PowerLogic®
Portable Circuit Monitor
Series 2000

[Image of a portable circuit monitor]
NOTICE

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

⚠️ DANGER

Used where there is hazard of severe bodily injury or death. Failure to follow a “DANGER” instruction will result in severe bodily injury or death.

⚠️ WARNING

Used where there is hazard of bodily injury or death. Failure to follow a “WARNING” instruction may result in bodily injury or death.

⚠️ CAUTION

Used where there is hazard of equipment damage. Failure to follow a “CAUTION” instruction may result in damage to equipment.

NOTE

Provides additional information to clarify or simplify a procedure.

PLEASE NOTE: Electrical equipment should be serviced only by qualified electrical maintenance personnel, and this document should not be viewed as sufficient for those who are not otherwise qualified to operate, service, or maintain the equipment discussed. Although reasonable care has been taken to provide accurate and authoritative information in this document, no responsibility is assumed by Square D for any consequences arising out of the use of this material.

FCC NOTICE: This equipment complies with the requirements in Part 15 of FCC rules for a Class A computing device. Operation of this equipment in a residential area may cause unacceptable interference to radio and TV reception, requiring the operator to take whatever steps are necessary to correct the interference.

TECHNICAL SUPPORT

For technical support, contact the Power Monitoring and Control Systems Technical Support Center. Hours are 7:30 A.M. to 4:30 P.M., Central Time, Monday through Friday.

Phone: (615) 459-8552   Fax: (615) 459-4294
CHAPTER 1—INTRODUCTION

CHAPTER CONTENTS

This chapter offers a general description of the portable circuit monitor (PCM), describes important safety precautions, tells how to best use this bulletin, and lists related documents. Topics are discussed in the following order:

What is the Portable Circuit Monitor? ................................................................. 1
Typical Applications ................................................................................................. 4
Maintenance and Service ......................................................................................... 5
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NOTE

This edition of the portable circuit monitor instruction bulletin describes features available in firmware version 16.007. Series 2000 circuit monitors with older firmware versions will not include all features described in this instruction bulletin.

If you have Series 2000 circuit monitors that do not have the latest firmware version and you want to upgrade their firmware, contact your local Square D representative for information on purchasing the Class 3020 Type CM-2000U Circuit Monitor Firmware Upgrade Kit.

WHAT IS THE PORTABLE CIRCUIT MONITOR?

The POWERLOGIC® Engineering Services Portable Circuit Monitor is a multifunction, digital instrumentation, data acquisition and control device. The PCM can stand alone or is equipped with RS-485 communications for integration into a POWERLOGIC power monitoring and control system.

The portable 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 31st harmonic.

Over 50 metered values plus extensive minimum and maximum data can be viewed from the six-digit LED display. Table 1-1 on page 3 provides a summary of portable circuit monitor instrumentation.
What is the Portable Circuit Monitor? (cont.)

The PCM comes standard with a CM-2452 circuit monitor to provide a broad range of electrical circuit information, including:

- instantaneous and integrated meter readings
  - amperes, volts, watts, vars, VAs
- power and energy data
  - power factor, frequency, demand amperes, demand power watts, demand power VA, watthours, varhours
- power quality data
  - total harmonic distortion for both current and voltage, K-factor, waveform captures, and sag/swell captures for voltage and current.

PCM capabilities can be expanded using add-on modules that are internally installed at the factory. Several input/output modules are available. See Chapter 6—I/O Capabilities for a description of the available I/O modules.

Using POWERLOGIC application software, users can upgrade PCM firmware through either the RS-485 or front panel optical communications ports. This feature can be used to keep all portable circuit monitors up to date with the latest system enhancements.

Some of the portable circuit monitor’s many features include:

- True rms Metering (31st Harmonic)
- Accepts Standard CT and PT Inputs
- High Accuracy—0.2% Current and Voltage
- Over 50 Displayed Meter Values
- Min/Max Displays for Metered Data
- Power Quality Readings—THD, K-Factor, Crest Factor
- On-board Clock/Calendar
- Easy Front Panel Setup (Password Protected)
- RS-485 Communications Standard
- Front Panel, Optical Communications Port Standard
- Modular, Field-Installable, Digital I/O
- I/O Modules Support Programmable KYZ Pulse Output
- Setpoint-Controlled Alarm/Relay Functions
- On-board Event and Data Logging
- Waveform Capture
- High-speed, Triggered, 12-Cycle Event Capture
- Downloadable Firmware
What is the Portable Circuit Monitor? (cont.)

- System Connections
  - 3-Phase, 3-Wire Delta
  - 3-Phase, 4-Wire Wye
  - Metered or Calculated Neutral
  - Other Metering Connections
- Optional Voltage/Power Module for Direct Connection to 480Y/277V
- Wide Operating Temperature Range, Standard (-25 to +70°C)
- Support for Analog I/O
- Disturbance Monitoring
- Event Recordings with up to 60 Cycles of Continuous Waveform Data
- Individual Harmonic Magnitude and Angle Values

### Table 1-1
Summary of Portable Circuit Monitor Instrumentation

<table>
<thead>
<tr>
<th>Real-Time Readings</th>
<th>Energy Readings</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Current (per phase, N, G, 3Ø)</td>
<td>• Accumulated Energy, Real</td>
</tr>
<tr>
<td>• Voltage (L-L, L-N)</td>
<td>• Accumulated Energy, Reactive</td>
</tr>
<tr>
<td>• Real Power (per phase, 3Ø)</td>
<td>• Accumulated Energy, Apparent*</td>
</tr>
<tr>
<td>• Reactive Power (per phase, 3Ø)</td>
<td>• Bidirectional Readings*</td>
</tr>
<tr>
<td>• Apparent Power (per phase, 3Ø)</td>
<td></td>
</tr>
<tr>
<td>• Power Factor (per phase, 3Ø)</td>
<td></td>
</tr>
<tr>
<td>• Frequency</td>
<td></td>
</tr>
<tr>
<td>• Temperature (internal ambient)*</td>
<td></td>
</tr>
<tr>
<td>• THD (current and voltage)</td>
<td></td>
</tr>
<tr>
<td>• K-Factor (per phase)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Demand Readings</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>• Demand Current (per-phase present, peak)</td>
<td>• Crest Factor (per phase)</td>
</tr>
<tr>
<td>• Average Power Factor (3Ø total)*</td>
<td>• K-Factor Demand (per phase)</td>
</tr>
<tr>
<td>• Demand Real Power (3Ø total)</td>
<td>• Displacement Power Factor (per phase, 3Ø)</td>
</tr>
<tr>
<td>• Demand Reactive Power (3Ø total)*</td>
<td>• Fundamental Voltages (per phase)</td>
</tr>
<tr>
<td>• Demand Apparent Power (3Ø total)</td>
<td>• Fundamental Currents (per phase)</td>
</tr>
<tr>
<td>• Coincident Readings*</td>
<td>• Fundamental Real Power (per phase)</td>
</tr>
<tr>
<td>• Predicted Demands*</td>
<td>• Fundamental Reactive Power (per phase)</td>
</tr>
</tbody>
</table>

* Available via communications only.
TYPICAL APPLICATIONS

The PCM is especially useful when temporary monitoring is desired or where existing switchgear will not accommodate permanent installation. The information provided by the PCM can be a valuable tool when used in troubleshooting activities.

The following is a list of some of the tasks that can be accomplished using the PCM:

- determining the condition of the load for balanced or unbalanced 3-phase systems up to 600 Vac max.
- determining if power factor correction is necessary
- determining the demand contribution of the load being monitored
- determining load interaction using power quality readings for total harmonic distortion (current and voltage)

More information can be obtained from the PCM by using software. Some possibilities include:

- detection of sag/swell disturbances for voltage or current and automatic triggering of multiple 12-cycle waveform captures. The waveforms can be stored in the on-board non-volatile memory, resident in the PCM, and retrieved using POWERLOGIC application software.
- on board event logging for alarm conditions defined by the user
- storing of data logs containing energy and power information in on-board memory
- displaying on-board data as trend plots
- storing data on the system hard drive as history files to be used by POWERLOGIC application software.
- establishing a base line for normal equipment operation
- periodic follow-up testing of equipment to compare with its baseline performance
MAINTENANCE AND SERVICE

The portable circuit monitor is not field serviceable. Any service required on the unit should be performed by the factory. Contact Tech Support at (615) 287-3400 for information on returning the unit to the factory for service.

SAFETY PRECAUTIONS

DANGER

HAZARD OF DEATH, PERSONAL INJURY, OR EQUIPMENT DAMAGE.

• Only qualified electrical workers should install, wire, remove, or perform maintenance on electrical equipment. Read this complete set of instructions before performing such work.

• 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.

• Disconnect all sources of electric power before connecting or disconnecting this equipment.

• Disconnect all sources of electric power before performing visual inspections, tests, or maintenance on electrical equipment.

• 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.

Failure to observe this precaution will cause death, severe personal injury, or equipment damage!
USING THIS BULLETIN

This document provides the information required to install and operate the portable circuit monitor. The document consists of a table of contents, thirteen chapters, and a number of appendices. Chapters longer than a few pages begin with a chapter table of contents. To locate information on a specific topic, refer to the table of contents at the beginning of the document, or the table of contents at the beginning of a specific chapter.

Topics Not Covered Here

Some of the portable circuit monitor’s advanced features, such as on-board data log and event log files, must be set up over the communications link using POWERLOGIC application software. This PCM instruction bulletin describes these advanced features, but does not tell how to set them up. For instructions on setting up these advanced features, refer to the application software instruction bulletin.

Notational Conventions

This document uses the following notational conventions:

- **Procedures.** Each procedure begins with an italicized statement of the task, followed by a numbered list of steps. Procedures require you to take action.

- **Bullets.** Bulleted lists, such as this one, provide information but not procedural steps. They do not require you to take action.

- **Cross-References.** Cross-references to other sections in the document appear in boldface. Example: see The Setup Mode in Chapter 4.
CHAPTER 2—HARDWARE DESCRIPTION

FRONT PANEL

The portable circuit monitor front panel is designed for maximum ease of use. The PCM has five modes of operation:

• METERS — for viewing real-time metered data
• MIN — for viewing the minimum of the selected metered value
• MAX — for viewing the maximum of the selected metered value
• ALARM — for viewing the status of on-board alarms
• [Setup] — for setting up the PCM

The general procedure for displaying data is simple:
1. Press the MODE button to select one of the five available modes.
2. Press the SELECT METER buttons to select a metered value.
3. Press the PHASE button to select a phase.

In [Setup] mode, use the alternate descriptions in grey to the right of the LEDs. In SETUP mode, the PHASE, MODE, and SELECT METER buttons function differently than in the other display modes. For details see Chapter 4—Front Panel Operation.

Figure 2-1 shows the front panel of the portable circuit monitor. A description of the front panel follows.

1 6-Digit LED display. For local display of metered values.
2 Kilo/Mega LEDs. The Kilo LED lights when the displayed value is in Kilo units. The Mega LED lights when the displayed value is in Mega units.
3 Meter Indication LEDs. The lit LED indicates the value being displayed.
4 Setup/Reset Parameters. These grey, bracketed values are used to set up the PCM and perform resets. Refer to these values when in [Setup] mode.
5 Phase Indication LEDs. Indicate the phase for the displayed value. Note: If you select a metered value that does not provide a reading for the selected phase, the PCM automatically jumps to a phase for which a reading exists. For example, assume that you are viewing Phase A Power Factor, then change to Frequency; the PCM automatically jumps from Phase A to 3-Phase, since the PCM does not provide a Phase A Frequency reading.
6 PHASE Select Button. Press to select the phase for the selected meter value. Note: In [Setup] mode, press this button to move from one setup parameter to the next. See Chapter 4—Front Panel Operation for details.
7 SELECT METER buttons. Press to change the metered value being displayed. Note: In [Setup] mode, press these buttons to change the value of the displayed setup parameter. See Chapter 4—Front Panel Operation for details.
Mode Indication LEDs. These LEDs indicate the present display mode. The Alarm LED flashes when an alarm is active.

Mode Select Button. Press to select the display mode.

