Range	—	—	0 – ±32,767	Value that the circuit monitor reports when the input reaches a maximum value.
Base + 19 ①	User Gain Adjustment	—	0.0001	8000 – 12,000	Analog input user gain adjustment in 100ths of a percent. Default = 10,000.
Base + 20 ①	User Offset Adjustment	—	—	0 – ±30000	Analog input user offset adjustment in bits of digital resolution. Default = 0.
Base + 26	Present Scaled Value	—	—	0 – ±32,767	Raw value corrected by calibration gain and offset adjustments and scaled based on range of register values.
Base + 27	Analog Input Calibration Offset	—	—	0 – ±32,767	Analog input offset adjustment in bits of digital resolution.
Base + 28	Calibration Gain (Voltage)	—	0.0001	8000 – 12,000	Analog input gain adjustment in 100ths of a percent.
Base + 29	Calibration Gain (Current)	—	0.0001	8000 – 12,000	Analog input gain adjustment

① These configuration registers require that you enter the setup mode to change the register’s contents. Issue command 9010 to enter setup mode and 9020 to exit setup mode. See “Using the Command Interface to Change Configuration Registers” on page 241 for instructions on how to use the setup-mode commands.

Table A–2: Abbreviated Register List for I/O Status

Register Number	Name	Scale Factor	Units	Range	Description
Analog Output Template					
Base ①	Analog Output Type	—	—	452	First digit (4) indicates point is analog output Second digit indicates the range of analog I/O values 5 = 4 - 20 Third digit indicates the digital resolution of the I/O hardware. 2 = 12-Bit, unipolar
Base + 1– Base + 8 ①	Analog Output Label	—	Alpha– Numeric	—	16–character label
Base + 12 ①	Analog Output Enable	—	—	0 – 1	Analog output control 0 = Enable (default) 1 = Disable
Base + 14 ①	Lower Limit Analog Value	—	—	0 – ±32,767	Lower limit of the analog output value. Default value based on I/O Point Type.
Base + 15 ①	Upper Limit Analog Value	—	—	0 – ±32,767	Upper limit of the analog output value. Default value based on I/O Point Type.
Base + 15 ①	Upper Limit Analog Value	—	—	0 – ±32,767	Upper limit of the analog input value. Default value based on I/O Point Type.
Base + 16 ①	Lower Limit Report Range	—	—	0 – ±32,767	Value that the circuit monitor reports when the input reaches a minimum value.
Base + 18 ①	Reference Register Number	—	—		Register location of value upon which to base the analog output.
Base + 19 ①	User Gain Adjustment	—	0.0001	8000 – 12,000	Analog output user gain adjustment in 100ths of a percent. Default = 10,000.
Base + 20 ①	User Offset Adjustment	—	—	0 – ±30000	Analog output user offset adjustment in bits of digital resolution. Default = 0.
Base + 26	Present Scaled Value to Analog Output	—	—	0 – ±32,767	Register value scaled based on range of register values and corrected by calibration gain and offset adjustments to produce the digital value to send to the analog output.
Base + 27	Calibration Offset	—	—	0 – ±32,767	Analog output offset adjustment in Bits of digital resolution.
Base + 28	Calibration Gain (Voltage)	—	0.0001	8000 – 12,000	Analog output gain adjustment in 100ths of a percent.

① These configuration registers require that you enter the setup mode to change the register's contents. Issue command 9010 to enter setup mode and 9020 to exit setup mode. See "Using the Command Interface to Change Configuration Registers" on page 241 for instructions on how to use the setup-mode commands.

Table A–3: Registers for Alarm Position Counters ①

Register	Alarm Position Counter Number	Register	Alarm Position Counter Number
10115	Alarm Position #001 Counter	10175	Alarm Position #061 Counter
10116	Alarm Position #002 Counter	10176	Alarm Position #062 Counter
10117	Alarm Position #003 Counter	10177	Alarm Position #063 Counter
10118	Alarm Position #004 Counter	10178	Alarm Position #064 Counter
10119	Alarm Position #005 Counter	10179	Alarm Position #065 Counter
10120	Alarm Position #006 Counter	10180	Alarm Position #066 Counter
10121	Alarm Position #007 Counter	10181	Alarm Position #067 Counter
10122	Alarm Position #008 Counter	10182	Alarm Position #068 Counter
10123	Alarm Position #009 Counter	10183	Alarm Position #069 Counter
10124	Alarm Position #010 Counter	10184	Alarm Position #070 Counter
10125	Alarm Position #011 Counter	10185	Alarm Position #071 Counter
10126	Alarm Position #012 Counter	10186	Alarm Position #072 Counter
10127	Alarm Position #013 Counter	10187	Alarm Position #073 Counter
10128	Alarm Position #014 Counter	10188	Alarm Position #074 Counter
10129	Alarm Position #015 Counter	10189	Alarm Position #075 Counter
10130	Alarm Position #016 Counter	10190	Alarm Position #076 Counter
10131	Alarm Position #017 Counter	10191	Alarm Position #077 Counter
10132	Alarm Position #018 Counter	10192	Alarm Position #078 Counter
10133	Alarm Position #019 Counter	10193	Alarm Position #079 Counter
10134	Alarm Position #020 Counter	10194	Alarm Position #080 Counter
10135	Alarm Position #021 Counter	10195	Alarm Position #081 Counter
10136	Alarm Position #022 Counter	10196	Alarm Position #082 Counter
10137	Alarm Position #023 Counter	10197	Alarm Position #083Counter
10138	Alarm Position #024 Counter	10198	Alarm Position #084 Counter
10139	Alarm Position #025 Counter	10199	Alarm Position #085 Counter
10140	Alarm Position #026 Counter	10200	Alarm Position #086 Counter
10141	Alarm Position #027 Counter	10201	Alarm Position #087 Counter
10142	Alarm Position #028 Counter	10202	Alarm Position #088 Counter
10143	Alarm Position #029 Counter	10203	Alarm Position #089 Counter
10144	Alarm Position #030 Counter	10204	Alarm Position #090 Counter
10145	Alarm Position #031 Counter	10205	Alarm Position #091 Counter
10146	Alarm Position #032 Counter	10206	Alarm Position #092 Counter
10147	Alarm Position #033 Counter	10207	Alarm Position #093 Counter
10148	Alarm Position #034 Counter	10208	Alarm Position #094 Counter
10149	Alarm Position #035 Counter	10209	Alarm Position #095 Counter
10150	Alarm Position #036 Counter	10210	Alarm Position #096 Counter
10151	Alarm Position #037 Counter	10211	Alarm Position #097 Counter
10152	Alarm Position #038 Counter	10212	Alarm Position #098 Counter
10153	Alarm Position #039 Counter	10213	Alarm Position #099 Counter
10154	Alarm Position #040 Counter	10214	Alarm Position #100 Counter
10155	Alarm Position #041 Counter	10215	Alarm Position #101 Counter
10156	Alarm Position #042 Counter	10216	Alarm Position #102 Counter
10157	Alarm Position #043 Counter	10217	Alarm Position #103 Counter
10158	Alarm Position #044 Counter	10218	Alarm Position #104 Counter
10159	Alarm Position #045 Counter	10219	Alarm Position #105 Counter
10160	Alarm Position #046 Counter	10220	Alarm Position #106 Counter
10161	Alarm Position #047 Counter	10221	Alarm Position #107 Counter
10162	Alarm Position #048 Counter	10222	Alarm Position #108 Counter
10163	Alarm Position #049 Counter	10223	Alarm Position #109 Counter
10164	Alarm Position #050 Counter	10224	Alarm Position #110 Counter
10165	Alarm Position #051 Counter	10225	Alarm Position #111 Counter
10166	Alarm Position #052 Counter	10226	Alarm Position #112 Counter
10167	Alarm Position #053 Counter	10227	Alarm Position #113 Counter
10168	Alarm Position #054 Counter	10228	Alarm Position #114 Counter
10169	Alarm Position #055 Counter	10229	Alarm Position #115 Counter
10170	Alarm Position #056 Counter	10230	Alarm Position #116 Counter
10171	Alarm Position #057 Counter	10231	Alarm Position #117 Counter
10172	Alarm Position #058 Counter	10232	Alarm Position #118 Counter

① These configuration registers require that you enter the setup mode to change the register's contents. Issue command 9010 to enter setup mode and 9020 to exit setup mode. See "Using the Command Interface to Change Configuration Registers" on page 241 for instructions on how to use the setup-mode commands.

Table A–3: Registers for Alarm Position Counters ①

Register	Alarm Position Counter Number	Register	Alarm Position Counter Number
10173	Alarm Position #059 Counter	10233	Alarm Position #119 Counter
10174	Alarm Position #060 Counter	10234	Alarm Position #120 Counter
10235	Alarm Position #121 Counter	10263	Alarm Position #149 Counter
10236	Alarm Position #122 Counter	10264	Alarm Position #150 Counter
10237	Alarm Position #123 Counter	10265	Alarm Position #151 Counter
10238	Alarm Position #124 Counter	10266	Alarm Position #152 Counter
10239	Alarm Position #125 Counter	10267	Alarm Position #153 Counter
10240	Alarm Position #126 Counter	10268	Alarm Position #154 Counter
10241	Alarm Position #127 Counter	10269	Alarm Position #155 Counter
10242	Alarm Position #128 Counter	10270	Alarm Position #156 Counter
10243	Alarm Position #129 Counter	10271	Alarm Position #157 Counter
10244	Alarm Position #130 Counter	10272	Alarm Position #158 Counter
10245	Alarm Position #131 Counter	10273	Alarm Position #159 Counter
10246	Alarm Position #132 Counter	10274	Alarm Position #160 Counter
10247	Alarm Position #133 Counter	10275	Alarm Position #161 Counter
10248	Alarm Position #134 Counter	10276	Alarm Position #162 Counter
10249	Alarm Position #135 Counter	10277	Alarm Position #163 Counter
10250	Alarm Position #136 Counter	10278	Alarm Position #164 Counter
10251	Alarm Position #137 Counter	10279	Alarm Position #165 Counter
10252	Alarm Position #138 Counter	10280	Alarm Position #166 Counter
10253	Alarm Position #139 Counter	10281	Alarm Position #167 Counter
10254	Alarm Position #140 Counter	10282	Alarm Position #168 Counter
10255	Alarm Position #141 Counter	10283	Alarm Position #169 Counter
10256	Alarm Position #142 Counter	10284	Alarm Position #170 Counter
10257	Alarm Position #143 Counter	10285	Alarm Position #171 Counter
10258	Alarm Position #144 Counter	10286	Alarm Position #172 Counter
10259	Alarm Position #145 Counter	10287	Alarm Position #173 Counter
10260	Alarm Position #146 Counter	10288	Alarm Position #174 Counter
10261	Alarm Position #147 Counter	10289	Alarm Position #175 Counter
10262	Alarm Position #148 Counter		

① These configuration registers require that you enter the setup mode to change the register’s contents. Issue command 9010 to enter setup mode and 9020 to exit setup mode. See “Using the Command Interface to Change Configuration Registers” on page 241 for instructions on how to use the setup-mode commands.