Optical Communications Port. This port allows the PCM to communicate to a portable computer using the optical communications interface (Class 3090 Type OCI-2000). The OCI-2000 mounts magnetically to the PCM and provides a standard RS-232 interface. Anything that can be done over the RS-485 communications link—including PCM setup—can also be done using the optical communications port. Appendix G tells how to use the OCI-2000.

Figure 2-1: Portable circuit monitor front panel
Figure 2-2 shows the connections for the PCM.

Figure 2-2: Portable circuit monitor connections
STANDARD HARDWARE

Standard hardware for the PCM includes a Model CM-2452 Circuit Monitor, a control power cable, a phase voltage cable for 3-wire connections, a phase voltage cable for 4-wire connections, four current transformer cables, two RS-485 communications cables, an RS-232 communications cable, and a heavy-duty canvas bag. The canvas bag is provided for transporting the cables, standard hardware, and optional hardware associated with the PCM.

The PCM is powered by 120 Vac. An ac power cable with ground is provided to supply control power to the PCM. Control power backup internal to the unit can provide power during an interruption for up to 15 seconds.

Two voltage cables are provided. Each voltage lead has a phase color code which matches the phase color code on the corresponding current lead. Both cables have quick connect screw type connectors on one end to connect to the PCM, and alligator clips on the other end to connect to the phase conductors and ground.

Four current transformer cables are provided, one for each of the three phases and one for the neutral current (optional). Each cable has a phase color code, which matches the phase color code of the corresponding voltage lead and the color code on the PCM.

The current transformer cables have quick connect screw type connectors on one end to connect to the PCM, and shrouded jacks on the other end to connect to optional clamp-on current transformers (CTs).

OPTIONAL HARDWARE

The following optional clamp-on current transformers (CTs) are available for specific applications:

- 150/300/600 AAC triplicate CTs, 1% accuracy 600V or below (assembly number: PLESNS36005)
- 500/1000/1500 AAC triplicate CTs, 1% accuracy 600V or below (assembly number: PLESH163155)
- 1000/2000/3000 AAC triplicate CTs, 1% accuracy 600V or below (assembly number: PLESHIP303305)

Each of the CTs listed above has a 5 amp secondary rating, and the software uses 5 amps as the default secondary rating. For example, to input the CT ratio into the optional software for the 150/300/600 AAC CT would require the user to simply input the primary rating of the CT (150, 300, or 600) into the appropriate field in the software.

An optional optical communications interface adapter (OCI-2000) is available to provide RS-232 communications through the circuit monitor front panel. (The order number for the OCI-2000 is 3090OCI-2000.)
An optional input/output module is available with form C relay output, KYZ relay output, and status inputs. For more information and specifications, refer to Chapter 6.

An optional internal modem is available for phone line connection.

**OPTIONAL SOFTWARE**

Any of the System Manager 3000 family of software products can be used with the PCM. For customers who do not have a permanently installed POWERLOGIC power monitoring system, the recommended software package for the PCM is SMS-121.

System Manager 3000 software is a Windows NT-based software package that provides real-time circuit information from POWERLOGIC circuit monitors, MICROLOGIC circuit breakers, Model-85 transformer temperature controllers, and other compatible devices. System Manager can provide comprehensive system information and device control from a single computer or from multiple personal computers on a network.

System Manager Software One-to-One is functionally the same as System Manager 3000 except that it is designed as stand-alone software that communicates with only one Series 2000 Circuit Monitor at a time.

**OPERATION AND CONNECTIONS**

The PCM is powered from 120 Vac nominal supply. The PCM is designed to measure up to 600 Vac rms and up to 5 amps current.

Clamp-on type CTs are available for connections around primary feed power cables or secondary load power cables. The PCM also accepts current inputs from existing CTs.

**Note:** The accuracy of the PCM when using external potential transformers and current transformers is based on the accuracy and burden of the transformers.
CHAPTER 3—INSTALLATION

CHAPTER CONTENTS

This chapter tells how to install the portable circuit monitor. Refer to the table of contents below to locate a specific topic.

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⚠️ DANGER

HAZARD OF PERSONAL INJURY OR DEATH.

Only qualified electrical workers should install and wire this equipment. Such work should be performed only after reading this complete set of instructions.

Failure to observe this precaution will result in severe personal injury or death!
WIRING CTs, PTs, AND CONTROL POWER

It is assumed that persons connecting the current and voltage leads of the PCM are qualified electrical workers.

Voltage Connections

Voltages up to 600 Vac can be measured with the PCM. Two types of voltage cables are provided, one to be used with four-wire systems and the other to be used with three-wire systems. The color coding on the voltage cables is as follows:

- Black: A phase
- Red: B phase
- Blue: C phase
- White: Neutral
- Green: Grounding lead

Which Cable Should be Used?

If the load of interest is a three phase, 4-wire load then the cable for four-wire systems should be used. The voltage cable to be used on four-wire systems has four voltage sensing leads and one equipment grounding lead.

If the load of interest is a three phase, 3 wire load with no neutral then the cable for three wire systems should be used. The voltage cable to be used on three-wire systems has three voltage sensing leads and one equipment grounding lead.

When connecting the voltage leads, the grounding conductor should be connected first. Care should be taken to avoid the situation described on the next page.

Current Connections

The current input connectors on the PCM are color coded the same as the voltage leads. Each current connection should first be made at the PCM assuring that the secondary path of the current transformer is complete.

<table>
<thead>
<tr>
<th>DANGER</th>
</tr>
</thead>
<tbody>
<tr>
<td>HAZARD OF DEATH, PERSONAL INJURY, OR EQUIPMENT DAMAGE.</td>
</tr>
</tbody>
</table>

Only qualified electrical workers should install and wire this equipment. Such work should be performed only after reading this complete set of instructions.

Follow proper safety procedures regarding CT secondary wiring. Never open circuit the secondary of a CT.

Tighten all CT connections securely.

Inspect the cables periodically for damage. Damage to the leads could result in open circuiting CTs. Damaged lead sets must be replaced.

Failure to observe this precaution will result in death, severe personal injury, or equipment damage!
Note: CONNECTING TO CIRCUIT. Read the following instructions carefully and completely before making any connections. Pay close attention to the notes as you are referred to them.

**DANGER**

**POTENTIALLY HAZARDOUS VOLTAGES.**

Elevated ground voltage condition may exist. Test for voltage potential between ground circuits before connecting the portable circuit monitor.

Failure to observe this precaution will result in death, serious personal injury, or electric shock!

Read the following information and the DANGER message above, and refer to figure 3.1 below before connecting monitored (equipment) ground at the circuit.

Temporary monitoring sometimes connects two unbonded ground systems which may be at different potentials. This condition can occur when the PCM is being powered from an external ac source. The PCM power cord contains a ground terminal. The PCM is also equipped with a ground lead to attach it to the circuit to be monitored. These two ground terminals are tied together within the PCM. The PCM chassis and case are also bonded to these ground terminals. This bonding is necessary.

If an elevated ground voltage condition exists, it is undesirable to connect the two ground systems through the PCM. Potentially hazardous voltage can be imposed on the PCM ground system (chassis), causing unwanted currents to flow (see figure 3.1 below). The best way to determine the existence of ground voltages is to measure (with a voltmeter) between the two grounds prior to hookup.

Before connecting the voltage leads to the monitored circuit, follow these steps:

1. Connect the PCM to a Control Power Source.
2. Connect the voltage sense cable to the PCM.
3. Using a voltmeter, measure the voltage between the green ground lead on the PCM voltage sense cable and the grounding point for the monitored circuit.
4. If the ground systems are at different potentials, do not proceed with the hookup until the ground voltage has been eliminated.

If necessary, Square D provides on-site engineering assistance which can resolve this and other power quality problems. Contact the POWERLOGIC Engineering Services Group at (615)287-3332.
Current Connections (cont’d)

Four-wire systems can be measured with either three (A, B, and C phases) or four current inputs (A, B, and C phases and Neutral). Three-wire systems require only two current inputs, one CT on A-phase and one CT on C-phase.

The proper procedure for installing current transformers is as follows:

1. Choose the correct size current transformer based on the expected current and the conductor size.
2. Connect the quick connect current connectors to the PCM observing the color codes.
3. Connect the current leads to the appropriate terminals on the current transformer. Figure 3-2 on the next page shows three CT terminal connections.
4. Install the CTs on the conductors being measured.

Be careful to remove the CTs in the reverse order. Removal of the quick connect connectors at the PCM before removing the CT from the conductor will result in an open circuit on the secondary of the CT creating a dangerous situation.

---

**DANGER**

HAZARD OF DEATH, PERSONAL INJURY, OR EQUIPMENT DAMAGE.

Only qualified electrical workers should install and wire this equipment. Such work should be performed only after reading this complete set of instructions.

Follow proper safety procedures regarding CT secondary wiring. Never open circuit the secondary of a CT.

Tighten all CT connections securely.

Inspect the cables periodically for damage. Damage to the leads could result in open circuiting CTs. Damaged lead sets must be replaced.

Failure to observe this precaution will result in death, severe personal injury, or equipment damage!
Figure 3-2: CT Terminals
Current Connections (cont'd)

The circuit monitor supports a variety of 3-phase power system wiring connections, including 3-wire delta, and 4-wire wye. Table 3-1 lists the supported system connections. Figures 3-3 through 3-5 show CT, PT, and control power wiring.

DANGER

HAZARD OF PERSONAL INJURY OR DEATH.
Only qualified electrical workers should install and wire this equipment. Such work should be performed only after reading this complete set of instructions.

Follow proper safety procedures regarding CT secondary wiring. Never open circuit the secondary of a CT.

Failure to observe this precaution will result in severe personal injury or death!

Table 3-1
Supported System Wiring Connections

<table>
<thead>
<tr>
<th>System Type</th>
<th>Sys ID</th>
<th># CTs</th>
<th>Aux. CT</th>
<th># PTs</th>
<th>PT Conn.</th>
<th>Currents</th>
<th>Voltages</th>
<th>Figure #</th>
</tr>
</thead>
<tbody>
<tr>
<td>3Ø, 3-wire Delta</td>
<td>30</td>
<td>2</td>
<td>None</td>
<td>2</td>
<td>Open Delta</td>
<td>A, B², C</td>
<td>A-B, B-C, C-A²</td>
<td>3-3</td>
</tr>
<tr>
<td>3Ø, 4-wire Wye, Ground</td>
<td>40</td>
<td>3</td>
<td>None</td>
<td>3</td>
<td>Wye-Wye</td>
<td>A, B, C, N²</td>
<td>A-N, B-N, C-N A-B², B-C², C-A²</td>
<td>3-4</td>
</tr>
<tr>
<td>3Ø, 4-wire Wye, Ground</td>
<td>41</td>
<td>3</td>
<td>Neut</td>
<td>3</td>
<td>Wye-Wye</td>
<td>A, B, C, N, G²</td>
<td>A-N, B-N, C-N A-B², B-C², C-A²</td>
<td>3-5</td>
</tr>
</tbody>
</table>

1 The System ID is used during setup to specify the system type.
2 Indicates a value that is calculated rather than measured directly.
Pay close attention to polarity marks (■) when connecting CTs and PTs.

Figure 3-3: 3-phase, 3-wire delta connection
Pay close attention to polarity marks (■) when connecting CTs and PTs.

**NOTE**

Figure 3-4: 3-phase, 4-wire wye, ground connection
Figure 3-5: 3-phase, 4-wire Wye, ground connection, metered neutral

Pay close attention to polarity marks (■) when connecting CTs and PTs.

NOTE

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Current Connections (cont’d)

The portable circuit monitor has internal 600:120 V PTs. To compensate for the 600:120 (5 to 1) ratio, the PT ratio of the circuit monitor has been set to 120:24. For example, for 120 V applied between the A-phase voltage lead and ground, the voltage is transformed to 24 V by the internal PTs. The circuit monitor senses 24 V, applies the 120:24 PT ratio, and the voltage reading for A-phase is 120 V.

In the event that the factory PT ratio settings are lost, the secondary PT ratio can be set by writing the desired value to register 2008. The portable circuit monitor ships from the factory with a value of 24 in register 2008. The primary PT ratio can be set using the front panel configuration (see Configuring the Portable Circuit Monitor in Chapter 4) or by using System Manager software.

The PCM can measure, with direct connection, up to 600 Vac. No change of the primary of the PT ratio is needed for direct connection to systems less than 600 V (see figure 3-6).

![Configuration Panel]

Figure 3-6: PT ratio is 120:24 for direct connection to systems less than 600 V.
**Current Connections (cont’d)**

Anytime external PTs are used to reduce the system voltage to a level suitable for monitoring, the ratio of the PTs must be input into the monitor. For example, to measure the voltage on a 12470 V, 3-phase, 4-wire system with 7200:120 V PTs, the PT primary ratio in the PCM should be set to 7200 V (see figure 3-7).

CT ratios in the PCM assume a 5 Amp secondary. For a 3000A to 5A CT the primary CT ratio in the PCM should be set to 3000A.

![Diagram](image)

*Figure 3-7: PT ratio is 7200:24 for a 12470 V, 3-phase, 4-wire system with 7200:120 V PTs.*
COMMUNICATIONS WIRING

There are three communications options available with the PCM. The first is RS-232 through the DB-25 connection port, located on the front panel of the PCM. The second is through the quick connect RS-485 communications ports on the exterior of the unit. These ports can be used to connect into an existing communications network. The third option provided is RS-232 through the optical communications interface (OCI), which is built into the front panel of the portable circuit monitor.

Note: Only one communications option can be used at any given time.

POWERLOGIC devices are equipped with RS-485 communications. The RS-485 standard lets you daisy-chain up to 32 POWERLOGIC-compatible devices to a single communications port. This document refers to a chain of POWERLOGIC devices connected by communications cable as a communications link.

A POWERLOGIC communications link can consist of up to 32 POWERLOGIC-compatible devices connected to a communications port on one of the following:

- POWERLOGIC System Display
- Personal computer
- POWERLOGIC Network Interface Module
- SY/MAX® programmable controller
- Other host devices with a POWERLOGIC-compatible port

Figures 3-8 through 3-12 show circuit monitors and other POWERLOGIC compatible devices connected in typical systems. The accompanying text describes important considerations for each connection alternative.

The figures also show the placement of communications adapters and terminators. For additional information on using the communications adapter and terminator, see Terminating the Communications Link, and Biasing the Communications Link in this chapter.
**Connecting to a System Display**

- Connect up to 32 circuit monitors to the system display for Circuit Monitors (Class 3050 Types SD-200, SD-220). See *Length of the Communications Link* in this chapter for distance limitations at varying baud rates.

- Connect circuit monitors to the RS-485 port on the bottom of the system display.

- Configure the system display’s baud rate to match the baud rate of circuit monitors on the communications link.

- Refer to the instruction bulletin for the system display for circuit monitors (Class 3050 Types SD-200, SD-220) for detailed instructions on configuring the system display.

Figure 3-8: PCM connected directly to system display
Connecting to a Personal Computer

- Connect up to 32 POWERLOGIC devices to a personal computer. See Length of the Communications Link in this chapter for distance limitations at varying baud rates.

- POWERLOGIC devices can be connected to a SY/LINK card installed in the personal computer. To do this, connect the POWERLOGIC devices to the RS-422 port (top port) of the SY/LINK card.

Figure 3-9: PCM connected directly to PC 9-pin serial port

Figure 3-10: PCM connected directly to PC SY/LINK card
Connecting to a POWERLOGIC • Network Interface Module (PNIM)

Connect up to 32 POWERLOGIC devices to a PNIM. See Length of the Communications Link in this chapter for distance limitations at different baud rates.

- Connect POWERLOGIC devices to PNIM port 0 (top RS-485 port) only.
- Configure PNIM port 0 for “POWERLOGIC” mode. (See side of PNIM for instructions on setting dip switches.
- Configure the baud rate of PNIM port 0 to match the baud rate of the POWERLOGIC devices on the communications link.
- Refer to the PNIM instruction bulletin for detailed instructions on configuring the PNIM.

Figure 3-11: POWERLOGIC devices connected to a PNIM
Connecting to a SY/MAX Programmable Controller

- Connect up to 32 POWERLOGIC devices to a programmable controller. See Length of the Communications Link in this chapter for distance limitations at different baud rates.
- Connect POWERLOGIC devices to the RS-422 port of the programmable controller.
- The programmable controller must contain a program to access POWERLOGIC device data.
- Configure the baud rate of the programmable controller’s port to match the baud rate of the POWERLOGIC devices on the communications link.
- Refer to the programmable controller instruction manual for detailed instructions on configuring the programmable controller.

NOTE

POWERLOGIC devices can be connected to other manufacturer’s systems using available communication interfaces. For further information, contact the POWERLOGIC Technical Support Center. See Getting Technical Support in Chapter 12—Maintenance and Troubleshooting.

Figure 3-12: POWERLOGIC devices connected to a SY/MAX programmable controller
Modem Communication

An internal modem is optional in the portable circuit monitor. If the modem option is chosen, the modem must be installed at the factory. An additional standard RS-232 cable will be shipped with the PCM to allow communications for modem setup from a PC to the internal modem (figure 3-13).

Modem communication to several portable circuit monitors on a communications link is shown in figure 3-14. In this fashion several circuits can be temporarily monitored at a remote site. The optional internal modem at the first PCM in the communications link provides a means to communicate onboard data logs from each PCM over the phone line.

The modem loopback connector must be in place for modem communications.

![Figure 3-13: Communication from PC to an internal modem for modem set-up](image)

**Note:** To set up the modem use the standard RS-232 cable supplied with the unit. Make sure the PCMMODJ11 is connected for setup.
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 PNIM, personal computer, system display, or processor, to the last device in the daisy-chain, cannot exceed 10,000 feet. When 17 or more devices are on a PCMCAB-107 or equivalent cable and a Multipoint Communications Adapter. See Biasing the Communications Link in this chapter for instructions.

Table 3-2
Maximum Distances of Comms Link at Different Baud Rates

<table>
<thead>
<tr>
<th>Baud Rate</th>
<th>1–16 devices</th>
<th>17–32 devices</th>
</tr>
</thead>
<tbody>
<tr>
<td>1200</td>
<td>10,000 ft. (3,050 m)</td>
<td>10,000 ft. (3,050 m)</td>
</tr>
<tr>
<td>2400</td>
<td>10,000 ft. (3,050 m)</td>
<td>5,000 ft. (1,525 m)</td>
</tr>
<tr>
<td>4800</td>
<td>10,000 ft. (3,050 m)</td>
<td>5,000 ft. (1,525 m)</td>
</tr>
<tr>
<td>9600</td>
<td>10,000 ft. (3,050 m)</td>
<td>4,000 ft. (1,220 m)</td>
</tr>
<tr>
<td>19200</td>
<td>10,000 ft. (3,050 m)</td>
<td>2,500 ft. (762.5 m)</td>
</tr>
</tbody>
</table>
Terminating the Communications Link

To ensure reliable communications, terminate the last device on a POWERLOGIC communications link. To terminate the last device, use a POWERLOGIC Multipoint Communications Terminator (PCM MCT-485).

**NOTE**

Terminate only the last device on the link. If a link has only one device, terminate that device.
Biasing the Communications Link

To ensure reliable communications, bias the communications link. To bias the communications link, use a POWERLOGIC Multipoint Communications Adapter (Class 3090 Type MCA-485).

To bias the communications link, plug the adapter into the communications port of the device to which one or more POWERLOGIC devices are connected. Plug the PCMCAB-107 cable connected to the first portable circuit monitor on the link into the other end of the MCA-485 adapter.

Figure 3-15 shows the adapter connected to a POWERLOGIC Network Interface Module (PNIM).

![Multipoint Communications Adapter connected to PNIM](image)
CHAPTER 4—FRONT PANEL OPERATION

CHAPTER CONTENTS

This chapter tells how to set up the portable circuit monitor from the front panel only. Some advanced portable circuit monitor features, such as event log/data log configuration, must be set up over the communications link. You can set up these advanced features using POWERLOGIC software. Refer to the software instruction bulletin for instructions on setting up advanced features.

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The Resets Option ............................................................................................ 34
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THE SETUP MODE

To access the Setup Mode, press the MODE button until the red LED next to [Setup] is lit. The portable circuit monitor displays “Config”—the first of four setup options. The portable circuit monitor displays the options as abbreviated combinations of uppercase and lowercase letters. The abbreviations displayed by the portable circuit monitor, and their full names are shown below.

<table>
<thead>
<tr>
<th>Full Name</th>
<th>CM Display</th>
</tr>
</thead>
<tbody>
<tr>
<td>Configuration Option</td>
<td>ConFig</td>
</tr>
<tr>
<td>Resets Option</td>
<td>rESETs</td>
</tr>
<tr>
<td>Alarm/Relay Option</td>
<td>ALrLy</td>
</tr>
<tr>
<td>Diagnostics Option</td>
<td>diAG</td>
</tr>
</tbody>
</table>

The Configuration Option

The Configuration option lets you configure the following values: CT and PT primaries, system type, demand interval, WH/pulse output, device address, baud rate, nominal frequency, and password. You can also reset energy, demand, and min/max values. See Configuring the Portable Circuit Monitor, on the following page, for more information.

The Resets Option

The Resets option lets you reset energy, demand and min/max values. These same reset operations can be done using the Configuration option. The difference is that using the Resets option, you cannot change portable circuit monitor configuration values. See Performing Resets Using the Resets Option, in this chapter for more information.

The Alarm/Relay Option

The Alarm/Relay option lets you configure the portable circuit monitor’s on-board alarm/relay functions. (See Appendix I for a complete listing of the portable circuit monitor’s predefined alarm conditions.) For each of the portable circuit monitor’s predefined alarm conditions, you can:

- Enable or disable it
- Assign a priority to it
- Define any required pickup and dropout setpoints, and pickup and dropout time delays
- Setup the portable circuit monitor to operate up to three relay outputs when the alarm condition occurs

See Setting Up Alarm/Relay Functions, on page 52, for details on how to use this option.

The Diagnostics Option

The Diagnostics option lets you read and write portable circuit monitor registers. Use this feature with caution. Writing an incorrect value, could cause the portable circuit monitor to operate incorrectly. See Appendix H for instructions on reading and writing registers using the Diagnostics option.
Choosing a Setup Option

To enter the [Setup] mode, press the MODE button until the [Setup] LED is lit. The portable circuit monitor displays “ConFig.” To move to a specific option, use the SELECT METER [Value] buttons. To select an option, press the PHASE [Enter] button (see figure 4-1).

How the Buttons Work

The portable circuit monitor’s front panel buttons perform different functions in Setup mode than in Meters mode. In Setup mode, the buttons work as described below.

The PHASE [Enter] button. In Setup mode, use this button as an “Enter” key to accept a new configuration value and move to the next configuration item. For example, after changing the CT Primary value, press this button to enter the new value and move to the next configuration item (PT Primary). Also, press this button to move through configuration items that don’t need to be changed, to reach a specific item.

SELECT METER [Value] buttons. In Setup mode, use these buttons to increase or decrease the displayed value. Also, use these buttons to toggle between Yes and No when required.

MODE button. Use this button to exit a setup option after making all desired changes. For example, after making all desired changes within the Configuration option, press the mode key. The portable circuit monitor then asks you to accept or reject your changes.
CONFIGURING THE PORTABLE CIRCUIT MONITOR

This section tells how to use the Configuration option to define the following values: CT and PT ratios, system type, demand interval, WH/pulse output, device address, baud rate, nominal frequency, and password. It also tells how to reset energy, demand and min/max values.

The section General Configuration Procedure describes the general steps required to configure the portable circuit monitor. The remaining sections tell how to configure specific values.