Table A–4: Spectral Components

Register Number	Description	Units	Range
Phase A Voltage			
15,500	Reserved	—	—
15.501	Reserved	—	—
15,502	H1 magnitude as a percent of H1 magnitude	% in 100ths	10000
15,503	H1 Va angle defined as 0.0 for H1 reference	In 10ths of degrees	0
15,504	H2 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,505	H2 Va angle defined as 0.0 for H2 reference	In 10ths of degrees	0
15,506	H3 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,507	H3 Va angle defined as 0.0 for H3 reference	In 10ths of degrees	0
15,508	H4 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,509	H4 Va angle defined as 0.0 for H4 reference	In 10ths of degrees	0
15,510	H5 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,511	H5 Va angle defined as 0.0 for H5 reference	In 10ths of degrees	0
15,512	H6 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,513	H6 Va angle defined as 0.0 for H6 reference	In 10ths of degrees	0
15,514	H7 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,515	H7 Va angle defined as 0.0 for H7 reference	tenths of degree	0
15,516	H8 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,517	H8 Va angle defined as 0.0 for H8 reference	In 10ths of degrees	0
15,518	H9 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,519	H9 Va angle defined as 0.0 for H9 reference	In 10ths of degrees	0
15,520	H10 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,521	H10 Va angle defined as 0.0 for H10 reference	In 10ths of degrees	0
15,522	H11 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,523	H11 Va angle defined as 0.0 for H11 reference	In 10ths of degrees	0
15,524	H12 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,525	H12 Va angle defined as 0.0 for H12 reference	In 10ths of degrees	0
15,526	H13 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,527	H13 Va angle defined as 0.0 for H13 reference	In 10ths of degrees	0
15,528	H14 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,529	H14 Va angle defined as 0.0 for H14 reference	In 10ths of degrees	0
15,530	H15 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,531	H15 Va angle defined as 0.0 for H15 reference	In 10ths of degrees	0
15,532	H16 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,533	H16 Va angle defined as 0.0 for H16 reference	In 10ths of degrees	0
15,534	H17 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,535	H17 Va angle defined as 0.0 for H17 reference	In 10ths of degrees	0
15,536	H18 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,537	H18 Va angle defined as 0.0 for H18 reference	In 10ths of degrees	0
15,538	H19 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,539	H19 Va angle defined as 0.0 for H19 reference	In 10ths of degrees	0
15,540	H20 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,541	H20 Va angle defined as 0.0 for H20 reference	In 10ths of degrees	0
15,542	H21 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,543	H21 Va angle defined as 0.0 for H21 reference	In 10ths of degrees	0
15,544	H22 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,545	H22 Va angle defined as 0.0 for H22 reference	In 10ths of degrees	0
15,546	H23 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,547	H23 Va angle defined as 0.0 for H23 reference	In 10ths of degrees	0
15,548	H24 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,549	H24 Va angle defined as 0.0 for H24 reference	In 10ths of degrees	0
15,550	H25 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,551	H25 Va angle defined as 0.0 for H25 reference	In 10ths of degrees	0
15,552	H26 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,553	H26 Va angle defined as 0.0 for H26 reference	In 10ths of degrees	0
15,554	H27 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,555	H27 Va angle defined as 0.0 for H27 reference	In 10ths of degrees	0
15,556	H28 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,557	H28 Va angle defined as 0.0 for H28 reference	In 10ths of degrees	0

Table A–4: Spectral Components

Register Number	Description	Units	Range
15,558	H29 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,559	H29 Va angle defined as 0.0 for H29 reference	In 10ths of degrees	0
15,560	H30 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,561	H30 Va angle defined as 0.0 for H30 reference	In 10ths of degrees	0
15,562	H31 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,563	H31 Va angle defined as 0.0 for H31 reference	In 10ths of degrees	0
15,564	H32 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,565	H32 Va angle defined as 0.0 for H32 reference	In 10ths of degrees	0
15,566	H33 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,567	H33 Va angle defined as 0.0 for H33 reference	In 10ths of degrees	0
15,568	H34 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,569	H34 Va angle defined as 0.0 for H34 reference	In 10ths of degrees	0
15,570	H35 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,571	H35 Va angle defined as 0.0 for H35 reference	In 10ths of degrees	0
15,572	H36 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,573	H36 Va angle defined as 0.0 for H36 reference	In 10ths of degrees	0
15,574	H37 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,575	H37 Va angle defined as 0.0 for H37 reference	In 10ths of degrees	0
15,576	H38 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,577	H38 Va angle defined as 0.0 for H38 reference	tenths of degree	0
15,578	H39 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,579	H39 Va angle defined as 0.0 for H39 reference	In 10ths of degrees	0
15,580	H40 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,581	H40 Va angle defined as 0.0 for H40 reference	In 10ths of degrees	0
15,582	H41 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,583	H41 Va angle defined as 0.0 for H41 reference	In 10ths of degrees	0
15,584	H42 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,585	H42 Va angle defined as 0.0 for H42 reference	In 10ths of degrees	0
15,586	H43 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,587	H43 Va angle defined as 0.0 for H43 reference	In 10ths of degrees	0
15,588	H44 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,589	H44 Va angle defined as 0.0 for H44 reference	In 10ths of degrees	0
15,590	H45 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,591	H45 Va angle defined as 0.0 for H45 reference	In 10ths of degrees	0
15,592	H46 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,593	H46 Va angle defined as 0.0 for H46 reference	In 10ths of degrees	0
15,594	H47 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,595	H47 Va angle defined as 0.0 for H47 reference	In 10ths of degrees	0
15,596	H48 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,597	H48 Va angle defined as 0.0 for H48 reference	In 10ths of degrees	0
15,598	H49 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,599	H49 Va angle defined as 0.0 for H49 reference	In 10ths of degrees	0
15,600	H50 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,601	H50 Va angle defined as 0.0 for H50 reference	In 10ths of degrees	0
15,602	H51 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,603	H51 Va angle defined as 0.0 for H20 reference	In 10ths of degrees	0
15,604	H52 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,605	H52 Va angle defined as 0.0 for H52 reference	In 10ths of degrees	0
15,606	H53 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,607	H53 Va angle defined as 0.0 for H53 reference	In 10ths of degrees	0
15,608	H54 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,609	H54 Va angle defined as 0.0 for H54 reference	In 10ths of degrees	0
15,610	H55 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,611	H55 Va angle defined as 0.0 for H55 reference	In 10ths of degrees	0
15,612	H56 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,613	H56 Va angle defined as 0.0 for H56 reference	In 10ths of degrees	0
15,614	H57 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,615	H57 Va angle defined as 0.0 for H57 reference	In 10ths of degrees	0
15,616	H58 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,617	H58 Va angle defined as 0.0 for H58 reference	In 10ths of degrees	0
15,618	H59 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767

Table A–4: Spectral Components

Register Number	Description	Units	Range
15,619	H59 Va angle defined as 0.0 for H59 reference	In 10ths of degrees	0
15,620	H60 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,621	H60 Va angle defined as 0.0 for H60 reference	In 10ths of degrees	0
15,622	H61 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,623	H61 Va angle defined as 0.0 for H61 reference	In 10ths of degrees	0
15,624	H62 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,625	H62 Va angle defined as 0.0 for H62 reference	In 10ths of degrees	0
15,626	H63 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15.627	H63 Va angle defined as 0.0 for H63 reference	In 10ths of degrees	0
Phase A Current			
15,628	Reserved		
15.629	Reserved		
15,630	H1 magnitude as a percent of H1 magnitude	% in 100ths	10000
15,631	H1 angle with reference to H1 Va angle	In 10ths of degrees	0 to 3599
15,632	H2 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,633	H2 angle with reference to H2 Va angle	In 10ths of degrees	0 to 3599
15,634	H3 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,635	H3 angle with reference to H3 Va angle	In 10ths of degrees	0 to 3599
15,636	H4 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,637	H4 angle with reference to H4 Va angle	In 10ths of degrees	0 to 3599
15,638	H5 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,639	H5 angle with reference to H5 Va angle	In 10ths of degrees	0 to 3599
15,640	H6 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,641	H6 angle with reference to H6 Va angle	In 10ths of degrees	0 to 3599
15,642	H7 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,643	H7 angle with reference to H7 Va angle	In 10ths of degrees	0 to 3599
15,644	H8 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,645	H8 angle with reference to H8 Va angle	In 10ths of degrees	0 to 3599
15,646	H9 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,647	H9 angle with reference to H9 Va angle	In 10ths of degrees	0 to 3599
15,648	H10 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,649	H10 angle with reference to H10 Va angle	In 10ths of degrees	0 to 3599
15,650	H11 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,651	H11 angle with reference to H11 Va angle	In 10ths of degrees	0 to 3599
15,652	H12 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,653	H12 angle with reference to H12 Va angle	In 10ths of degrees	0 to 3599
15,654	H13 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,655	H13 angle with reference to H13 Va angle	In 10ths of degrees	0 to 3599
15,656	H14 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,657	H14 angle with reference to H14 Va angle	In 10ths of degrees	0 to 3599
15,658	H15 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,659	H15 angle with reference to H15 Va angle	In 10ths of degrees	0 to 3599
15,660	H16 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,661	H16 angle with reference to H16 Va angle	In 10ths of degrees	0 to 3599
15,662	H17 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,663	H17 angle with reference to H17 Va angle	In 10ths of degrees	0 to 3599
15,664	H18 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,665	H18 angle with reference to H18 Va angle	In 10ths of degrees	0 to 3599
15,666	H19 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,667	H19 angle with reference to H19 Va angle	In 10ths of degrees	0 to 3599
15,668	H20 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,669	H20 angle with reference to H20 Va angle	In 10ths of degrees	0 to 3599
15,670	H21 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,671	H21 angle with reference to H21 Va angle	In 10ths of degrees	0 to 3599
15,672	H22 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,673	H22 angle with reference to H22 Va angle	In 10ths of degrees	0 to 3599
15,674	H23 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,675	H23 angle with reference to H23 Va angle	In 10ths of degrees	0 to 3599
15,676	H24 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,677	H24 angle with reference to H24 Va angle	In 10ths of degrees	0 to 3599

Table A–4: Spectral Components

Register Number	Description	Units	Range
15,678	H25 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,679	H25 angle with reference to H25 Va angle	In 10ths of degrees	0 to 3599
15,680	H26 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,681	H26 angle with reference to H26 Va angle	In 10ths of degrees	0 to 3599
15,682	H27 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,683	H27 angle with reference to H27 Va angle	In 10ths of degrees	0 to 3599
15,684	H28 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,685	H28 angle with reference to H28 Va angle	In 10ths of degrees	0 to 3599
15,686	H29 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,687	H29 angle with reference to H29 Va angle	In 10ths of degrees	0 to 3599
15,688	H30 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,689	H30 angle with reference to H30 Va angle	In 10ths of degrees	0 to 3599
15,690	H31 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,691	H31 angle with reference to H31 Va angle	In 10ths of degrees	0 to 3599
15,692	H32 magnitude as a percent of H1 magnitude	% in 100ths	10000
15,693	H32 angle with reference to H32 Va angle	In 10ths of degrees	0 to 3599
15,694	H33 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,695	H33 angle with reference to H33 Va angle	In 10ths of degrees	0 to 3599
15,696	H34 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,697	H34 angle with reference to H34 Va angle	In 10ths of degrees	0 to 3599
15,698	H35 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,699	H35 angle with reference to H35 Va angle	In 10ths of degrees	0 to 3599
15,700	H36 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,701	H36 angle with reference to H36 Va angle	In 10ths of degrees	0 to 3599
15,702	H37 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,703	H37 angle with reference to H37 Va angle	In 10ths of degrees	0 to 3599
15,704	H38 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,705	H38 angle with reference to H38 Va angle	In 10ths of degrees	0 to 3599
15,706	H39 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,707	H39 angle with reference to H39 Va angle	In 10ths of degrees	0 to 3599
15,708	H40 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,709	H40 angle with reference to H40 Va angle	In 10ths of degrees	0 to 3599
15,710	H41 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,711	H41 angle with reference to H41 Va angle	In 10ths of degrees	0 to 3599
15,712	H42 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,713	H42 angle with reference to H42 Va angle	In 10ths of degrees	0 to 3599
15,714	H43 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,715	H43 angle with reference to H43 Va angle	In 10ths of degrees	0 to 3599
15,716	H44 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,717	H44 angle with reference to H44 Va angle	In 10ths of degrees	0 to 3599
15,718	H45 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,719	H45 angle with reference to H45 Va angle	In 10ths of degrees	0 to 3599
15,720	H46 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,721	H46 angle with reference to H46 Va angle	In 10ths of degrees	0 to 3599
15,722	H47 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,723	H47 angle with reference to H47 Va angle	In 10ths of degrees	0 to 3599
15,724	H48 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,725	H48 angle with reference to H48 Va angle	In 10ths of degrees	0 to 3599
15,726	H49 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,727	H49 angle with reference to H49 Va angle	In 10ths of degrees	0 to 3599
15,728	H50 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,729	H50 angle with reference to H50 Va angle	In 10ths of degrees	0 to 3599
15,730	H51 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,731	H51 angle with reference to H51 Va angle	In 10ths of degrees	0 to 3599
15,732	H52 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,733	H52 angle with reference to H52 Va angle	In 10ths of degrees	0 to 3599
15,734	H53 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,735	H53 angle with reference to H53 Va angle	In 10ths of degrees	0 to 3599
15,736	H54 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,737	H54 angle with reference to H54 Va angle	In 10ths of degrees	0 to 3599
15,738	H55 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767