Factory Defaults

Table 4-1 lists the front panel configuration parameters, their allowed values, and their factory defaults.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Allowed Values</th>
<th>Default</th>
</tr>
</thead>
<tbody>
<tr>
<td>CT Primary</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Primary, 3-Phase</td>
<td>1 to 32,767</td>
<td>5</td>
</tr>
<tr>
<td>Primary, Neutral</td>
<td>1 to 32,767</td>
<td>5</td>
</tr>
<tr>
<td>PT Primary</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Primary, 3-Phase</td>
<td>1 to 1,700,000</td>
<td>120</td>
</tr>
<tr>
<td>System Type</td>
<td>30, 40, 41</td>
<td>40</td>
</tr>
<tr>
<td>Demand Interval</td>
<td>5 to 60 min.</td>
<td>15</td>
</tr>
<tr>
<td>WH/Pulse output</td>
<td>0 to 3276.7 kWh</td>
<td>0</td>
</tr>
<tr>
<td>Device Address</td>
<td>0 to 199</td>
<td>1</td>
</tr>
<tr>
<td>Baud Rate</td>
<td>1200-19.2K</td>
<td>9600</td>
</tr>
<tr>
<td>Frequency (Nom.)</td>
<td>50, 60, 400</td>
<td>60</td>
</tr>
<tr>
<td>Password</td>
<td>0 to 9998</td>
<td>0</td>
</tr>
</tbody>
</table>

General Configuration Procedure

This section describes the general steps required to configure the Portable Circuit Monitor from the front panel. The configuration items (and reset items) are the grey items in square brackets on the front panel of the portable circuit monitor. Refer to these items when configuring the portable circuit monitor.

The front panel configuration procedure is described below. Alternately, figure 4-2 on page 36 shows the configuration procedure, with less detail, as a flow chart.

To configure the portable circuit monitor, complete the following steps:

1. Press the MODE button until the red LED next to [Setup] is lit. The portable circuit monitor displays “ConFig”.
2. Press the PHASE [Enter] button to select the Configuration option. The portable circuit monitor displays the password prompt “P - - - -.”
3. Enter the password.
   To enter the password, use the SELECT METER [Value] buttons to increase or decrease the displayed value until it reaches the password value. Then press the PHASE [Enter] button. (The portable circuit monitor’s default password is 0.)
   The red LED next to [CT Primary] flashes.

4. Press the PHASE [Enter] button to select a configuration item.
   The red LED next to the selected configuration item flashes.

5. Press the SELECT METER [Value] buttons to increase or decrease the displayed value until the desired value is displayed.
   In the case of the [Reset] items, use the SELECT METER [Value] buttons to toggle between Yes and No. See Resetting Demand, Energy, and Min/Max Values in this chapter for more on resets.

6. Repeat steps 4 and 5 until you’ve made all desired configuration changes.

7. After making all desired configuration changes, press the MODE button once.
   The red LED next to [Accept] flashes. The portable circuit monitor display reads No, and the red LEDs next to the items that you have changed are lit. Verify that only the LEDs next to the setup items you wish to change are lit.

8. To reject the changes, press the PHASE [Enter] button once.
   The portable circuit monitor returns to Meters mode.

9. To accept the changes, press the SELECT METER [Value] button to change from No to Yes. Then, press the PHASE [Enter] button.
   The portable circuit monitor goes through its restart procedure. This indicates that the changes have been made.
START

Press the MODE key until the [Setup] LED is lit.

Press the PHASE [Enter] key to enter Configuration mode.

Use the SELECT METER keys to display the password. Then press the PHASE [Enter] key.

The CM enters Configuration mode.

Press the PHASE [Enter] key to move to the value to be changed.

Use the SELECT METER keys to change the value.

Do you want to change another value?

YES

NO

Press the MODE key once.

Do you want to accept the changes?

NO

Press the PHASE [Enter] key. The CM leaves Configuration mode.

YES

Press the SELECT METER key.

Press the PHASE [Enter] key. CM accepts changes and restarts.

Figure 4-2: Flowchart for front panel configuration
**Viewing Configuration Data in Protected Mode**

The portable circuit monitor provides a special protected viewing mode that lets you view, but not change, configuration data.

*To view configuration data, complete the following steps:*

1. Press the MODE button until the red LED next to [Setup] is lit.
   The portable circuit monitor displays “ConFig”.
2. Press the PHASE [Enter] button.
   The portable circuit monitor displays the password prompt “P - - - -.”
3. Enter 9999 for the password.
   To enter 9999, use the SELECT METER [Value] buttons to decrease the displayed value until it reaches 9999. Then press the PHASE [Enter] button.
   The portable circuit monitor enters the protected viewing mode and scrolls through the following device information:
   - d=2452 (the number after “d=” represents the device model number)
   - s=0345 (the numbers following “s=” represent the last four digits of the device serial number)
   - r=1516 (the first two digits after “r=” represent the reset code revision and the last two digits represent the portable circuit monitor firmware revision level)
   - 1=007 (the digits following “1=” represent the portable circuit monitor firmware sub-revision level, as in firmware version 16.001)

   After this scrolling sequence, the display shows the present CT ratio.

4. Press the PHASE [Enter] button to move from one configuration item to the next.
5. To exit the protected viewing mode, press the MODE button.
   The portable circuit monitor returns to METERS mode.
Setting the Master Password

The portable circuit monitor’s four setup modes are password protected. A master password can be used to access any of the four setup modes. In addition to the master password, the portable circuit monitor provides a reset password. The reset password provides access to the Resets option only. Until you define a unique reset password, the reset password defaults to the master password. For instructions on defining and using the reset password see Performing Resets Using the Resets Option in this chapter.

The master password can be any value in the range 0 to 9998. The factory default is 0.

To change the master password, complete the following steps:

1. Press the MODE button until the red LED next to [Setup] is lit. The portable circuit monitor displays “ConFig.”
2. Press the PHASE [Enter] button to select the Configuration option. The portable circuit monitor displays the password prompt “P - - - -.”
3. Enter the existing master password. To enter the password, use the SELECT METER [Value] buttons to increase or decrease the displayed value until it reaches the password value. Then press the PHASE [Enter] button. (The portable circuit monitor’s default password is 0.)
4. Press the PHASE [Enter] button until the red LED next to [Set Password] flashes.
5. Press the SELECT METER [Value] buttons until the desired password value is displayed. The password can be any value from 0 to 9998.
7. To reject the new password, press the PHASE [Enter] button once. The portable circuit monitor returns to METERS mode.
8. To accept the new password, press the up arrow SELECT METER [Value] button to change from No to Yes. Then, press the PHASE [Enter] button. The portable circuit monitor returns to METERS mode.
**Setting the CT Ratios**

The portable circuit monitor supports two primary CT ratings: one for the phase CTs and one for the neutral CT. The allowable range is 1 to 32,767. The factory default for both CT secondaries is 5.

**Note:** The neutral CT is optional. If the portable circuit monitor is set up for any system type that does not require a neutral CT, the portable circuit monitor ignores the neutral CT rating (even if neutral currents are reported).

*To change the primary CT ratings, complete the following steps:*

1. Press the MODE button until the red LED next to [Setup] is lit. The portable circuit monitor displays “ConFig”.
2. Press the PHASE [Enter] button to select the Configuration option. The portable circuit monitor displays the password prompt “P - - - -.”
3. Enter the master password. To enter the password, use the SELECT METER [Value] buttons to increase or decrease the displayed value until it reaches the password value. Then press the PHASE [Enter] button.
   The red LED next to [CT Primary] flashes indicating that the portable circuit monitor is in Configuration mode. The 3-PHASE LED also lights indicating that the portable circuit monitor is displaying the 3-phase, primary CT rating.
4. Press the SELECT METER [Value] buttons until the desired 3-phase, primary CT rating is displayed.
5. Press the PHASE [Enter] button once. The N (Neutral) phase LED lights, and the portable circuit monitor displays the primary CT rating for the neutral CT.
6. Press the SELECT METER [Value] buttons until the desired neutral primary CT rating is displayed.
7. Press the MODE button once. The red LED next to [Accept] flashes. The red LED next to [CT Primary] glows steadily.
8. To reject the new CT rating(s), press the PHASE [Enter] button once. The portable circuit monitor returns to METERS mode.
9. To accept the new CT rating(s), press the UP ARROW SELECT METER [Value] button to change from No to Yes. Then, press the PHASE [Enter] button. The portable circuit monitor restarts.
Setting the PT Ratio

The portable circuit monitor supports one primary PT rating. The allowable range is 1 to 1,700,000 volts. The factory default PT secondary is 120 V.

To change the primary PT rating, complete the following steps:

1. Press the MODE button until the red LED next to [Setup] is lit.
   The portable circuit monitor displays “ConFig”.
2. Press the PHASE [Enter] button to select the Configuration option.
   The portable circuit monitor displays the password prompt “P - - - -.”
3. Enter the master password.
   To enter the password, use the SELECT METER [Value] buttons to increase or decrease the displayed value until it reaches the password value. Then press the PHASE [Enter] button.
3. Press the PHASE [Enter] button twice.
   The red LED next to the [PT Primary] item flashes. The 3-PHASE LED lights, and the portable circuit monitor displays the primary PT rating for the 3-Phase PTs.
4. Press the SELECT METER [Value] buttons until the desired primary PT rating is displayed.
5. Press the MODE button once.
   The red LED next to [Accept] flashes. The red LED next to [PT Primary] glows steadily.
6. To reject the new PT rating, press the PHASE [Enter] button once.
   The portable circuit monitor returns to METERS mode.
7. To accept the new PT rating, press the up arrow SELECT METER [Value] button to change from No to Yes. Then, press the PHASE [Enter] button.

Table 4-2
Supported System Type System Code Selections

<table>
<thead>
<tr>
<th>System Type</th>
<th># Phase CTs</th>
<th>Aux CT</th>
<th># PTs</th>
<th>PT Conn.</th>
<th>System Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>3φ, 3-wire Delta</td>
<td>2</td>
<td>None</td>
<td>2</td>
<td>Open Delta</td>
<td>30</td>
</tr>
<tr>
<td>3φ, 4-wire Wye, Grounded</td>
<td>3</td>
<td>None</td>
<td>3</td>
<td>Wye-Wye</td>
<td>40</td>
</tr>
<tr>
<td>3φ, 4-wire Wye, Grounded</td>
<td>3</td>
<td>1 (Neut)</td>
<td>3</td>
<td>Wye-Wye</td>
<td>41</td>
</tr>
</tbody>
</table>
Setting the System Type

For the portable circuit monitor to meter correctly, you must specify the system connection type. The portable circuit monitor supports three system wiring connections. Table 4-2 shows the system connection types. The factory default is 40.

To change the system type, complete the following steps:

1. Press the MODE button until the red LED next to [Setup] is lit.
   The portable circuit monitor displays “ConFig.”

2. Press the PHASE [Enter] button to select the Configuration option.
   The portable circuit monitor displays the password prompt “P - - - -.”

3. Enter the password.
   To enter the password, use the SELECT METER [Value] buttons to increase or decrease the displayed value until it reaches the password value. Then press the PHASE [Enter] button.

4. Press the PHASE [Enter] button until the red LED next to [Sys. Type] flashes.

5. Press the SELECT METER [Value] buttons until the system code matching your system type is displayed.
   Refer to table 4-2 to determine the system code for your system type.

6. Press the MODE button once.
   The red LED next to [Accept] flashes. The red LED next to [Sys. Type] glows steadily.

7. To reject the new system type, press the PHASE [Enter] button once.
   The portable circuit monitor returns to METERS mode.

8. To accept the new system type, press the SELECT METER [Value] button to change from No to Yes. Then, press the PHASE [Enter] button.
   The portable circuit monitor restarts.

Setting the Demand Interval

The portable circuit monitor supports several methods to calculate average demand real power. The default method is the thermal demand method. For a description of available demand calculation methods, see Demand Readings in Chapter 5.

One optional method is the demand synch pulse input method. In this method, the portable circuit monitor accepts an external synch pulse from another demand meter. The portable circuit monitor then uses the same time interval as the other meter for each demand calculation. For a more detailed description of the demand synch pulse input method, see Demand Synch Pulse Input in Chapter 6. Note: The portable circuit monitor must be equipped with an input/output module to use the Demand Synch Pulse Input feature.
Setting the Demand Interval (cont.)

The thermal demand (default) method and the demand synch pulse input method can be set up from the portable circuit monitor front panel. Other methods must be set up over the communications link, or using the front panel diagnostics feature (see Appendix H for instructions on using this feature).

To set up the portable circuit monitor for the default thermal demand method, complete the procedure below—entering a demand interval from 5 to 60 minutes (the factory default is 15). To set up the portable circuit monitor for the demand synch pulse input method, follow the procedure below and set the demand interval to 0 minutes.