Table A–4: Spectral Components

Register Number	Description	Units	Range
15,739	H55 angle with reference to H55 Va angle	In 10ths of degrees	0 to 3599
15,740	H56 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,741	H56 angle with reference to H56 Va angle	In 10ths of degrees	0 to 3599
15,742	H57 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,743	H57 angle with reference to H57 Va angle	In 10ths of degrees	0 to 3599
15,744	H58 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,745	H58 angle with reference to H58 Va angle	In 10ths of degrees	0 to 3599
15,746	H59 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,747	H59 angle with reference to H59 Va angle	In 10ths of degrees	0 to 3599
15,748	H60 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,749	H60 angle with reference to H60 Va angle	In 10ths of degrees	0 to 3599
15,750	H61 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,751	H61 angle with reference to H61 Va angle	In 10ths of degrees	0 to 3599
15,752	H62 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,753	H62 angle with reference to H62 Va angle	In 10ths of degrees	0 to 3599
15,754	H63 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,755	H63 angle with reference to H63 Va angle	In 10ths of degrees	0 to 3599
Phase B Voltage			
15,756	Reserved		
15.757	Reserved		
15,758	H1 magnitude as a percent of H1 magnitude	% in 100ths	10000
15,759	H1 angle with reference to H1 Va angle	In 10ths of degrees	0 to 3599
15,760	H2 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,761	H2 angle with reference to H2 Va angle	In 10ths of degrees	0 to 3599
15,762	H3 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,763	H3 angle with reference to H3 Va angle	In 10ths of degrees	0 to 3599
15,764	H4 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,765	H4 angle with reference to H4 Va angle	In 10ths of degrees	0 to 3599
15,766	H5 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,767	H5 angle with reference to H5 Va angle	In 10ths of degrees	0 to 3599
15,768	H6 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,769	H6 angle with reference to H6 Va angle	In 10ths of degrees	0 to 3599
15,770	H7 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,771	H7 angle with reference to H7 Va angle	tenths of degree	0 to 3599
15,772	H8 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,773	H8 angle with reference to H8 Va angle	In 10ths of degrees	0 to 3599
15,774	H9 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,775	H9 angle with reference to H9 Va angle	In 10ths of degrees	0 to 3599
15,776	H10 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,777	H10 angle with reference to H10 Va angle	In 10ths of degrees	0 to 3599
15,778	H11 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,779	H11 angle with reference to H11 Va angle	In 10ths of degrees	0 to 3599
15,780	H12 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,781	H12 angle with reference to H12 Va angle	In 10ths of degrees	0 to 3599
15,782	H13 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,783	H13 angle with reference to H13 Va angle	In 10ths of degrees	0 to 3599
15,784	H14 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,785	H14 angle with reference to H14 Va angle	In 10ths of degrees	0 to 3599
15,786	H15 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,787	H15 angle with reference to H15 Va angle	In 10ths of degrees	0 to 3599
15,788	H16 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,789	H16 angle with reference to H16 Va angle	In 10ths of degrees	0 to 3599
15,790	H17 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,791	H17 angle with reference to H17 Va angle	In 10ths of degrees	0 to 3599
15,792	H18 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,793	H18 angle with reference to H18 Va angle	In 10ths of degrees	0 to 3599
15,794	H19 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,795	H19 angle with reference to H19 Va angle	In 10ths of degrees	0 to 3599
15,796	H20 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,797	H20 angle with reference to H20 Va angle	In 10ths of degrees	0 to 3599

Table A–4: Spectral Components

Register Number	Description	Units	Range
15,798	H21 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,799	H21 angle with reference to H21 Va angle	In 10ths of degrees	0 to 3599
15,800	H22 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,801	H22 angle with reference to H22 Va angle	In 10ths of degrees	0 to 3599
15,802	H23 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,803	H23 angle with reference to H23 Va angle	In 10ths of degrees	0 to 3599
15,804	H24 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,805	H24 angle with reference to H24 Va angle	In 10ths of degrees	0 to 3599
15,806	H25 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,807	H25 angle with reference to H25 Va angle	In 10ths of degrees	0 to 3599
15,808	H26 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,809	H26 angle with reference to H26 Va angle	In 10ths of degrees	0 to 3599
15,810	H27 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,811	H27 angle with reference to H27 Va angle	In 10ths of degrees	0 to 3599
15,812	H28 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,813	H28 angle with reference to H28 Va angle	In 10ths of degrees	0 to 3599
15,814	H29 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,815	H29 angle with reference to H29 Va angle	In 10ths of degrees	0 to 3599
15,816	H30 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,817	H30 angle with reference to H30 Va angle	In 10ths of degrees	0 to 3599
15,818	H31 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,819	H31 angle with reference to H31 Va angle	In 10ths of degrees	0 to 3599
15,820	H32 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,821	H32 angle with reference to H32 Va angle	In 10ths of degrees	0 to 3599
15,822	H33 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,823	H33 angle with reference to H33 Va angle	In 10ths of degrees	0 to 3599
15,824	H34 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,825	H34 angle with reference to H34 Va angle	In 10ths of degrees	0 to 3599
15,826	H35 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,827	H35 angle with reference to H35 Va angle	In 10ths of degrees	0 to 3599
15,828	H36 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,829	H36 angle with reference to H36 Va angle	In 10ths of degrees	0 to 3599
15,830	H37 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,831	H37 angle with reference to H37 Va angle	In 10ths of degrees	0 to 3599
15,832	H38 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,833	H38 angle with reference to H38 Va angle	In 10ths of degrees	0 to 3599
15,834	H39 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,835	H39 angle with reference to H39 Va angle	In 10ths of degrees	0 to 3599
15,836	H40 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,837	H40 angle with reference to H40 Va angle	In 10ths of degrees	0 to 3599
15,838	H41 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,839	H41 angle with reference to H41 Va angle	In 10ths of degrees	0 to 3599
15,840	H42 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,841	H42 angle with reference to H42 Va angle	In 10ths of degrees	0 to 3599
15,842	H43 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,843	H43 angle with reference to H43 Va angle	In 10ths of degrees	0 to 3599
15,844	H44 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,845	H44 angle with reference to H44 Va angle	In 10ths of degrees	0 to 3599
15,846	H45 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,847	H45 angle with reference to H45 Va angle	In 10ths of degrees	0 to 3599
15,848	H46 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,849	H46 angle with reference to H46 Va angle	In 10ths of degrees	0 to 3599
15,850	H47 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,851	H47 angle with reference to H47 Va angle	In 10ths of degrees	0 to 3599
15,852	H48 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,853	H48 angle with reference to H48 Va angle	In 10ths of degrees	0 to 3599
15,854	H49 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,855	H49 angle with reference to H49 Va angle	In 10ths of degrees	0 to 3599
15,856	H50 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,857	H50 angle with reference to H50 Va angle	In 10ths of degrees	0 to 3599
15,858	H51 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767

Table A–4: Spectral Components

Register Number	Description	Units	Range
15,859	H51 angle with reference to H51 Va angle	In 10ths of degrees	0 to 3599
15,860	H52 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,861	H52 angle with reference to H52 Va angle	In 10ths of degrees	0 to 3599
15,862	H53 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,863	H53 angle with reference to H53 Va angle	In 10ths of degrees	0 to 3599
15,864	H54 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,865	H54 angle with reference to H54 Va angle	In 10ths of degrees	0 to 3599
15,866	H55 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,867	H55 angle with reference to H55 Va angle	In 10ths of degrees	0 to 3599
15,868	H56 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,869	H56 angle with reference to H56 Va angle	In 10ths of degrees	0 to 3599
15,870	H57 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,871	H57 angle with reference to H57 Va angle	In 10ths of degrees	0 to 3599
15,872	H58 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,873	H58 angle with reference to H58 Va angle	In 10ths of degrees	0 to 3599
15,874	H59 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,875	H59 angle with reference to H59 Va angle	In 10ths of degrees	0 to 3599
15,876	H60 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,877	H60 angle with reference to H60 Va angle	In 10ths of degrees	0 to 3599
15,878	H61 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,879	H61 angle with reference to H61 Va angle	In 10ths of degrees	0 to 3599
15,880	H62 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,881	H62 angle with reference to H62 Va angle	In 10ths of degrees	0 to 3599
15,882	H63 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,883	H63 angle with reference to H63 Va angle	In 10ths of degrees	0 to 3599
Phase B Current			
15,884	Reserved		
15,885	Reserved		
15,886	H1 magnitude as a percent of H1 magnitude	% in 100ths	10000
15,887	H1 angle with reference to H1 Va angle	In 10ths of degrees	0 to 3599
15,888	H2 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,889	H2 angle with reference to H2 Va angle	In 10ths of degrees	0 to 3599
15,890	H3 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,891	H3 angle with reference to H3 Va angle	In 10ths of degrees	0 to 3599
15,892	H4 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,893	H4 angle with reference to H4 Va angle	In 10ths of degrees	0 to 3599
15,894	H5 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,895	H5 angle with reference to H5 Va angle	In 10ths of degrees	0 to 3599
15,896	H6 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,897	H6 angle with reference to H6 Va angle	In 10ths of degrees	0 to 3599
15,898	H7 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,899	H7 angle with reference to H7 Va angle	tenths of degree	0 to 3599
15,900	H8 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,901	H8 angle with reference to H8 Va angle	In 10ths of degrees	0 to 3599
15,902	H9 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,903	H9 angle with reference to H9 Va angle	In 10ths of degrees	0 to 3599
15,904	H10 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,905	H10 angle with reference to H10 Va angle	In 10ths of degrees	0 to 3599
15,906	H11 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,907	H11 angle with reference to H11 Va angle	In 10ths of degrees	0 to 3599
15,908	H12 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,909	H12 angle with reference to H12 Va angle	In 10ths of degrees	0 to 3599
15,910	H13 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,911	H13 angle with reference to H13 Va angle	In 10ths of degrees	0 to 3599
15,912	H14 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,913	H14 angle with reference to H14 Va angle	In 10ths of degrees	0 to 3599
15,914	H15 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,915	H15 angle with reference to H15 Va angle	In 10ths of degrees	0 to 3599
15,916	H16 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,917	H16 angle with reference to H16 Va angle	In 10ths of degrees	0 to 3599

Table A–4: Spectral Components

Register Number	Description	Units	Range
15,918	H17 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,919	H17 angle with reference to H17 Va angle	In 10ths of degrees	0 to 3599
15,920	H18 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,921	H18 angle with reference to H18 Va angle	In 10ths of degrees	0 to 3599
15,922	H19 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,923	H19 angle with reference to H19 Va angle	In 10ths of degrees	0 to 3599
15,924	H20 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,925	H20 angle with reference to H20 Va angle	In 10ths of degrees	0
15,926	H21 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,927	H21 angle with reference to H21 Va angle	In 10ths of degrees	0 to 3599
15,928	H22 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,929	H22 angle with reference to H22 Va angle	In 10ths of degrees	0 to 3599
15,930	H23 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,931	H23 angle with reference to H23 Va angle	In 10ths of degrees	0 to 3599
15,932	H24 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,933	H24 angle with reference to H24 Va angle	In 10ths of degrees	0 to 3599
15,934	H25 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,935	H25 angle with reference to H25 Va angle	In 10ths of degrees	0 to 3599
15,936	H26 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,937	H26 angle with reference to H26 Va angle	In 10ths of degrees	0 to 3599
15,938	H27 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,939	H27 angle with reference to H27 Va angle	In 10ths of degrees	0 to 3599
15,940	H28 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,941	H28 angle with reference to H28 Va angle	In 10ths of degrees	0 to 3599
15,942	H29 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,943	H29 angle with reference to H29 Va angle	In 10ths of degrees	0 to 3599
15,944	H30 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,945	H30 angle with reference to H30 Va angle	In 10ths of degrees	0 to 3599
15,946	H31 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,947	H31 angle with reference to H31 Va angle	In 10ths of degrees	0 to 3599
15,948	H32 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,949	H32 angle with reference to H32 Va angle	In 10ths of degrees	0 to 3599
15,950	H33 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,951	H33 angle with reference to H33 Va angle	In 10ths of degrees	0 to 3599
15,952	H34 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,953	H34 angle with reference to H34 Va angle	In 10ths of degrees	0 to 3599
15,954	H35 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,955	H35 angle with reference to H35 Va angle	In 10ths of degrees	0 to 3599
15,956	H36 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,957	H36 angle with reference to H36 Va angle	In 10ths of degrees	0 to 3599
15,958	H37 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,959	H37 angle with reference to H37 Va angle	In 10ths of degrees	0 to 3599
15,960	H38 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,961	H38 angle with reference to H38 Va angle	In 10ths of degrees	0 to 3599
15,962	H39 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,963	H39 angle with reference to H39 Va angle	In 10ths of degrees	0 to 3599
15,964	H40 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,965	H40 angle with reference to H40 Va angle	In 10ths of degrees	0 to 3599
15,966	H41 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,967	H41 angle with reference to H41 Va angle	In 10ths of degrees	0 to 3599
15,968	H42 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,969	H42 angle with reference to H42 Va angle	In 10ths of degrees	0 to 3599
15,970	H43 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,971	H43 angle with reference to H43 Va angle	In 10ths of degrees	0 to 3599
15,972	H44 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,973	H44 angle with reference to H44 Va angle	In 10ths of degrees	0 to 3599
15,974	H45 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,975	H45 angle with reference to H45 Va angle	In 10ths of degrees	0 to 3599
15,976	H46 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,977	H46 angle with reference to H46 Va angle	In 10ths of degrees	0 to 3599
15,978	H47 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767

Table A–4: Spectral Components

Register Number	Description	Units	Range
15,979	H47 angle with reference to H47 Va angle	In 10ths of degrees	0 to 3599
15,980	H48 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,981	H48 angle with reference to H48 Va angle	In 10ths of degrees	0 to 3599
15,982	H49 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,983	H49 angle with reference to H49 Va angle	In 10ths of degrees	0 to 3599
15,984	H50 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,985	H50 angle with reference to H50 Va angle	In 10ths of degrees	0 to 3599
15,986	H51 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,987	H51 angle with reference to H51 Va angle	In 10ths of degrees	0 to 3599
15,988	H52 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,989	H52 angle with reference to H52 Va angle	In 10ths of degrees	0 to 3599
15,990	H53 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,991	H53 angle with reference to H53 Va angle	In 10ths of degrees	0 to 3599
15,992	H54 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,993	H54 angle with reference to H54 Va angle	In 10ths of degrees	0 to 3599
15,994	H55 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,995	H55 angle with reference to H55 Va angle	In 10ths of degrees	0 to 3599
15,996	H56 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,997	H56 angle with reference to H56 Va angle	In 10ths of degrees	0 to 3599
15,998	H57 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
15,999	H57 angle with reference to H57 Va angle	In 10ths of degrees	0 to 3599
16,000	H58 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,001	H58 angle with reference to H58 Va angle	In 10ths of degrees	0 to 3599
16,002	H59 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,003	H59 angle with reference to H59 Va angle	In 10ths of degrees	0 to 3599
16,004	H60 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,005	H60 angle with reference to H60 Va angle	In 10ths of degrees	0 to 3599
16,006	H61 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,007	H61 angle with reference to H61 Va angle	In 10ths of degrees	0 to 3599
16,008	H62 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,009	H62 angle with reference to H62 Va angle	In 10ths of degrees	0 to 3599
16,010	H63 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,011	H63 angle with reference to H63 Va angle	In 10ths of degrees	0 to 3599
Phase C Voltage			
16,012	Reserved		
16,013	Reserved		
16,014	H1 magnitude as a percent of H1 magnitude	% in 100ths	10000
16,015	H1 angle with reference to H1 Va angle	In 10ths of degrees	0 to 3599
16,016	H2 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,017	H2 angle with reference to H2 Va angle	In 10ths of degrees	0 to 3599
16,018	H3 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,019	H3 angle with reference to H3 Va angle	In 10ths of degrees	0 to 3599
16,020	H4 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,021	H4 angle with reference to H4 Va angle	In 10ths of degrees	0 to 3599
16,022	H5 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,023	H5 angle with reference to H5 Va angle	In 10ths of degrees	0 to 3599
16,024	H6 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,025	H6 angle with reference to H6 Va angle	In 10ths of degrees	0 to 3599
16,026	H7 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,027	H7 angle with reference to H7 Va angle	tenths of degree	0 to 3599
16,028	H8 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,029	H8 angle with reference to H8 Va angle	In 10ths of degrees	0 to 3599
16,030	H9 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,031	H9 angle with reference to H9 Va angle	In 10ths of degrees	0 to 3599
16,032	H10 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,033	H10 angle with reference to H10 Va angle	In 10ths of degrees	0 to 3599
16,034	H11 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,035	H11 angle with reference to H11 Va angle	In 10ths of degrees	0 to 3599
16,036	H12 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,037	H12 angle with reference to H12 Va angle	In 10ths of degrees	0 to 3599

Table A–4: Spectral Components

Register Number	Description	Units	Range
16,038	H13 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,039	H13 angle with reference to H13 Va angle	In 10ths of degrees	0 to 3599
16,040	H14 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,041	H14 angle with reference to H14 Va angle	In 10ths of degrees	0 to 3599
16,042	H15 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,043	H15 angle with reference to H15 Va angle	In 10ths of degrees	0 to 3599
16,044	H16 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,045	H16 angle with reference to H16 Va angle	In 10ths of degrees	0 to 3599
16,046	H17 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,047	H17 angle with reference to H17 Va angle	In 10ths of degrees	0 to 3599
16,048	H18 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,049	H18 angle with reference to H18 Va angle	In 10ths of degrees	0 to 3599
16,050	H19 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,051	H19 angle with reference to H19 Va angle	In 10ths of degrees	0 to 3599
16,052	H20 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,053	H20 angle with reference to H20 Va angle	In 10ths of degrees	0 to 3599
16,054	H21 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,055	H21 angle with reference to H21 Va angle	In 10ths of degrees	0 to 3599
16,056	H22 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,057	H22 angle with reference to H22 Va angle	In 10ths of degrees	0 to 3599
16,058	H23 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,059	H23 angle with reference to H23 Va angle	In 10ths of degrees	0 to 3599
16,060	H24 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,061	H24 angle with reference to H24 Va angle	In 10ths of degrees	0 to 3599
16,062	H25 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,063	H25 angle with reference to H25 Va angle	In 10ths of degrees	0 to 3599
16,064	H26 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,065	H26 angle with reference to H26 Va angle	In 10ths of degrees	0 to 3599
16,066	H27 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,067	H27 angle with reference to H27 Va angle	In 10ths of degrees	0 to 3599
16,068	H28 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,069	H28 angle with reference to H28 Va angle	In 10ths of degrees	0 to 3599
16,070	H29 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,071	H29 angle with reference to H29 Va angle	In 10ths of degrees	0 to 3599
16,072	H30 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,073	H30 angle with reference to H30 Va angle	In 10ths of degrees	0 to 3599
16,074	H31 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,075	H31 angle with reference to H31 Va angle	In 10ths of degrees	0 to 3599
16,076	H32 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,077	H32 angle with reference to H32 Va angle	In 10ths of degrees	0 to 3599
16,078	H33 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,079	H33 angle with reference to H33 Va angle	In 10ths of degrees	0 to 3599
16,080	H34 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,081	H34 angle with reference to H34 Va angle	In 10ths of degrees	0 to 3599
16,082	H35 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,083	H35 angle with reference to H35 Va angle	In 10ths of degrees	0 to 3599
16,084	H36 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,085	H36 angle with reference to H36 Va angle	In 10ths of degrees	0 to 3599
16,086	H37 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,087	H37 angle with reference to H37 Va angle	In 10ths of degrees	0 to 3599
16,088	H38 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,089	H38 angle with reference to H38 Va angle	In 10ths of degrees	0 to 3599
16,090	H39 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,091	H39 angle with reference to H39 Va angle	In 10ths of degrees	0 to 3599
16,092	H40 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,093	H40 angle with reference to H40 Va angle	In 10ths of degrees	0 to 3599
16,094	H41 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,095	H41 angle with reference to H41 Va angle	In 10ths of degrees	0 to 3599

Table A–4: Spectral Components

Register Number	Description	Units	Range
16,096	H42 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,097	H42 angle with reference to H42 Va angle	In 10ths of degrees	0 to 3599
16,098	H43 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,099	H43 angle with reference to H43 Va angle	In 10ths of degrees	0 to 3599
16,100	H44 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,101	H44 angle with reference to H44 Va angle	In 10ths of degrees	0 to 3599
16,102	H45 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,103	H45 angle with reference to H45 Va angle	In 10ths of degrees	0 to 3599
16,104	H46 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,105	H46 angle with reference to H46 Va angle	In 10ths of degrees	0 to 3599
16,106	H47 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,107	H47 angle with reference to H47 Va angle	In 10ths of degrees	0 to 3599
16,108	H48 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,109	H48 angle with reference to H48 Va angle	In 10ths of degrees	0 to 3599
16,110	H49 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,111	H49 angle with reference to H49 Va angle	In 10ths of degrees	0 to 3599
16,112	H50 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,113	H50 angle with reference to H50 Va angle	In 10ths of degrees	0 to 3599
16,114	H51 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,115	H51 angle with reference to H51 Va angle	In 10ths of degrees	0 to 3599
16,116	H52 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,117	H52 angle with reference to H52 Va angle	In 10ths of degrees	0 to 3599
16,118	H53 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,119	H53 angle with reference to H53 Va angle	In 10ths of degrees	0 to 3599
16,120	H54 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,121	H54 angle with reference to H54 Va angle	In 10ths of degrees	0 to 3599
16,122	H55 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,123	H55 angle with reference to H55 Va angle	In 10ths of degrees	0 to 3599
16,124	H56 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,125	H56 angle with reference to H56 Va angle	In 10ths of degrees	0 to 3599
16,126	H57 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,127	H57 angle with reference to H57 Va angle	In 10ths of degrees	0 to 3599
16,128	H58 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,129	H58 angle with reference to H58 Va angle	In 10ths of degrees	0 to 3599
16,130	H59 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,131	H59 angle with reference to H59 Va angle	In 10ths of degrees	0 to 3599
16,132	H60 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,133	H60 angle with reference to H60 Va angle	In 10ths of degrees	0 to 3599
16,134	H61 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,135	H61 angle with reference to H61 Va angle	In 10ths of degrees	0 to 3599
16,136	H62 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,137	H62 angle with reference to H62 Va angle	In 10ths of degrees	0 to 3599
16,138	H63 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,139	H63 angle with reference to H63 Va angle	In 10ths of degrees	0 to 3599
Phase C Current			
16.140	Reserved		
16,141	Reserved		
16,142	H1 magnitude as a percent of H1 magnitude	% in 100ths	10000
16,143	H1 angle with reference to H1 Va angle	In 10ths of degrees	0 to 3599
16,144	H2 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,145	H2 angle with reference to H2 Va angle	In 10ths of degrees	0 to 3599
16,146	H3 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,147	H3 angle with reference to H3 Va angle	In 10ths of degrees	0 to 3599
16,148	H4 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,149	H4 angle with reference to H4 Va angle	In 10ths of degrees	0 to 3599
16,150	H5 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,151	H5 angle with reference to H5 Va angle	In 10ths of degrees	0 to 3599
16,152	H6 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,153	H6 angle with reference to H6 Va angle	In 10ths of degrees	0 to 3599
16,154	H7 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,155	H7 angle with reference to H7 Va angle	tenths of degree	0 to 3599