To change the demand interval, complete the following steps:

1. Press the MODE button until the red LED next to [Setup] is lit.
   The portable circuit monitor displays “ConFig.”

2. Press the PHASE [Enter] button to select the Configuration option.
   The portable circuit monitor displays the password prompt “P - - - -.”

3. Enter the password.
   To enter the password, use the SELECT METER [Value] buttons to increase or decrease the displayed value until it reaches the password value. Then press the PHASE [Enter] button.

4. Press the PHASE [Enter] button until the red LED next to [Dmd. Int.] flashes.

5. Press the SELECT METER [Value] buttons until the desired demand interval is displayed.
   Select 0 for the demand synch pulse input method.

6. Press the MODE button once.

7. To reject the new demand interval, press the PHASE [Enter] button.
   The portable circuit monitor returns to METERS mode.

8. To accept the new demand interval, press the SELECT METER [Value] button to change from No to Yes. Then, press the PHASE [Enter] button.
   The portable circuit monitor restarts.
Setting the Watthour/Pulse Output

The allowable range for the watthours-per-pulse output is 0 to 3,276.7 kWh. The watthours per pulse can be set in one-tenth kWh increments, generating a pulse as often as every 0.1 kWh (not to exceed 10 pulses per second), or as seldom as every 3276.0 kWh. Setting the watthours per pulse to 0 disabling the pulse. The factory default is 0.

Note: The portable circuit monitor must be equipped with an input/output module to use this feature. For a more detailed description of the watthour pulse output feature, see Solid-State KYZ Pulse Output in Chapter 6.

To change the Watthour/Pulse output, complete the following steps:

1. Press the MODE button until the red LED next to [Setup] is lit. The portable circuit monitor displays “ConFig.”
2. Press the PHASE [Enter] button to select the Configuration option. The portable circuit monitor displays the password prompt “P - - - -.”
3. Enter the password.
   To enter the password, use the SELECT METER [Value] buttons to increase or decrease the displayed value until it reaches the password value. Then press the PHASE [Enter] button.
4. Press the PHASE [Enter] button until the red LED next to [WH/Pulse] flashes.
5. Press the SELECT METER [Value] buttons until the desired kilowatthours per pulse value is displayed.
6. Press the MODE button once.
   The red LED next to [Accept] flashes. The red LED next to [WH/Pulse] glows steadily.
7. To reject the new pulse interval, press the PHASE [Enter] button once. The portable circuit monitor returns to METERS mode.
8. To accept the new pulse interval, press the SELECT METER [Value] button to change from No to Yes. Then, press the PHASE [Enter] button. The portable circuit monitor restarts.
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.) The allowable range of addresses is 1 to 198. The factory default address is 1. (The portable circuit monitor will actually accept address 199, but address 199 is a special reserved address and we recommend that you not use it.)

Note: By networking groups of devices, POWERLOGIC systems can support a virtually unlimited number of devices.

When addressing POWERLOGIC devices, remember the following points:

• Each device on a single communications link—including the PNIM or SY/LINK card—must be assigned a unique address.

• Normally, the last device on a communications link—the device farthest from the communications port—should be assigned device address 1.

• If a communications link has only a single device, assign it address 1.

• If you add devices to the communications link, the last device should retain the address 1.

To change the device address, complete the following steps:

1. Press the MODE button until the red LED next to [Setup] is lit. The portable circuit monitor displays “ConFig.”

2. Press the PHASE [Enter] button to select the Configuration option. The portable circuit monitor displays the password prompt “P - - - -.”

3. Enter the password.
   To enter the password, use the SELECT METER [Value] buttons to increase or decrease the displayed value until it reaches the password value. Then press the PHASE [Enter] button.

4. Press the PHASE [Enter] button until the red LED next to [Address] flashes.

5. Press the SELECT METER [Value] buttons until the desired address is displayed.

6. Press the MODE button once.
   The red LED next to [Accept] flashes. The red LED next to [Address] glows steadily.

7. To reject the new address, press the PHASE [Enter] button once.
   The portable circuit monitor returns to METERS mode.

8. To accept the new address, press the SELECT METER [Value] button to change from No to Yes. Then, press the PHASE [Enter] button.
   The portable circuit monitor restarts.
Setting the Baud Rate

Set the portable circuit monitor’s baud rate to match the baud rate of all other devices on the communications link. The available baud rates are 1200, 2400, 4800, 9600, and 19200. The factory default is 9600 bps.

The maximum baud rate may be limited by the number of devices and total length of the communications link. Table 4-3 shows distance restrictions at varying baud rates.

To change the baud rate, complete the following steps:

1. Press the MODE button until the red LED next to [Setup] is lit.
   The portable circuit monitor displays “ConFig.”
2. Press the PHASE [Enter] button to select the Configuration option.
   The portable circuit monitor displays the password prompt “P - - - -.”
3. Enter the password.
   To enter the password, use the SELECT METER [Value] buttons to increase or decrease the displayed value until it reaches the password value. Then press the PHASE [Enter] button.
4. Press the PHASE [Enter] button until the red LED next to [Baud Rate] flashes.
5. Press the SELECT METER [Value] buttons until the desired baud rate is displayed.
6. Press the MODE button once.
   The red LED next to [Accept] flashes. The red LED next to [Baud Rate] glows steadily.
7. To reject the new baud rate, press the PHASE [Enter] button once.
   The portable circuit monitor returns to METERS mode.
8. To accept the new baud rate, press the SELECT METER [Value] button once to change from No to Yes. Then, press the PHASE [Enter] button.
   The portable circuit monitor restarts.

### Table 4-3
Maximum Distances of Comms Link at Varying Baud Rates

<table>
<thead>
<tr>
<th>Baud Rate (bps)</th>
<th>1–16 devices</th>
<th>17–32 devices</th>
</tr>
</thead>
<tbody>
<tr>
<td>1200</td>
<td>10,000 ft. (3,050 m)</td>
<td>10,000 ft. (3,050 m)</td>
</tr>
<tr>
<td>2400</td>
<td>10,000 ft. (3,050 m)</td>
<td>5,000 ft. (1,525 m)</td>
</tr>
<tr>
<td>4800</td>
<td>10,000 ft. (3,050 m)</td>
<td>5,000 ft. (1,525 m)</td>
</tr>
<tr>
<td>9600</td>
<td>10,000 ft. (3,050 m)</td>
<td>4,000 ft. (1,220 m)</td>
</tr>
<tr>
<td>19200</td>
<td>10,000 ft. (3,050 m)</td>
<td>2,500 ft. (762.5 m)</td>
</tr>
</tbody>
</table>
Setting the Nominal Frequency

The portable circuit monitor supports three nominal frequencies: 50 Hz, 60 Hz, and 400 Hz. The factory default is 60 Hz.

To change the nominal frequency, complete the following steps:

1. Press the MODE button until the red LED next to [Setup] is lit.
   The portable circuit monitor displays “ConFig.”

2. Press the PHASE [Enter] button to select the Configuration option.
   The portable circuit monitor displays the password prompt “P - - - -.”

3. Enter the password.
   To enter the password, use the SELECT METER [Value] buttons to increase or decrease the displayed value until it reaches the password value. Then press the PHASE [Enter] button.

4. Press the PHASE [Enter] button until the red LED next to [Nom. Freq.] flashes.

5. Press the SELECT METER [Value] buttons until the desired frequency is displayed.

6. Press the MODE button once.

7. To reject the new nominal frequency, press the PHASE [Enter] button once.
   The portable circuit monitor returns to METERS mode.

8. To accept the new nominal frequency, press the SELECT METER [Value] button once to change from No to Yes. Then, press the PHASE [Enter] button.
   The portable circuit monitor restarts.

NOTE

If the PCM cannot measure a valid frequency, it uses the nominal frequency to perform metering calculations. For example, with no voltage present, the portable circuit monitor will meter amps using the nominal frequency in place of the missing measured frequency. Some metered values—such as THD and K-Factor—require a valid frequency. When a valid frequency cannot be measured, the portable circuit monitor displays dashes in place of values.
**Resetting Demand, Energy, and Min/Max Values**

The following values can be reset from the portable circuit monitor front panel: Demand Ammeter (A), Demand Power (W), Demand Power (VA), Watthour Meter, Varhour Meter, and Minimums and Maximums.

Demand Power (W) and Demand Power (VA) are reset together; you cannot reset one without resetting the other. Likewise, the Watthour Meter and Varhour Meter are reset together.

**Note**: You can also reset energy, demand, and min/max values using the Resets option. The Resets option lets you perform resets but not change configuration values. See *Performing Resets Using the Resets Option*, on the following page, for more information.

To reset data, complete the following steps:

1. Press the MODE button until the red LED next to [Setup] is lit.
   
   The portable circuit monitor displays “ConFig.”

2. Press the PHASE [Enter] button to select the Configuration option.
   
   The portable circuit monitor displays the password prompt “P - - - -.”

3. Enter the password.
   
   To enter the password, use the SELECT METER [Value] buttons to increase or decrease the displayed value until it reaches the password value. Then press the PHASE [Enter] button.

4. Press the PHASE [Enter] button until the red LED next to the desired reset item flashes.
   
   Remember, if you choose Demand Power (W), the LED for Demand Power (VA) also lights, and vice versa. Likewise, if you choose Watthour Meter, the LED for Varhour Meter also lights, and vice versa.

5. Press the up arrow SELECT METER [Value] button to change the portable circuit monitor display from No to Yes.

6. Repeat steps 4 and 5 until you’ve said Yes to all items to be reset.

7. Press the MODE button once.
   
   The red LED next to [Accept] flashes. The red LEDs next to the selected reset items glow steadily.

8. To cancel the reset(s), press the PHASE [Enter] button once.
   
   The portable circuit monitor display flashes and the portable circuit monitor returns to METERS mode.

9. To perform the reset(s), press the SELECT METER [Value] button once to change from No to Yes. Then, press the PHASE [Enter] button.
   
   The portable circuit monitor performs the resets and returns to METERS mode.
PERFORMING RESETS
USING THE RESETS OPTION

The Resets option lets you reset energy, demand, and min/max values. The same reset operations can be done using the Configuration option (described on the previous page). The difference is that using the Resets option, you can perform resets only—you cannot change configuration values.

The Resets option is password protected. To access the Resets option, you must enter either the master password, or a special reset password. (See Setting the Master Password in this chapter for instructions on defining the master password.)

The reset password can be used to prevent accidental changes to configuration values. For example, you could provide an operator with the reset password only, allowing the operator to perform resets, but not change configuration values.

The reset password defaults to the master password. The portable circuit monitor’s factory default master password is 0. Therefore, when you receive a new portable circuit monitor, its reset password is also 0. When you change the master password, the reset password changes to match it. To define a reset password different than the master password, you must write a unique value—in the range 1–9998—to portable circuit monitor register 2031. You can write to register 2031 in one of two ways:

• From a remote PC, using POWERLOGIC application software. (Refer to the software instruction manual for specific instructions on writing to portable circuit monitor registers.)
• From the front panel of the portable circuit monitor, using the Diagnostics option. (See Appendix H for instructions on reading and writing registers using the Diagnostics option.)

Important: After you’ve defined a reset password, you can access the Resets option using either the reset password or the master password.

To perform resets, using the Resets option, refer to figure 4-3 and complete the following steps:

1. Press the MODE button until the red LED next to [Setup] is lit.
   The portable circuit monitor displays “ConFig.”
2. Press the down arrow SELECT METER button once.
   The portable circuit monitor displays “rESETS.”
3. Press the PHASE [Enter] button to select the Resets option.
   The portable circuit monitor displays the password prompt “P - - - -.”
4. Enter either the master password or the reset password.
   To enter a password, use the SELECT METER [Value] buttons to increase or decrease the displayed value until it reaches the password value. Then press the PHASE [Enter] button.
5. Follow steps 4–9 of the reset procedure described on the previous page.
Figure 4-3: Flowchart for performing resets using the Resets option

Start

Press MODE key until [Setup] LED is lit.

Press the \( \downarrow \) SELECT METER key until “RESETS” is displayed.

Press the PHASE (Enter) key to select the “RESETS” option.
P... is displayed.

Press the SELECT METER keys until your password is displayed. Then press the PHASE (Enter) key.
No is displayed.