Table A–4: Spectral Components

Register Number	Description	Units	Range
16,156	H8 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,157	H8 angle with reference to H8 Va angle	In 10ths of degrees	0 to 3599
16,158	H9 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,159	H9 angle with reference to H9 Va angle	In 10ths of degrees	0 to 3599
16,160	H10 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,161	H10 angle with reference to H10 Va angle	In 10ths of degrees	0 to 3599
16,162	H11 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,163	H11 angle with reference to H11 Va angle	In 10ths of degrees	0 to 3599
16,164	H12 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,165	H12 angle with reference to H12 Va angle	In 10ths of degrees	0 to 3599
16,166	H13 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,167	H13 angle with reference to H13 Va angle	In 10ths of degrees	0 to 3599
16,168	H14 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,169	H14 angle with reference to H14 Va angle	In 10ths of degrees	0 to 3599
16,170	H15 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,171	H15 angle with reference to H15 Va angle	In 10ths of degrees	0 to 3599
16,172	H16 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,173	H16 angle with reference to H16 Va angle	In 10ths of degrees	0 to 3599
16,174	H17 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,175	H17 angle with reference to H17 Va angle	In 10ths of degrees	0 to 3599
16,176	H18 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,177	H18 angle with reference to H18 Va angle	In 10ths of degrees	0 to 3599
16,178	H19 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,179	H19 angle with reference to H19 Va angle	In 10ths of degrees	0 to 3599
16,180	H20 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,181	H20 angle with reference to H20 Va angle	In 10ths of degrees	0 to 3599
16,182	H21 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,183	H21 angle with reference to H21 Va angle	In 10ths of degrees	0 to 3599
16,184	H22 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,185	H22 angle with reference to H22 Va angle	In 10ths of degrees	0 to 3599
16,186	H23 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,187	H23 angle with reference to H23 Va angle	In 10ths of degrees	0 to 3599
16,188	H24 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,189	H24 angle with reference to H24 Va angle	In 10ths of degrees	0 to 3599
16,190	H25 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,191	H25 angle with reference to H25 Va angle	In 10ths of degrees	0 to 3599
16,192	H26 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,193	H26 angle with reference to H26 Va angle	In 10ths of degrees	0 to 3599
16,194	H27 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,195	H27 angle with reference to H27 Va angle	In 10ths of degrees	0 to 3599
16,196	H28 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,197	H28 angle with reference to H28 Va angle	In 10ths of degrees	0 to 3599
16,198	H29 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,199	H29 angle with reference to H29 Va angle	In 10ths of degrees	0 to 3599
16,200	H30 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,201	H30 angle with reference to H30 Va angle	In 10ths of degrees	0 to 3599
16,202	H31 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,203	H31 angle with reference to H31 Va angle	In 10ths of degrees	0 to 3599
16,204	H32 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,205	H32 angle with reference to H32 Va angle	In 10ths of degrees	0 to 3599
16,206	H33 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,207	H33 angle with reference to H33 Va angle	In 10ths of degrees	0 to 3599
16,208	H34 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,209	H34 angle with reference to H34 Va angle	In 10ths of degrees	0 to 3599
16,210	H35 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,211	H35 angle with reference to H35 Va angle	In 10ths of degrees	0 to 3599
16,212	H36 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,213	H36 angle with reference to H36 Va angle	In 10ths of degrees	0 to 3599
16,214	H37 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,215	H37 angle with reference to H37 Va angle	In 10ths of degrees	0 to 3599

Table A–4: Spectral Components

Register Number	Description	Units	Range
16,216	H38 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,217	H38 angle with reference to H38 Va angle	In 10ths of degrees	0 to 3599
16,218	H39 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,219	H39 angle with reference to H39 Va angle	In 10ths of degrees	0 to 3599
16,220	H40 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,221	H40 angle with reference to H40 Va angle	In 10ths of degrees	0 to 3599
16,222	H41 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,223	H41 angle with reference to H41 Va angle	In 10ths of degrees	0 to 3599
16,224	H42 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,225	H42 angle with reference to H42 Va angle	In 10ths of degrees	0 to 3599
16,226	H43 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,227	H43 angle with reference to H43 Va angle	In 10ths of degrees	0 to 3599
16,228	H44 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,229	H44 angle with reference to H44 Va angle	In 10ths of degrees	0 to 3599
16,230	H45 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,231	H45 angle with reference to H45 Va angle	In 10ths of degrees	0 to 3599
16,232	H46 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,233	H46 angle with reference to H46 Va angle	In 10ths of degrees	0 to 3599
16,234	H47 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,235	H47 angle with reference to H47 Va angle	In 10ths of degrees	0 to 3599
16,236	H48 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,237	H48 angle with reference to H48 Va angle	In 10ths of degrees	0 to 3599
16,238	H49 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,239	H49 angle with reference to H49 Va angle	In 10ths of degrees	0 to 3599
16,240	H50 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,241	H50 angle with reference to H50 Va angle	In 10ths of degrees	0 to 3599
16,242	H51 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,243	H51 angle with reference to H51 Va angle	In 10ths of degrees	0 to 3599
16,244	H52 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,245	H52 angle with reference to H52 Va angle	In 10ths of degrees	0 to 3599
16,246	H53 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,247	H53 angle with reference to H53 Va angle	In 10ths of degrees	0 to 3599
16,248	H54 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,249	H54 angle with reference to H54 Va angle	In 10ths of degrees	0 to 3599
16,250	H55 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,251	H55 angle with reference to H55 Va angle	In 10ths of degrees	0 to 3599
16,252	H56 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,253	H56 angle with reference to H56 Va angle	In 10ths of degrees	0 to 3599
16,254	H57 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,255	H57 angle with reference to H57 Va angle	In 10ths of degrees	0 to 3599
16,256	H58 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,257	H58 angle with reference to H58 Va angle	In 10ths of degrees	0 to 3599
16,258	H59 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,259	H59 angle with reference to H59 Va angle	In 10ths of degrees	0 to 3599
16,260	H60 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,261	H60 angle with reference to H60 Va angle	In 10ths of degrees	0 to 3599
16,262	H61 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,263	H61 angle with reference to H61 Va angle	In 10ths of degrees	0 to 3599
16,264	H62 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,265	H62 angle with reference to H62 Va angle	In 10ths of degrees	0 to 3599
16,266	H63 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,267	H63 angle with reference to H63 Va angle	In 10ths of degrees	0 to 3599
Neutral Voltage			
16,268	Reserved		
16,269	Reserved		
16,270	H1 magnitude as a percent of H1 magnitude	% in 100ths	10000
16,271	H1 angle with reference to H1 Va angle	In 10ths of degrees	0 to 3599
16,272	H2 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,273	H2 angle with reference to H2 Va angle	In 10ths of degrees	0 to 3599
16,274	H3 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,275	H3 angle with reference to H3 Va angle	In 10ths of degrees	0 to 3599

Table A–4: Spectral Components

Register Number	Description	Units	Range
16,276	H4 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,277	H4 angle with reference to H4 Va angle	In 10ths of degrees	0 to 3599
16,278	H5 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,279	H5 angle with reference to H5 Va angle	In 10ths of degrees	0 to 3599
16,280	H6 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,281	H6 angle with reference to H6 Va angle	In 10ths of degrees	0 to 3599
16,282	H7 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,283	H7 angle with reference to H7 Va angle	tenths of degree	0 to 3599
16,284	H8 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,285	H8 angle with reference to H8 Va angle	In 10ths of degrees	0 to 3599
16,286	H9 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,287	H9 angle with reference to H9 Va angle	In 10ths of degrees	0 to 3599
16,288	H10 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,289	H10 angle with reference to H10 Va angle	In 10ths of degrees	0 to 3599
16,290	H11 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,291	H11 angle with reference to H11 Va angle	In 10ths of degrees	0 to 3599
16,292	H12 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,293	H12 angle with reference to H12 Va angle	In 10ths of degrees	0 to 3599
16,294	H13 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,295	H13 angle with reference to H13 Va angle	In 10ths of degrees	0 to 3599
16,296	H14 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,297	H14 angle with reference to H14 Va angle	In 10ths of degrees	0 to 3599
16,298	H15 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,299	H15 angle with reference to H15 Va angle	In 10ths of degrees	0 to 3599
16,300	H16 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,301	H16 angle with reference to H16 Va angle	In 10ths of degrees	0 to 3599
16,302	H17 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,303	H17 angle with reference to H17 Va angle	In 10ths of degrees	0 to 3599
16,304	H18 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,305	H18 angle with reference to H18 Va angle	In 10ths of degrees	0 to 3599
16,306	H19 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,307	H19 angle with reference to H19 Va angle	In 10ths of degrees	0 to 3599
16,308	H20 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,309	H20 angle with reference to H20 Va angle	In 10ths of degrees	0 to 3599
16,310	H21 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,311	H21 angle with reference to H21 Va angle	In 10ths of degrees	0 to 3599
16,312	H22 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,313	H22 angle with reference to H22 Va angle	In 10ths of degrees	0 to 3599
16,314	H23 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,315	H23 angle with reference to H23 Va angle	In 10ths of degrees	0 to 3599
16,316	H24 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,317	H24 angle with reference to H24 Va angle	In 10ths of degrees	0 to 3599
16,318	H25 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,319	H25 angle with reference to H25 Va angle	In 10ths of degrees	0 to 3599
16,320	H26 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,321	H26 angle with reference to H26 Va angle	In 10ths of degrees	0 to 3599
16,322	H27 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,323	H27 angle with reference to H27 Va angle	In 10ths of degrees	0 to 3599
16,324	H28 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,325	H28 angle with reference to H28 Va angle	In 10ths of degrees	0 to 3599
16,326	H29 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,327	H29 angle with reference to H29 Va angle	In 10ths of degrees	0 to 3599
16,328	H30 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,329	H30 angle with reference to H30 Va angle	In 10ths of degrees	0 to 3599
16,330	H31 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,331	H31 angle with reference to H31 Va angle	In 10ths of degrees	0 to 3599
16,332	H32 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,333	H32 angle with reference to H32 Va angle	In 10ths of degrees	0 to 3599
16,334	H33 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,335	H33 angle with reference to H33 Va angle	In 10ths of degrees	0 to 3599
16,336	H34 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767

Table A–4: Spectral Components

Register Number	Description	Units	Range
16,337	H34 angle with reference to H34 Va angle	In 10ths of degrees	0 to 3599
16,338	H35 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,339	H35 angle with reference to H35 Va angle	In 10ths of degrees	0 to 3599
16,340	H36 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,341	H36 angle with reference to H36 Va angle	In 10ths of degrees	0 to 3599
16,342	H37 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,343	H37 angle with reference to H37 Va angle	In 10ths of degrees	0 to 3599
16,344	H38 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,345	H38 angle with reference to H38 Va angle	In 10ths of degrees	0 to 3599
16,346	H39 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,347	H39 angle with reference to H39 Va angle	In 10ths of degrees	0 to 3599
16,348	H40 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,349	H40 angle with reference to H40 Va angle	In 10ths of degrees	0 to 3599
16,350	H41 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,351	H41 angle with reference to H41 Va angle	In 10ths of degrees	0 to 3599
16,352	H42 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,353	H42 angle with reference to H42 Va angle	In 10ths of degrees	0 to 3599
16,354	H43 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,355	H43 angle with reference to H43 Va angle	In 10ths of degrees	0 to 3599
16,356	H44 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,357	H44 angle with reference to H44 Va angle	In 10ths of degrees	0 to 3599
16,358	H45 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,359	H45 angle with reference to H45 Va angle	In 10ths of degrees	0 to 3599
16,360	H46 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,361	H46 angle with reference to H46 Va angle	In 10ths of degrees	0 to 3599
16,362	H47 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,363	H47 angle with reference to H47 Va angle	In 10ths of degrees	0 to 3599
16,364	H48 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,365	H48 angle with reference to H48 Va angle	In 10ths of degrees	0 to 3599
16,366	H49 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,367	H49 angle with reference to H49 Va angle	In 10ths of degrees	0 to 3599
16,368	H50 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,369	H50 angle with reference to H50 Va angle	In 10ths of degrees	0 to 3599
16,370	H51 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,371	H51 angle with reference to H51 Va angle	In 10ths of degrees	0 to 3599
16,372	H52 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,373	H52 angle with reference to H52 Va angle	In 10ths of degrees	0 to 3599
16,374	H53 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,375	H53 angle with reference to H53 Va angle	In 10ths of degrees	0 to 3599
16,376	H54 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,377	H54 angle with reference to H54 Va angle	In 10ths of degrees	0 to 3599
16,378	H55 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,379	H55 angle with reference to H55 Va angle	In 10ths of degrees	0 to 3599
16,380	H56 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,381	H56 angle with reference to H56 Va angle	In 10ths of degrees	0 to 3599
16,382	H57 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,383	H57 angle with reference to H57 Va angle	In 10ths of degrees	0 to 3599
16,384	H58 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,385	H58 angle with reference to H58 Va angle	In 10ths of degrees	0 to 3599
16,386	H59 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,387	H59 angle with reference to H59 Va angle	In 10ths of degrees	0 to 3599
16,388	H60 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,389	H60 angle with reference to H60 Va angle	In 10ths of degrees	0 to 3599
16,390	H61 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,391	H61 angle with reference to H61 Va angle	In 10ths of degrees	0 to 3599
16,392	H62 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,393	H62 angle with reference to H62 Va angle	In 10ths of degrees	0 to 3599
16,394	H63 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,395	H63 angle with reference to H63 Va angle	In 10ths of degrees	0 to 3599
Neutral Current			
16.396	Reserved		

Table A–4: Spectral Components

Register Number	Description	Units	Range
16,397	Reserved		
16,398	H1 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,399	H1 angle with reference to H1 Va angle	In 10ths of degrees	0 to 3599
16,400	H2 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,401	H2 angle with reference to H2 Va angle	In 10ths of degrees	0 to 3599
16,402	H3 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,403	H3 angle with reference to H3 Va angle	In 10ths of degrees	0 to 3599
16,404	H4 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,405	H4 angle with reference to H4 Va angle	In 10ths of degrees	0 to 3599
16,406	H5 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,407	H5 angle with reference to H5 Va angle	In 10ths of degrees	0 to 3599
16,408	H6 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,409	H6 angle with reference to H6 Va angle	In 10ths of degrees	0 to 3599
16,410	H7 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,411	H7 angle with reference to H7 Va angle	tenths of degree	0 to 3599
16,412	H8 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,413	H8 angle with reference to H8 Va angle	In 10ths of degrees	0 to 3599
16,414	H9 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,415	H9 angle with reference to H9 Va angle	In 10ths of degrees	0 to 3599
16,416	H10 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,417	H10 angle with reference to H10 Va angle	In 10ths of degrees	0 to 3599
16,418	H11 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,419	H11 angle with reference to H11 Va angle	In 10ths of degrees	0 to 3599
16,420	H12 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,421	H12 angle with reference to H12 Va angle	In 10ths of degrees	0 to 3599
16,422	H13 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,423	H13 angle with reference to H13 Va angle	In 10ths of degrees	0 to 3599
16,424	H14 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,425	H14 angle with reference to H14 Va angle	In 10ths of degrees	0 to 3599
16,426	H15 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,427	H15 angle with reference to H15 Va angle	In 10ths of degrees	0 to 3599
16,428	H16 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,429	H16 angle with reference to H16 Va angle	In 10ths of degrees	0 to 3599
16,430	H17 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,431	H17 angle with reference to H17 Va angle	In 10ths of degrees	0 to 3599
16,432	H18 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,433	H18 angle with reference to H18 Va angle	In 10ths of degrees	0 to 3599
16,434	H19 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,435	H19 angle with reference to H19 Va angle	In 10ths of degrees	0 to 3599
16,436	H20 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,437	H20 angle with reference to H20 Va angle	In 10ths of degrees	0 to 3599
16,438	H21 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,439	H21 angle with reference to H21 Va angle	In 10ths of degrees	0 to 3599
16,440	H22 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,441	H22 angle with reference to H22 Va angle	In 10ths of degrees	0 to 3599
16,442	H23 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,443	H23 angle with reference to H23 Va angle	In 10ths of degrees	0 to 3599
16,444	H24 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,445	H24 angle with reference to H24 Va angle	In 10ths of degrees	0 to 3599
16,446	H25 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,447	H25 angle with reference to H25 Va angle	In 10ths of degrees	0 to 3599
16,448	H26 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,449	H26 angle with reference to H26 Va angle	In 10ths of degrees	0 to 3599
16,450	H27 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,451	H27 angle with reference to H27 Va angle	In 10ths of degrees	0 to 3599
16,452	H28 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,453	H28 angle with reference to H28 Va angle	In 10ths of degrees	0 to 3599
16,454	H29 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,455	H29 angle with reference to H29 Va angle	In 10ths of degrees	0 to 3599
16,456	H30 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,457	H30 angle with reference to H30 Va angle	In 10ths of degrees	0 to 3599

Table A–4: Spectral Components

Register Number	Description	Units	Range
16,458	H31 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,459	H31 angle with reference to H31 Va angle	In 10ths of degrees	0 to 3599
16,460	H32 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,461	H32 angle with reference to H32 Va angle	In 10ths of degrees	0 to 3599
16,462	H33 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,463	H33 angle with reference to H33 Va angle	In 10ths of degrees	0 to 3599
16,464	H34 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,465	H34 angle with reference to H34 Va angle	In 10ths of degrees	0 to 3599
16,466	H35 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,467	H35 angle with reference to H35 Va angle	In 10ths of degrees	0 to 3599
16,468	H36 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,469	H36 angle with reference to H36 Va angle	In 10ths of degrees	0 to 3599
16,470	H37 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,471	H37 angle with reference to H37 Va angle	In 10ths of degrees	0 to 3599
16,472	H38 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,473	H38 angle with reference to H38 Va angle	In 10ths of degrees	0 to 3599
16,474	H39 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,475	H39 angle with reference to H39 Va angle	In 10ths of degrees	0 to 3599
16,476	H40 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,477	H40 angle with reference to H40 Va angle	In 10ths of degrees	0 to 3599
16,478	H41 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,479	H41 angle with reference to H41 Va angle	In 10ths of degrees	0 to 3599
16,480	H42 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,481	H42 angle with reference to H42 Va angle	In 10ths of degrees	0 to 3599
16,482	H43 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,483	H43 angle with reference to H43 Va angle	In 10ths of degrees	0 to 3599
16,484	H44 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,485	H44 angle with reference to H44 Va angle	In 10ths of degrees	0 to 3599
16,486	H45 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,487	H45 angle with reference to H45 Va angle	In 10ths of degrees	0 to 3599
16,488	H46 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,489	H46 angle with reference to H46 Va angle	In 10ths of degrees	0 to 3599
16,490	H47 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,491	H47 angle with reference to H47 Va angle	In 10ths of degrees	0 to 3599
16,492	H48 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,493	H48 angle with reference to H48 Va angle	In 10ths of degrees	0 to 3599
16,494	H49 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,495	H49 angle with reference to H49 Va angle	In 10ths of degrees	0 to 3599
16,496	H50 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,497	H50 angle with reference to H50 Va angle	In 10ths of degrees	0 to 3599
16,498	H51 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,499	H51 angle with reference to H51 Va angle	In 10ths of degrees	0 to 3599
16,500	H52 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,501	H52 angle with reference to H52 Va angle	In 10ths of degrees	0 to 3599
16,502	H53 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,503	H53 angle with reference to H53 Va angle	In 10ths of degrees	0 to 3599
16,504	H54 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,505	H54 angle with reference to H54 Va angle	In 10ths of degrees	0 to 3599
16,506	H55 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,507	H55 angle with reference to H55 Va angle	In 10ths of degrees	0 to 3599
16,508	H56 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,509	H56 angle with reference to H56 Va angle	In 10ths of degrees	0 to 3599
16,510	H57 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,511	H57 angle with reference to H57 Va angle	In 10ths of degrees	0 to 3599
16,512	H58 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,513	H58 angle with reference to H58 Va angle	In 10ths of degrees	0 to 3599
16,514	H59 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,515	H59 angle with reference to H59 Va angle	In 10ths of degrees	0 to 3599
16,516	H60 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,517	H60 angle with reference to H60 Va angle	In 10ths of degrees	0 to 3599
16,518	H61 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767

Table A–4: Spectral Components

Register Number	Description	Units	Range
16,519	H61 angle with reference to H61 Va angle	In 10ths of degrees	0 to 3599
16,520	H62 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,521	H62 angle with reference to H62 Va angle	In 10ths of degrees	0 to 3599
16,522	H63 magnitude as a percent of H1 magnitude	% in 100ths	0 to 32767
16,523	H63 angle with reference to H63 Va angle	In 10ths of degrees	0 to 3599

APPENDIX B—SPECIFICATIONS

This appendix contains specifications for the circuit monitor and display.

Table B–1: Specifications

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, see “Real-Time Readings” on page 106 for more information).
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) 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 Inputs④	
Nominal Full Scale	347 Vac Line to Neutral, 600 Line to Line
Metering Over-range	50%
Input Impedance	Greater than 2 Megohm

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” on page 123 for more information.
④ Any voltage input to the meter that is below 1.0 V is reported as zero.

Table B–1: Specifications

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” on page 15.)
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	2
Installation Category	II
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 “Dimensions” on page 14.

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” on page 123 for more information.
④ Any voltage input to the meter that is below 1.0 V is reported as zero.

Table B–1: Specifications

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 1000-4-2 level 3
Immunity to Electrical Fast Transient	IEC pub 1000-4-4 level 3
Immunity to Surge (Impulse Wave)	IEC pub 1000-4-5 level 4
Dielectric Withstand	UL 508, CSA C22.2-14-M1987, EN 61010
Immunity to Radiated Fields	IEC pub 1000-4-3 level 3
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
Listings	**cUL and UL Listed 18X5 Ind Cont. Eq.**
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” on page 123 for more information.
④ Any voltage input to the meter that is below 1.0 V is reported as zero.

APPENDIX C—USING THE COMMAND INTERFACE

This appendix describes how to use the command interface to perform various operations.

CONTENTS

OVERVIEW OF THE COMMAND INTERFACE

The circuit monitor provides a command interface, which you can use to issue commands that perform various operations such as controlling relays. Table C–2 on page 237 lists the available commands. The command interface is located in memory at registers 8000–8149. Table C–1 lists the definitions for the registers.

Table C–1: Location of the command interface

Register	Description
8000	This is the register where you write the commands.
8001–8015	These are the registers where you write the parameters for a command. Commands can have up to 15 parameters associated with them.
8017	Status pointer to the user area. The status of the last command processed is placed in this register.
8018	Results pointer to the user area. When an error occurs, the error code is placed in this register.
8019	I/O data pointer to the user area. Use this register to point to data buffer registers where you can send additional data or return data.
8020–8149	These registers are for you (the user) to write information. Depending on which pointer places the information in the register, the register can contain status (from pointer 8017), results (from pointer 8018), or data (from 8019). The registers will contain information such as whether the function is enabled or disabled, set to fill and hold, start and stop times, logging intervals, and so forth. By default, return data will start at 8020 unless you specify otherwise.

When registers 8017–8019 are set to zero, no values are returned. When any or all of these registers contain a value, the value in the register “points” to a target register, which contains the status, error code, or I/O data (depending on the command) when the command is executed. Figure C–1 shows how these registers work.

NOTE: You determine the register location where results will be written. Therefore, take care when assigning register values in the pointer registers; values may be corrupted when two commands use the same register.

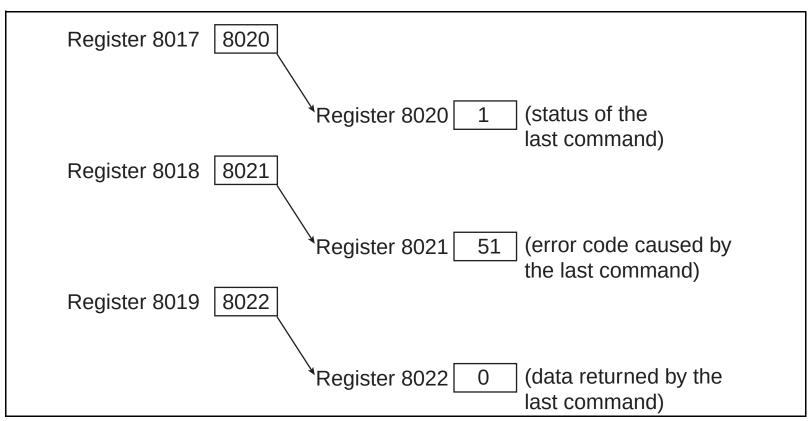


Figure C–1 Command Interface Pointer Registers

Issuing Commands

To issue commands using the command interface, follow these general steps:

1. Write the related parameter(s) to the command parameter registers 8001–15.
2. Write the command code to command interface register 8000.

If no parameters are associated with the command, then you need only to write the command code to register 8000. Table C–2 lists the command codes that can be written to the command interface into register 8000. Some commands have an associated registers where you write parameters for that command. For example, when you write the parameter 9999 to register 8001 and issue command code 3351, all relays will be energized if they are set up for external control.