Press the PHASE (Enter) key until the LED next to the value to be reset is lit.

Press the \( \uparrow \) SELECT METER (Value) key to change from No to Yes.

Do you want to select another reset option?

YES

NO

Press the MODE key once.

Circuit Monitor displays No.

Execute the selected resets?

NO

Press the PHASE (Enter) key

Circuit Monitor returns to METERS mode.

YES

Press the \( \uparrow \) SELECT METER (Value) key to select Yes

Press PHASE (Enter) key

Circuit Monitor performs resets.
SETTING UP ALARM/RELAY FUNCTIONS

The portable circuit monitor (models CM-2150 and higher) can detect over 100 alarm conditions, including over/under conditions, status input changes, phase unbalance conditions, and more. (See Alarm Conditions and Alarm Codes in Appendix F for a complete listing.)

Each alarm condition can be set up to automatically operate one or more portable circuit monitor relays. Also, multiple alarm conditions can be assigned to operate the same relay(s). For a description of the portable circuit monitor’s alarm/relay functions, see Chapter 7—Alarm Functions.

If you do not have POWERLOGIC application software, you can set up the portable circuit monitor’s on-board alarm/relay functions from the portable circuit monitor’s front panel. Perform this set up using the Alarm/Relay (AL.rLY) option, one of the portable circuit monitor’s four setup options. For each alarm condition you can:

• Enable or disable the alarm condition
• Assign a priority level to the alarm condition
• Define any required pickup and dropout setpoints, and pickup and dropout time delays
• Set up the portable circuit monitor to operate up to three relay outputs when the alarm condition occurs

The portable circuit monitor’s relay outputs provide ten operating modes. (See Relay Operating Modes in Chapter 6 for descriptions of the modes.) When you assign an alarm condition to operate a relay from the front panel of the portable circuit monitor, the portable circuit monitor configures the relay to operate in Normal mode. If Normal mode is not acceptable, you’ll need to do one of the following:

• Set up the portable circuit monitor’s alarm/relay functions over the communications link, using POWERLOGIC application software (which lets you choose from the 10 available modes)
• First set up the alarm/relay functions from the portable circuit monitor’s front panel, then change the relay’s operating mode by performing register read/writes using either POWERLOGIC application software or the portable circuit monitor’s Diagnostics option (see Appendix H for instructions on reading and writing registers using the Diagnostics option)
General Setup Procedure

The procedure below describes the general steps required to set up alarm/relay functions. Figure 4-4 illustrates the procedure. For detailed steps, see Detailed Setup Procedure on the following page.

The general steps required to set up alarm/relay functions are:

2. Choose the Alarm/Relay (AL.rLy) option.
3. Select an alarm number to configure. (See Appendix F for a list of alarm numbers.)
4. Define the required alarm/relay configuration items (priority level, pickup setpoint, pickup delay, and so on).
5. Accept or reject the changes just made.
6. Repeat steps 3–5 until you’ve configured all desired alarms.
7. Exit to Meters mode.

Figure 4-4: Alarm/Relay setup
Detailed Setup Procedure

This section offers detailed steps on how to set up alarm/relay functions from the front panel. Figure 4-4 illustrates the general flow of the setup procedure.

To set up alarm/relay functions, complete the following steps:

1. Press the MODE button until the red LED next to [Setup] is lit.
   The portable circuit monitor displays “ConFig.”
2. Press the down arrow SELECT METER button until the Circuit Monitor displays “AL.rLy.”
3. Press the PHASE [Enter] button to select the Alarm/Relay option.
   The portable circuit monitor displays the password prompt “P - - - -.”
4. Enter the master password.
   To enter the password, use the SELECT METER [Value] buttons to increase or decrease the displayed value until it reaches the password value. Then press the PHASE [Enter] button.
   The display alternates between “ALr No” (an abbreviation for alarm number) and “1”. Appendix F shows that alarm number 1 corresponds to the alarm condition “Over Current Phase A.” Refer to Appendix F while setting up alarm/relay functions. **Note:** The term alarm number used here is equivalent to the term alarm code used in Appendix F.
5. Use the SELECT METER [Value] buttons to increase or decrease the displayed alarm number until you reach the desired number.
   The portable circuit monitor display stops alternating while you change the alarm number. If an alarm condition is enabled, the portable circuit monitor displays the alarm condition’s priority to the left of the alarm number. For example, if you had previously enabled alarm number 1 and assigned it priority 0, the portable circuit monitor would display “P0 1”.
6. Press the PHASE [Enter] button to select the alarm number.
   If you have not previously enabled this alarm condition, the display alternates between “ENAbLE” and “OFF.” If you’ve previously enabled this alarm condition, the display alternates between “ENAbLE” and the chosen alarm priority (P0, P1, P2, or P3).
7. To enable the selected alarm condition, and to assign the alarm condition a priority level, press the down arrow SELECT METER [Value] button until the desired priority level is displayed.

**Note:** Using POWERLOGIC software, you can assign one or more of the following actions for each alarm condition. The portable circuit monitor performs the assigned actions each time the alarm condition occurs, **no matter what the priority level.**
- Operate one or more relay outputs
- Force data log entries into 1–14 user-defined data log files
- Perform a 4-cycle waveform capture
- Perform a 12-cycle event capture
Detailed Setup Procedure

You must assign these actions to alarm conditions using POWERLOGIC software.

Depending on the chosen priority level, the portable circuit monitor also performs the actions described below.

**P0**—No priority. On the occurrence of a P0 alarm, the portable circuit monitor does the following:

- Puts the alarm number in the list of active alarms, accessible from the front panel (see Viewing Active Alarms in Chapter 4 for instructions on viewing active alarms)

**P1**—Highest priority level. On the occurrence of a P1 alarm, the Circuit Monitor does the following:

- Puts the alarm number in the list of active alarms, accessible from the front panel (see Viewing Active Alarms in Chapter 4 for instructions on viewing active alarms)
- Records the occurrence in the portable circuit monitor’s event log file
- Enters the alarm number in the P1 log, accessible from the front panel (see Viewing the Priority 1 Log in Chapter 4 for instructions on viewing the P1 log)

**P2**—Middle priority level. On the occurrence of a P2 alarm, the Circuit Monitor does the following:

- Puts the alarm number in the list of active alarms, accessible from the front panel (see Viewing Active Alarms in Chapter 4 for instructions on viewing active alarms)
- Records the alarm occurrence in the portable circuit monitor’s event log file

**P3**—Lowest priority level. On the occurrence of a P3 alarm, the portable circuit monitor does the following:

- Puts the alarm number in the list of active alarms, accessible from the front panel (see Viewing Active Alarms in Chapter 4 for instructions on viewing active alarms)
- Records the alarm occurrence in the portable circuit monitor’s event log file

8. Press the PHASE [Enter] button to select the priority level.
   The display alternates between “PU SP” (an abbreviation for pickup setpoint) and the setpoint value.

9. Use the SELECT METER [Value] buttons to increase or decrease the displayed value until you reach the desired pickup setpoint.
   See Setpoint-Driven Alarms in Chapter 7 for a description of pickup and dropout setpoint and time delays.
Detailed Setup Procedure (cont.)

If you are configuring an alarm condition that does not require some or all of the pickup and dropout setpoints and delays, for example status input transition alarm conditions, the portable circuit monitor allows you to enter setpoints and delays, but it ignores any values that don’t apply.

10. Press the PHASE [Enter] button.
   The display alternates between “PU dLy” (an abbreviation for pickup delay) and the delay value.

11. Use the SELECT METER [Value] buttons to increase or decrease the displayed value until you reach the desired pickup delay (in seconds).

12. Press the PHASE [Enter] button.
   The portable circuit monitor display alternates between “do SP” (an abbreviation for dropout setpoint) and the setpoint value.

13. Use the SELECT METER [Value] buttons to increase or decrease the displayed value until you reach the desired dropout setpoint.

14. Press the PHASE [Enter] button.
   The display alternates between “do dLy” (an abbreviation for dropout delay) and the delay value.

15. Use the SELECT METER [Value] buttons to increase or decrease the displayed value until you reach the desired dropout delay (in seconds).

16. Press the PHASE [Enter] button.
   The portable circuit monitor displays “r1 No”. “r1” stands for relay 1.

17. If you want the portable circuit monitor to operate relay R1 each time the alarm condition occurs, press the up arrow SELECT METER [Value] button to change from No to Yes. Then press the PHASE [Enter] button.
   The portable circuit monitor displays “r2 No”.

18. If you want the portable circuit monitor to operate relay R2 each time the alarm condition occurs, press the up arrow SELECT METER [Value] button to change from No to Yes. Then press the PHASE [Enter] button.
   The portable circuit monitor displays “r3 No”.

19. If you want the portable circuit monitor to operate relay R3 each time the alarm condition occurs, press the up arrow SELECT METER [Value] button to change from No to Yes. Then press the PHASE [Enter] button.
   The display alternates between “ENAbLE” and the priority level.

20. Press the MODE button.
   The portable circuit monitor displays “No.”
Detailed Setup Procedure
(cont.)

21. To save the configuration changes you just made, press the up arrow
SELECT METER [Value] button to change from “No” to “Yes.” Then
press the PHASE [Enter] button. To discard the changes, press the
PHASE [Enter] button.

The portable circuit monitor displays the alarm number. At this point
you’ve completed the configuration process for one alarm condition.

22. Repeat steps 5-24 above for each additional alarm condition that you’d
like to configure.

23. To leave the Alarm/Relay setup option, press the MODE button while
the portable circuit monitor is displaying the “ALr No” prompt.

The portable circuit monitor returns to METERS mode.

VIEWING ACTIVE ALARMS

Each of the portable circuit monitor’s alarm conditions has an associated
alarm code. The alarm codes of the active alarms can be viewed from the
front panel. (The alarm conditions and their associated alarm codes are listed
in Appendix F.)

Note: The ALARM mode LED, on the portable circuit monitor’s front panel,
flashes while at least one of the following conditions is true: a nonzero
priority alarm is active, or a priority one alarm has occurred since the last
time the priority 1 log was cleared.

To view the active alarm codes, complete the following steps:

1. Press the MODE button until the red LED next to Alarm glows steadily.
The portable circuit monitor displays “P1.Log.”

2. Press the up arrow SELECT METER [Value] button until “AL.CodE” (an
abbreviation for alarm code) is displayed.

3. Press the PHASE [Enter] button.
The portable circuit monitor displays the lowest active alarm code. If
there are no active alarms, the portable circuit monitor displays -None-. Each alarm code is displayed with either an “rLY” extension or an “AL”
extension. If you have set up the alarm condition to operate one or more
relays, the code appears with an rLY extension (for relay). If you did not
set up the alarm condition to operate a relay, the code appears with an
AL extension (for alarm only).

4. Press the down arrow SELECT METER [Value] button to cycle through
the active alarms.
The portable circuit monitor displays the codes from lowest to highest.
VIEWING
THE PRIORITY 1 LOG

To provide a record of high priority alarm occurrences, the portable circuit
monitor maintains a priority 1 log (P1 log). See Setting Up Alarm/Relay
Functions in Chapter 4 for a complete description of the priority levels, and
instructions on assigning priority levels from the front panel.

The P1 log stores up to 10 of the last priority 1 alarms. The log operates in
a first-in-first-out (FIFO) manner. In other words, when the log is full, the
oldest log entry (the first in) is removed to make room for the new entry.

When a priority 1 alarm occurs, the portable circuit monitor records it in the
P1 log. The alarm remains in the P1 log until one of the following occurs: 10
new P1 alarms occur pushing it out of the log, or you manually clear the P1
log (see Clearing the Priority 1 Log on the following page).

Note: The ALARM mode LED, on the portable circuit monitor’s front panel,
flashes while at least one of the following conditions is true: a nonzero
priority alarm is active, or a priority one alarm has occurred since the last
time the priority 1 log was cleared.

You can view the P1 log from the portable circuit monitor’s front panel. The
following procedure tells how.