Table C–2: Command Codes

Command Code	Command Parameter Register	Parameters	Description
1110	None	None	Causes soft reset of the unit (re-initializes the circuit monitor).
1210	None	None	Clears the communications counters.
1310	 8001 8002 8003 8004 8005 8006	 Month Day Year Hour Minute Second	Sets the system date and time. Values for the registers are: Month (1–12) Day (1–31) Year (4-digit, for example 2000) Hour (Military time, for example 14 = 2:00pm) Minute (1–59) Second (1–59)
Relay Outputs			
3310	8001	Relay Output Number ①	Configures relay for external control.
3311	8001	Relay Output Number ①	Configures relay for internal control.
3320	8001	Relay Output Number ①	De-energizes designated relay.
3321	8001	Relay Output Number ①	Energizes designated relay.
3330	8001	Relay Output Number ①	Releases specified relay from latched condition.
3340	8001	Relay Output Number ①	Releases specified relay from override control.
3341	8001	Relay Output Number ①	Places specified relay under override control.
3350	8001	9999	De-energizes all relays.
3351	8001	9999	Energizes all relays.
3361	8001	Relay Output Number ①	Resets operation counter for specified relay.
3362	8001	Relay Output Number ①	Resets the turn-on time for specified relay.
3363	8001	None	Resets the operation counter for all relays.
3364	8001	None	Resets the turn-on time for all relays.
3365	8001	Input Number ①	Resets the operation counter for specified input.
3366	8001	Input Number ①	Resets turn-on time for specified input.
3367	8001	None	Resets the operation counter for all inputs.
3368	8001	None	Resets turn-on time for all inputs.
3369	8001	None	Resets all counters and timers for all I/Os.

① You must write to register 8001 the number that identifies which output you would like to use. To determine the identifying number, refer to “I/O Position Numbers” on page 240 for instructions.

② Data buffer location (register 8019) is the pointer to the first register where data will be stored. By default, return data begins at register 8020, although you can use any of the registers from 8020–8149. *Take care when assigning pointers. Values may be corrupted if two commands are using the same register.*

Table C–2: Command Codes

Command Code	Command Parameter Register	Parameters	Description
3370	8001	Analog Output Number ①	Disables specified analog output.
3371	8001	Analog Output Number ①	Enables specified analog output.
3380	8001	9999	Disables all analog outputs.
3381	8002	9999	Enables all analog outputs.
Resets			
4110	None	None	Resets min/max.
5110	None	None	Resets all demand registers.
5111	None	None	Resets current demand.
5112	None	None	Resets voltage demand.
5113	None	None	Resets power demand.
5114	None	None	Resets input demand.
5115	None	None	Resets generic 1 demand for first group of 10 quantities.
5116	None	None	Resets generic 2 demand for second group of 10 quantities.
5210	None	None	Resets all min/max demand.
5211	None	None	Resets current min/max demand.
5212	None	None	Resets voltage min/max demand.
5213	None	None	Resets power min/max demand.
5214	None	None	Resets input min/max demand.
5215	None	None	Resets generic 1 min/max demand.
5216	None	None	Resets generic 2 min/max demand.
5910	None	Bitmap	Bit 0 = Power Demand 1 = Current Demand 2 = Voltage Demand 3 = Input Metering Demand 4 = Generic Demand Profile 1 5 = Generic Demand Profile 2
6210	None	None	Clears all energies.
6211	None	None	Clears all accumulated energy values.
6212	None	None	Clears conditional energy values.
6213	None	None	Clears incremental energy values.
6214	None	None	Clears input metering accumulation.
6220	None	None	Clears all conditional energy values.
6320	None	None	Disables conditional energy accumulation.
6321	None	None	Enables conditional energy accumulation.

① You must write to register 8001 the number that identifies which output you would like to use. To determine the identifying number, refer to “I/O Position Numbers” on page 240 for instructions.

② Data buffer location (register 8019) is the pointer to the first register where data will be stored. By default, return data begins at register 8020, although you can use any of the registers from 8020–8149. *Take care when assigning pointers. Values may be corrupted if two commands are using the same register.*

Table C–2: Command Codes

Command Code	Command Parameter Register	Parameters	Description
6910	None	None	Starts a new incremental energy interval.
Files			
7510	8001	Files 1–4 to trigger	Triggers data log entry. Bitmap where Bit 0 = Data Log 1, Bit 1 = Data Log 2, Bit 2 = Data Log 3, etc.
7511	8001	File Number	Triggers single data log entry.
Setup			
9020		None	Enter into setup mode.
9021	8001	1 = Save 2 = Do not save	End setup mode session and save all changes.

① You must write to register 8001 the number that identifies which output you would like to use. To determine the identifying number, refer to "I/O Position Numbers" on page 240 for instructions.

② Data buffer location (register 8019) is the pointer to the first register where data will be stored. By default, return data begins at register 8020, although you can use any of the registers from 8020–8149. *Take care when assigning pointers. Values may be corrupted if two commands are using the same register.*

I/O POSITION NUMBERS

All inputs and outputs of the circuit monitor have a reference number and a label that correspond to the position of that particular input or output.

- The reference number is used to manually control the input or output with the command interface.
- The label is the default identifier that identifies that same input or output. The label appears on the display, in SMS, on the option card, and on the I/O extender.

Figure C–2 shows the reference number and its label equivalent.

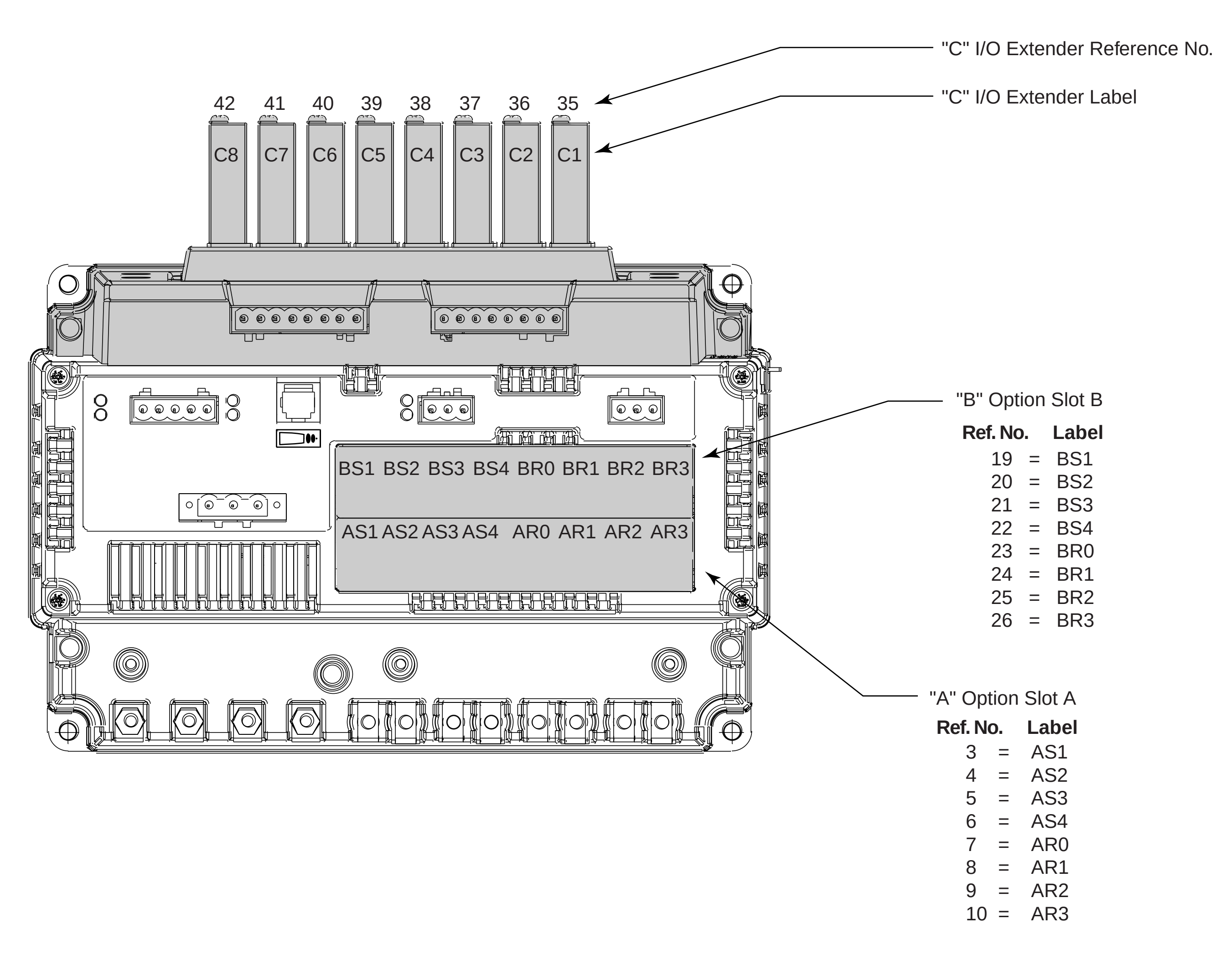


Figure C–2 Identifying I/Os for the command interface

OPERATING OUTPUTS FROM THE COMMAND INTERFACE

To operate an output from the command interface, first identify the relay using the *reference number*. Then, set the output to external control. For example, to energize the last output on Option Card B, write the commands as follows:

1. Write number 26 to register 8001.
2. Write command code 3310 to register 8000 to set the relay to external control.
3. Write command code 3321 to register 8000.

If you look in Table C–2 on page 237, you'll see that command code 3310 sets the relay to external control and command code 3321 is listed as the command used to energize a relay. Command codes 3310–3381 are for use with inputs and outputs.

USING THE COMMAND INTERFACE TO CHANGE CONFIGURATION REGISTERS

You can also use the command interface to change values in selected metering-related registers, such as synchronizing the time of day of the clock or resetting generic demand.

Two commands, 9020 and 9021, work together as part of the command interface procedure when you use it to change circuit monitor configuration. You must first issue command 9020 to enter into setup mode, change the register, and then issue 9021 to save your changes and exit setup mode.

Only one session at a time is allowed in setup mode. While in this mode, if the circuit monitor detects more than two minutes of inactivity, that is, if you do not write any register values or press any buttons on the display, the circuit monitor will timeout and restore the original configuration values. All changes will be lost. Also, if the circuit monitor loses power or communications while in setup mode, your changes will be lost.

The general procedure for changing configuration registers using the command interface is as follows:

1. Issue command 9020 in register 8000 to enter into the setup mode.
2. Make changes to the appropriate register by writing the new value to that register. Perform register writes to all registers that you want to change. For instructions on reading and writing registers, see "Reading and Writing Registers" on page 102 in **Chapter 7—Operation**.
3. To save the changes, write the value 1 to register 8001.

   NOTE: Writing any other value except 1 to register 8001 lets you exit setup mode without saving your changes.
4. Issue command 9021 in register 8000 to initiate the save and reset the circuit monitor.

For example, the procedure to change the demand interval for current is as follows:

1. Issue command code 9020.
2. Write the new demand interval to register 1801.
3. Write 1 to register 8001.
4. Issue command code 9021.

See **Appendix A—Abbreviated Register Listing** on page 181 for those registers that require you to enter setup mode to make changes to the registers.

CONDITIONAL ENERGY

Circuit monitor registers 1728–1744 are conditional energy registers.

Conditional energy can be controlled in one of two ways:

- Over the communications link, by writing commands to the circuit monitor's command interface, or
- By a digital input—for example, conditional energy accumulates when the assigned digital input is on, but does not accumulate when the digital input is off.

The following procedures tell how to set up conditional energy for command interface control, and for digital input control. The procedures refer to register numbers and command codes. For a listing of circuit monitor registers, see **Appendix A—Abbreviated Register Listing** on page 181. For a listing of command codes, see Table C–2 on page 237 in this chapter.

Command Interface Control

Set Control—To *set control* of conditional energy to the command interface:

1. Write command code 9020 to register 8000.
2. In register 3227, set bit 6 to 1 (preserve other bits that are ON).
3. Write 1 to register 8001.
4. Write command code 9021 to register 8000.

Start— To *start* conditional energy accumulation, write command code 6321 to register 8000.

Verify Setup—To *verify proper setup*, read register 1794. The register should read 1, indicating conditional energy accumulation is ON.