To view the P1 log, complete the following steps:

1. Press the MODE button until the red LED next to ALARM glows
   steadily.
   The portable circuit monitor displays “P1.Log.”
2. Press the PHASE [Enter] button.
   The portable circuit monitor displays the alarm code of the lowest
   priority 1 alarm. If no priority 1 alarms have occurred since the P1 log
   was last cleared, the portable circuit monitor displays -None-.
   Each alarm code is displayed with either an “rLY” extension or an “AL”
   extension. If you have set up the alarm condition to operate one or more
   relays, the code appears with an rLY extension (for relay). If you did not
   set up the alarm condition to operate a relay, the code appears with an
   AL extension (for alarm only).
3. Press the down arrow SELECT METER [Value] button to cycle through
   the alarm codes.
   The portable circuit monitor displays the codes from lowest to highest.
4. To exit the P1 log but remain in the ALARM mode, press the PHASE
   [Enter] button. To exit the ALARM mode altogether, press the MODE
   button.
CLEARING
THE PRIORITY 1 LOG

To provide a record of high priority alarm occurrences available for display from the front panel, the portable circuit monitor maintains a priority 1 log (P1 log). See Setting Up Alarm/Relay Functions in Chapter 4 for a complete description of the priority levels, and instructions on assigning priority levels from the front panel. See Viewing the Priority 1 Log on the previous page for instructions on viewing the P1 log.

The P1 log stores up to 10 of the last priority 1 alarms. The log operates in a first-in-first-out (FIFO) manner. In other words, when the log is full, the first alarm entry in (the oldest) is the first out.

When a priority 1 alarm occurs, the portable circuit monitor records it in the P1 log. The alarm remains in the P1 log until one of the following occurs: 10 new P1 alarms occur pushing it out of the log, or you manually clear the P1 log. The procedure below tells how to clear the P1 log.

IMPORTANT: Clearing the P1 log causes the portable circuit monitor to release all relays that meet the following conditions:

- The relay must be configured to operate in latched mode.
- The relay must be configured for internal control. In other words, you must have set up the portable circuit monitor to operate the relay in response to an alarm condition.
- All alarms assigned to operate the latched relay must not be in their alarm state.

To clear the P1 log, complete the following steps:

1. Press the MODE button until the red LED next to ALARM glows steadily.
   The portable circuit monitor displays “P1.Log.”
2. Press the SELECT METER [Value] buttons until “CLEAr” is displayed.
3. Press the PHASE [Enter] button.
   The portable circuit monitor displays “CLr. No”.
4. To abort the clear, press the PHASE [Enter] button.
5. To clear the log, press the up arrow SELECT METER [Value] button to change from “CLr. No” to “CLr.YES.” Then press the PHASE [Enter] button.
   The portable circuit monitor clears the P1 Log, and releases any relays that meet the conditions described above.
CHAPTER 5—METERING CAPABILITIES

REAL-TIME READINGS

The portable circuit monitor measures currents and voltages and reports rms values for all three phases and neutral/ground current. In addition, the portable circuit monitor calculates power factor, real power, reactive power, and more. Table 5-1 lists the real-time readings and their reportable ranges.

Table 5-1
Real-Time Readings

<table>
<thead>
<tr>
<th>Real-Time Reading</th>
<th>Reportable Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current</td>
<td></td>
</tr>
<tr>
<td>Per-Phase</td>
<td>0 to 32,767 A</td>
</tr>
<tr>
<td>Neutral</td>
<td>0 to 32,767 A</td>
</tr>
<tr>
<td>Ground</td>
<td>0 to 32,767 A</td>
</tr>
<tr>
<td>3-Phase Average</td>
<td>0 to 32,767 A</td>
</tr>
<tr>
<td>Apparent rms</td>
<td>0 to 32,767 A</td>
</tr>
<tr>
<td>Current Unbalance</td>
<td>0 to 100%</td>
</tr>
<tr>
<td>Voltage</td>
<td></td>
</tr>
<tr>
<td>Line-to-Line, Per-Phase</td>
<td>0 to 3,276,700 V</td>
</tr>
<tr>
<td>Line-to-Neutral, Per-Phase</td>
<td>0 to 3,276,700 V</td>
</tr>
<tr>
<td>3-Phase Average</td>
<td>0 to 3,276,700 V</td>
</tr>
<tr>
<td>Voltage Unbalance</td>
<td>0 to 100%</td>
</tr>
<tr>
<td>Real Power</td>
<td></td>
</tr>
<tr>
<td>3-Phase Total</td>
<td>0 to +/- 3,276.70 MW</td>
</tr>
<tr>
<td>Per-Phase</td>
<td>0 to +/- 3,276.70 MW</td>
</tr>
<tr>
<td>Reactive Power</td>
<td></td>
</tr>
<tr>
<td>3-Phase Total</td>
<td>0 to +/- 3,276.70 MVAr</td>
</tr>
<tr>
<td>Per-Phase</td>
<td>0 to +/- 3,276.70 MVAr</td>
</tr>
<tr>
<td>Apparent Power</td>
<td></td>
</tr>
<tr>
<td>3-Phase Total</td>
<td>0 to 3,276.70 MVA</td>
</tr>
<tr>
<td>Per-Phase</td>
<td>0 to 3,276.70 MVA</td>
</tr>
<tr>
<td>Power Factor (True)</td>
<td></td>
</tr>
<tr>
<td>3-Phase Total</td>
<td>-0.010 to 1.000 to +0.010</td>
</tr>
<tr>
<td>Per-Phase</td>
<td>-0.010 to 1.000 to +0.010</td>
</tr>
<tr>
<td>Power Factor (Displacement)</td>
<td></td>
</tr>
<tr>
<td>3-Phase Total</td>
<td>-0.010 to 1.000 to +0.010</td>
</tr>
<tr>
<td>Per-Phase</td>
<td>-0.010 to 1.000 to +0.010</td>
</tr>
<tr>
<td>Frequency</td>
<td></td>
</tr>
<tr>
<td>50/60 Hz</td>
<td>23.00 to 67.00 Hz</td>
</tr>
<tr>
<td>400 Hz</td>
<td>350.00 to 450.00 Hz</td>
</tr>
<tr>
<td>Temperature (Internal Ambient)</td>
<td>-100.00°C to +100.00°C</td>
</tr>
</tbody>
</table>

Via communications only.
Min/Max Values

The portable circuit monitor stores minimum and maximum values for all real-time readings in nonvolatile memory. In addition, the portable circuit monitor (except model CM-2050) stores the date and time associated with each minimum and each maximum.

Minimums and maximums for front panel values can be viewed on the portable circuit monitor’s LED display. All min/max values—including those not displayable from the front panel—can be reset from the portable circuit monitor’s front panel. See **Resetting Demand, Energy and Min/Max Values** in Chapter 4 for reset instructions.

Using POWERLOGIC application software you can:

- View all min/max values and their associated dates and times
- Upload min/max values—and their associated dates and times—from the portable circuit monitor and save them to disk
- Reset all min/max values

For instructions on viewing, saving, and resetting min/max data using POWERLOGIC software, refer to the instruction bulletin included with the software.

Power Factor Min/Max Conventions

All running min/max values, with the exception of power factor, are arithmetic minimums and maximums. For example, the minimum phase A-B voltage is simply the lowest value in the range 0 to 3,276,700 V that has occurred since the min/max values were last reset. In contrast, power factor min/max values—since the meter’s midpoint is unity—are not true arithmetic minimums and maximums. Instead, the minimum value represents the measurement closest to -0 on a continuous scale of -0 to 1.00 to +0. The maximum value is the measurement closest to +0 on the same scale.

Figure 5-1 shows the min/max values in a typical environment, assuming a positive power flow. In figure 5-1, the minimum power factor is -.7 (lagging) and the maximum is .8 (leading). It is important to 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). Likewise, if the power factor ranged from +.9 to +.95, the minimum would be +.95 (leading) and the maximum would be +.90 (leading).

See **Changing the VAR Sign Convention** in Chapter 13 for instructions on changing the sign convention over the communications link.
Chapter 5—Metering Capabilities

Figure 5-1: Power factor min/max example

Figure 5-2: Default VAR sign convention

Figure 5-3: Optional VAR sign convention
DEMAND READINGS

The portable circuit monitor provides a variety of demand readings, including coincident readings and predicted demands. Table 5-2 lists the available demand readings and their reportable ranges.

<table>
<thead>
<tr>
<th>Demand Reading</th>
<th>Reportable Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Demand Current, Per-Phase</td>
<td></td>
</tr>
<tr>
<td>Present</td>
<td>0 to 32,767 A</td>
</tr>
<tr>
<td>Peak</td>
<td>0 to 32,767 A</td>
</tr>
<tr>
<td>Avg. Power Factor (True), 3Ø Total</td>
<td></td>
</tr>
<tr>
<td>Present (1)</td>
<td>-0.010 to 1.000 to +0.010</td>
</tr>
<tr>
<td>Coincident w/ kW Peak (1)</td>
<td>-0.010 to 1.000 to +0.010</td>
</tr>
<tr>
<td>Coincident w/ kVAR Peak (1)</td>
<td>-0.010 to 1.000 to +0.010</td>
</tr>
<tr>
<td>Coincident w/ kVA Peak (1)</td>
<td>-0.010 to 1.000 to +0.010</td>
</tr>
<tr>
<td>Demand Real Power, 3Ø Total</td>
<td></td>
</tr>
<tr>
<td>Present</td>
<td>0 to +/-3,276.70 MW</td>
</tr>
<tr>
<td>Predicted (1)</td>
<td>0 to +/-3,276.70 MW</td>
</tr>
<tr>
<td>Peak</td>
<td>0 to +/-3,276.70 MW</td>
</tr>
<tr>
<td>Coincident kVA Demand (1)</td>
<td>0 to 3,276.70 MVA</td>
</tr>
<tr>
<td>Coincident kVAR Demand (1)</td>
<td>0 to +/-3,276.70 MVAR</td>
</tr>
<tr>
<td>Demand Reactive Power, 3Ø Total</td>
<td></td>
</tr>
<tr>
<td>Present</td>
<td>0 to +/-3,276.70 MVAR</td>
</tr>
<tr>
<td>Predicted (1)</td>
<td>0 to +/-3,276.70 MVAR</td>
</tr>
<tr>
<td>Peak</td>
<td>0 to +/-3,276.70 MVAR</td>
</tr>
<tr>
<td>Coincident kVA Demand (1)</td>
<td>0 to 3,276.70 MVA</td>
</tr>
<tr>
<td>Coincident KW Demand (1)</td>
<td>0 to +/-3,276.70 MW</td>
</tr>
<tr>
<td>Demand Apparent Power, 3Ø Total</td>
<td></td>
</tr>
<tr>
<td>Present</td>
<td>0 to 3,276.70 MVA</td>
</tr>
<tr>
<td>Predicted (1)</td>
<td>0 to 3,276.70 MVA</td>
</tr>
<tr>
<td>Peak</td>
<td>0 to 3,276.70 MVA</td>
</tr>
<tr>
<td>Coincident KW Demand (1)</td>
<td>0 to +/-3,276.70 MW</td>
</tr>
<tr>
<td>Coincident KVAR Demand (1)</td>
<td>0 to +/-3,276.70 MVAR</td>
</tr>
</tbody>
</table>

(1) Via communications only.

Demand Power Calculation Methods

To be compatible with electric utility billing practices, the Circuit Monitor provides the following types of demand power calculations:

- Thermal Demand
- Block Interval Demand with Rolling Sub-Interval
- External Pulse Synchronized Demand

The default demand calculation method is Thermal Demand. The Thermal Demand Method and the External Synch Pulse method can be set up from the portable circuit monitor faceplate. (See Setting the Demand Interval in Chapter 4 for setup instructions.) Other demand calculation methods can be set up over the communications link. A brief description of each demand method follows.
Demand Power Calculation Methods (cont.)

Thermal Demand:
The thermal demand method calculates the demand based on a thermal response and updates its demand calculation every 15 seconds on a sliding window basis. The user can select the demand interval from 5 to 60 minutes in 5 minute increments. See Setting the Demand Interval in Chapter 4 for instructions. (This is the same method used by the series 100/200 portable circuit monitors.)

Block Interval Demand:
The block interval demand mode supports a standard block interval and an optional subinterval calculation for compatibility with electric utility electronic demand registers.