Stop—To *stop* conditional energy accumulation, write command code 6320 to register 8000.

Clear—To *clear* all conditional energy registers (1728-1747), write command code 6212 to register 8000.

Digital Input Control

Set Control—To configure conditional energy for digital input control:

1. Write command code 9020 to register 8000.
2. In register 3227, set bit 6 to 0 (preserve other bits that are ON).
3. Configure the digital input that will drive condition energy accumulation. For the appropriate digital input, write 3 to the *Base +9* register. See the digital input templates in Table A–2 on page 204 in **Appendix A—Abbreviated Register Listing**.
4. Write 1 to register 8001.
5. Write command code 9021 to register 8000.

Clear—To clear all conditional energy registers (1728–1747), write command code 6212 to register 8000.

Verify Setup—To *verify proper setup*, read register 1794. The register should read 0 when the digital input is off, indicating that conditional energy accumulation is off. The register should read 1 when conditional energy accumulation is on.

INCREMENTAL ENERGY

The circuit monitor's incremental energy feature allows you to define a start time, end time, and time interval for incremental energy accumulation. At the end of each incremental energy period, the following information is available:

- Wh IN during the last completed interval (reg. 1748–1750)
- VARh IN during the last completed interval (reg. 1751–1753)
- Wh OUT during the last completed interval (reg. 1754–1756)
- VARh OUT during the last completed interval (reg. 1757–1759)
- VAh during the last completed interval (reg. 1760–1762)
- Date/time of the last completed interval (reg. 1763–1766)
- Peak kW demand during the last completed interval (reg. 1940)
- Date/Time of Peak kW during the last interval (reg. 1941–1944)
- Peak kVAR demand during the last completed interval (reg. 1945)
- Date/Time of Peak kVAR during the last interval (reg. 1946–1949)
- Peak kVA demand during the last completed interval (reg. 1950)
- Date/Time of Peak kVA during the last interval (reg. 1951–1954)

The circuit monitor can log the incremental energy data listed above. This logged data provides all the information needed to analyze energy and power usage against present or future utility rates. The information is especially useful for comparing different time-of-use rate structures.

When using the incremental energy feature, keep the following points in mind:

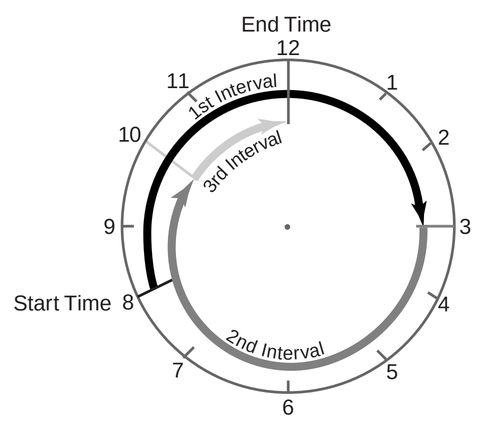
- Peak demands help minimize the size of the data log in cases of sliding or rolling demand. Shorter incremental energy periods make it easier to reconstruct a load profile analysis.
- Since the incremental energy registers are synchronized to the circuit monitor clock, it is possible to log this data from multiple circuits and perform accurate totalizing.

Using Incremental Energy

Incremental energy accumulation begins at the specified start time and ends at the specified end time. When the start time arrives, a new incremental energy period begins. The start and end time are specified in minutes from midnight. For example:

Interval: 420 minutes (7 hours)
Start time: 480 minutes (8:00 a.m.)
End time = 1440 minutes (12:00 p.m.)

The first incremental energy calculation will be from 8:00 a.m. to 3:00 p.m. (7 hours) as illustrated in Figure C–3. The next interval will be from 3:00 p.m. to 10:00 p.m., and the third interval will be from 10 p.m. to 12:00 p.m. because 12:00 p.m. is the specified end time. A new interval will begin on the next day at 8:00 a.m. Incremental energy accumulation will continue in this manner until the configuration is changed or a new interval is started by a remote master.



1st Interval (7 hours) = 8:00 a.m. to 3:00 p.m
2nd Interval (7 hours) = 3:00 p.m. to 10:00 p.m
3rd Interval (2 hours) = 10:00 p.m. to 12:00 p.m

Figure C–3 Increment Energy Example

Set up—To set up incremental energy:

1. Write command code 9020 to register 8000.
2. In register 3230, write a start time (in minutes-from-midnight).
   For example, 8:00 am is 480 minutes.
3. In register 3231, write an end time (in minutes-from-midnight).
4. Write the desired interval length, from 0–1440 minutes, to register 3229.
   If incremental energy will be controlled from a remote master, such as a programmable controller, write 0 to the register.
5. Write 1 to register 8001.
6. Write command code 9021 to register 8000.

Start—To start a new incremental energy interval from a remote master, write command code 6910 to register 8000.

SETTING UP INDIVIDUAL HARMONIC CALCULATIONS

The circuit monitor can perform harmonic magnitude and angle calculations for each metered value and for each residual value. The harmonic magnitude can be formatted as either a percentage of the fundamental (THD) or as a percentage of the rms values (thd). The harmonic magnitude and angles are stored in a set of registers: 16,768–22,911. The circuit monitor updates the values in these registers over a 10-metering update cycle period. During the time that the circuit monitor is refreshing harmonic data, the circuit monitor posts a value of 0 in register 3243. When the set of harmonic registers is updated with new data, the circuit monitor posts a value of 1 in register 3243. The circuit monitor can be configured to hold the values in these registers for up to 60 metering update cycles once the data processing is complete.

The circuit monitor has three operating modes for harmonic data processing: disabled, voltage only, and voltage and current. Because of the extra processing time necessary to perform these calculations, the factory default operating mode is disabled.

To configure the harmonic data processing, write to the registers described in Table C–3:

Table C–3: Registers for Harmonic Calculations

Reg No.	Value	Description
3240	0, 1	Harmonic magnitude formatting; 0 = % of fundamental (default) 1 = % of rms
3241	0, 1, 2	Harmonic processing; 0 = disabled 1 = voltage harmonics only enabled 2 = voltage and current harmonics enabled
3242	0–60	This register shows the number of metering update cycles remaining before the next update (of harmonic data).
3243	0,1	This register indicates whether harmonic data processing is complete: 0 = processing incomplete 1 = processing complete

CHANGING SCALE FACTORS

The circuit monitor stores instantaneous metering data in 16-bit single registers. A value held in each register must be between –32,767 and +32,767. Because some values for metered current, voltage, and power readings fall outside this range, the circuit monitor uses multipliers, or scale factors. This enables the circuit monitor to extend the range of metered values that it can record.

When a value is larger than 32,767 it can be associated with a multiplier from 0.001 to 1,000. The circuit monitor stores these multipliers as scale factors. A scale factor is the multiplier expressed as a power of 10. For example, a multiplier of 10 is represented as a scale factor of 1, since 10^1=10; a multiplier of 100 is represented as a scale factor of 2, since 10^2=100.

You can change the default value of 1 to other values such as 10, 100, or 1000. However, these scale factors are automatically selected when you set up the circuit monitor, either from the display or by using SMS.

If the circuit monitor displays “overflow” for any reading, change the scale factor to bring the reading back into a range that fits in the register. For example, because the register cannot store a number as large as 138,000, a 138 kV system requires a multiplier of 10. 138,000 is converted to 13,800 x 10. The circuit monitor stores this value as 13,800 with a scale factor of 1 (because 10^1=10).

Scale factors are arranged in scale groups. The abbreviated register list in **Appendix A—Abbreviated Register Listing** on page 181 shows the scale group associated with each metered value.

You can use the command interface to change scale factors on a group of metered values. However, be aware of these important points if you choose to change scale factors:

Notes:

- *We **strongly recommend** that you do not change the default scale factors, which are automatically selected by POWERLOGIC hardware and software.*
- *When using custom software to read circuit monitor data over the communications link, you must account for these scale factors. To correctly read any metered value with a scale factor other than 0, multiply the register value read by the appropriate power of 10.*
- *When you change a scale factor, all min/max and peak values are reset.*

APPENDIX D—CABLE PINOUTS

This appendix contains pinouts for circuit monitor and display connections.

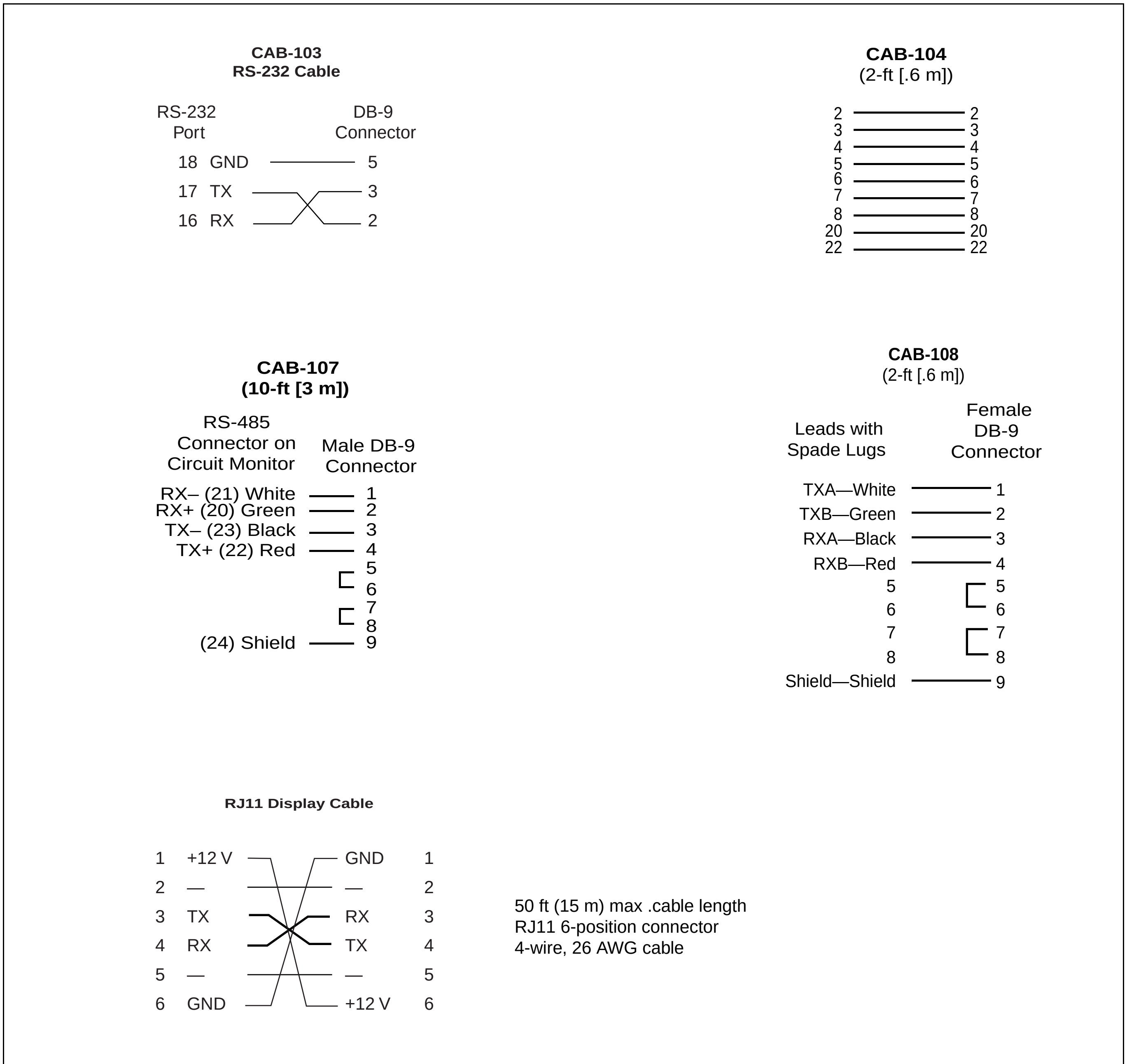


Figure D–1 Cable Pinouts

GLOSSARY

accumulated energy—energy can accumulates 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.

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

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

CVM—current/voltage module that is 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 where 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 non linear 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 because they can be inserted into slots in the circuit monitor.

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 your 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. Calculated by dividing watts by volt amperes. Power factor is the difference between the total power your 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.

INDEX

D

E

F

G

H