In the standard block interval mode, the user can select a demand interval from 5 to 60 minutes in 5-minute increments. (See Setting the Demand Interval in Chapter 4 for instructions.) The demand calculation is performed at the end of each interval. The present demand value displayed by the portable circuit monitor is the value for the last completed demand interval.

Block Interval Demand with Sub-Interval Option:
When using the block interval method, a demand subinterval can be defined. The user must select both a block interval and a subinterval length. The block interval must be divisible by an integer number of subintervals. (A common selection would be a 15-minute block interval with three 5-minute subintervals.) The block interval demand is recalculated at the end of every subinterval. If the user programs a subinterval of 0, the demand calculation updates every 15 seconds on a sliding window basis.

External Pulse Synchronized Demand:
The portable circuit monitor can be configured to accept—through status input S1—a demand synch pulse from another meter. The portable circuit monitor then uses the same time interval as the other meter for each demand calculation. See Demand Synch Pulse Input in Chapter 6 for additional details.

Predicted Demand
The portable circuit monitor calculates predicted demand for kW, kVAR, and kVA. The predicted demand is equal to the average power over a one-minute interval. The predicted demand is updated every 15 seconds.

Peak Demands
The portable circuit monitor maintains, in nonvolatile memory, a running maximum—called “peak demand”—for each average demand current and average demand power value. It also stores the date and time of each peak demand. In addition to the peak demand, the portable circuit monitor stores the coinciding average (demand) 3-phase power factor. The average 3-phase power factor is defined as “demand kW/demand kVA” for the peak demand interval.
Peak Demands (cont.)

Peak demand values can be reset from the portable circuit monitor front panel, or over the communications link using POWERLOGIC application software. To reset peak demand values from the portable circuit monitor front panel, see Resetting Demand, Energy, and Min/Max Values in Chapter 4.

ENERGY READINGS

The portable circuit monitor provides energy values for kWh and kVARH. These values can be displayed on the portable circuit monitor, or read over the communications link.

The portable circuit monitor can accumulate these energy values in one of two modes: signed or unsigned (absolute). In signed mode, the portable circuit monitor considers the direction of power flow, allowing the accumulated energy magnitude to both increase and decrease. In unsigned mode, the portable circuit monitor accumulates energy as positive, 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.

The portable circuit monitor provides additional energy readings that are available over the communications link only. They are:

- Directional accumulated energy readings. The portable circuit monitor calculates and stores in nonvolatile memory accumulated values for energy (kWh) and reactive energy (kVARH) both into and out of the load. The portable circuit monitor also calculates and stores apparent energy (kVAH).

Table 5-3

<table>
<thead>
<tr>
<th>Energy Reading, 3-Phase</th>
<th>Reportable Range ①</th>
<th>Reportable Front Panel</th>
<th>Front Panel Display ②</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Accumulated Energy</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Real (Signed/Absolute)</td>
<td>0 to 9,999,999,999,999,999 WHR</td>
<td>0 kWh to 9999.99 MWh</td>
<td>000.000 kWh to 0000.00 MWh; 000.000 kVAR to 0000.00 MVARh</td>
</tr>
<tr>
<td>Reactive (Signed/Absolute)</td>
<td>0 to 9,999,999,999,999,999 VARH</td>
<td>Not Applicable</td>
<td>Not Applicable</td>
</tr>
<tr>
<td><strong>Accumulated Energy, Conditional</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Real (In)</td>
<td>0 to 9,999,999,999,999,999 WHR</td>
<td>Not Applicable</td>
<td></td>
</tr>
<tr>
<td>Real (Out)</td>
<td>0 to 9,999,999,999,999,999 WHR</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reactive (In)</td>
<td>0 to 9,999,999,999,999,999 VARH</td>
<td>Not Applicable</td>
<td></td>
</tr>
<tr>
<td>Reactive (Out)</td>
<td>0 to 9,999,999,999,999,999 VARH</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Apparent</td>
<td>0 to 9,999,999,999,999,999 VAH</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Accumulated Energy, Incremental</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Real (In)</td>
<td>0 to 999,999,999,999 WHR</td>
<td>Not Applicable</td>
<td></td>
</tr>
<tr>
<td>Real (Out)</td>
<td>0 to 999,999,999,999 WHR</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reactive (In)</td>
<td>0 to 999,999,999,999 VARH</td>
<td>Not Applicable</td>
<td></td>
</tr>
<tr>
<td>Reactive (Out)</td>
<td>0 to 999,999,999,999 VARH</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Apparent</td>
<td>0 to 999,999,999,999 VAH</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

① Via communications only.
② When the energy readings are reset, the front panel display auto-ranges from 000.000 kWh to 9999.99 MWh as energy accumulates.
ENERGY READINGS
(cont.)

• Conditional accumulated energy readings. Using these values, energy accumulation can be turned off or on for special metering applications. Accumulation can be turned on over the communications link, or activated from a status input change. The portable circuit monitor stores the date and time of the last reset of conditional energy in nonvolatile memory.

• Incremental accumulated energy readings. The real, reactive and apparent incremental energy values reflect the energy accumulated during the last incremental energy period. You can define the increment start time and time interval. Incremental energy values can be logged in portable circuit monitor memory (models CM-2150 and up) and used for load-profile analysis.

POWER ANALYSIS VALUES

The portable circuit monitor provides a number of power analysis values that can be used to detect power quality problems, diagnose wiring problems, and more. Table 5-4 summarizes the power analysis values.

THD—Total Harmonic Distortion (THD) is a quick measure of the total distortion present in a waveform. It provides a general indication of the “quality” of a waveform. The portable circuit monitor uses the following equation to calculate THD:

\[ \text{THD} = \left( \frac{H_2^2 + H_3^2 + H_4^2 + \ldots}{H_1^2} \right) \times 100\% \]

thd—An alternate method for calculating Total Harmonic Distortion, used widely in Europe. The portable circuit monitor uses the following equation to calculate thd:

\[ \text{thd} = \left( \frac{H_2^2 + H_3^2 + H_4^2 + \ldots}{\text{Total rms}} \right) \times 100\% \]

K-Factor—K-Factor is a simple numerical rating used to specify transformers for nonlinear loads. The portable circuit monitor uses the following formula to calculate K-Factor:

\[ K = \frac{\text{SUM} (I_i^2 h_i^2)}{I_{rms}^2} \]

Displacement Power Factor—For purely sinusoidal loads, the power factor calculation kW/kVA is equal to the cosine of the angle between the current and voltage waveforms. For harmonically distorted loads, the true power factor equals kW/kVA—but this may not equal the angle between the fundamental components of current and voltage. The displacement power factor is based on the angle between the fundamental components of current and voltage.

Harmonic Values—The individual per-phase harmonic magnitudes and angles through the 31st harmonic are determined for all currents and voltages in model numbers 2350 and higher portable circuit monitors. The harmonic magnitudes can be formatted as either a percentage of the fundamental (default), or a percentage of the rms value. Refer to chapter 13 for information on how to configure the harmonic calculations.
<table>
<thead>
<tr>
<th>Value</th>
<th>Reportable Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>THD-Voltage, Current</td>
<td>0 to 327.67%</td>
</tr>
<tr>
<td>3-phase, per-phase, neutral</td>
<td></td>
</tr>
<tr>
<td>thd-Voltage, Current</td>
<td>0 to 100.00%</td>
</tr>
<tr>
<td>3-phase, per-phase, neutral</td>
<td></td>
</tr>
<tr>
<td>K-Factor (per phase)</td>
<td>0.0 to 100.0</td>
</tr>
<tr>
<td>K-Factor Demand (per phase)</td>
<td>0.0 to 100.0</td>
</tr>
<tr>
<td>Crest Factor (per phase)</td>
<td>0.0 to 100.0</td>
</tr>
<tr>
<td>Displacement P.F. (per phase, 3-phase)</td>
<td>–0.010 to 1.000 to +0.010</td>
</tr>
<tr>
<td>Fundamental Voltages (per phase)</td>
<td></td>
</tr>
<tr>
<td>Magnitude</td>
<td>0 to 3,276,700 V</td>
</tr>
<tr>
<td>Angle</td>
<td>0.0 to 359.9°</td>
</tr>
<tr>
<td>Fundamental Currents (per phase)</td>
<td>0 to 32,767 A</td>
</tr>
<tr>
<td>Magnitude</td>
<td>0.0 to 359.9°</td>
</tr>
<tr>
<td>Angle</td>
<td></td>
</tr>
<tr>
<td>Fundamental Real Power (per phase, 3-phase)</td>
<td>0 to 327,670 kW</td>
</tr>
<tr>
<td>Fundamental Reactive Power (per phase)</td>
<td>0 to 327,670 kVAR</td>
</tr>
<tr>
<td>Harmonic Power (per phase, 3-phase)</td>
<td>0 to 327,670 kW</td>
</tr>
<tr>
<td>Phase Rotation</td>
<td>ABC or CBA</td>
</tr>
<tr>
<td>Unbalance (current and voltage)</td>
<td>0.0 to 100%</td>
</tr>
<tr>
<td>Individual Harmonic Magnitudes</td>
<td>0 to 327.67%</td>
</tr>
<tr>
<td>Individual Harmonic Angles</td>
<td>0.0° to 360.0°</td>
</tr>
</tbody>
</table>

① Via communications only.
Chapter 6—Input/Output Capabilities

CHAPTER 6—INPUT/OUTPUT CAPABILITIES

CHAPTER CONTENTS

Input/Output Modules
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Analog Inputs
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Solid State KYZ Pulse Output
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INPUT/OUTPUT MODULES

The optional factory installed input/output module used for the portable circuit monitor is the PCMIOM-44. The PCMIOM-44 has two status inputs, one mechanical relay output, and one KYZ output. If custom functionality is desired, the PCM will also support other input/output modules as listed in Table 6-1. All of these custom I/O modules must be factory installed and some limitations may apply. Each I/O module provides some or all of the following:

• Status Inputs
• Mechanical Relay Outputs
• Solid State KYZ Pulse Output
• Analog Inputs
• Analog Outputs

The remainder of this chapter describes the I/O capabilities. For detailed technical specifications, see Appendix A—Installing and Wiring Optional I/O Modules.

Table 6-1

<table>
<thead>
<tr>
<th>Class</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Custom</td>
<td>PCMIOM-44</td>
<td>2 status IN, 1 KYZ pulse OUT, 1 Form-C relay OUT</td>
</tr>
<tr>
<td>Custom</td>
<td>IOM-11</td>
<td>1 status IN, 1 KYZ pulse OUT</td>
</tr>
<tr>
<td>Custom</td>
<td>IOM-18</td>
<td>8 status IN, 1 KYZ pulse OUT</td>
</tr>
<tr>
<td>Custom</td>
<td>IOM-44</td>
<td>4 status IN, 1 KYZ pulse OUT</td>
</tr>
<tr>
<td>Custom</td>
<td>IOM-441-01*</td>
<td>4 status IN, 1 KYZ pulse OUT, 3 Form-C relay OUT, 1 Analog IN&lt;sup&gt;1&lt;/sup&gt;, 1 Analog OUT (0–1 mA)</td>
</tr>
<tr>
<td>Custom</td>
<td>IOM-441-20*</td>
<td>4 status IN, 1 KYZ pulse OUT, 3 Form-C relay OUT, 1 Analog IN&lt;sup&gt;1&lt;/sup&gt;, 1 Analog OUT (4–20 mA)</td>
</tr>
<tr>
<td>Custom</td>
<td>IOM-444-01*</td>
<td>4 status IN, 1 KYZ pulse OUT, 3 Form-C relay OUT, 4 Analog IN&lt;sup&gt;1&lt;/sup&gt;, 4 Analog OUT (0–1 mA)</td>
</tr>
<tr>
<td>Custom</td>
<td>IOM-444-20*</td>
<td>4 status IN, 1 KYZ pulse OUT, 3 Form-C relay OUT, 4 Analog IN&lt;sup&gt;1&lt;/sup&gt;, 4 Analog OUT (4–20 mA)</td>
</tr>
</tbody>
</table>

<sup>1</sup> Analog Inputs are 0–5 Vdc. Each analog input can be independently configured to accept a 4-20 mA input by connecting an external jumper wire. See Analog Inputs in this chapter for more information.

* Requires elimination of the 15-second control power backup module.
STATUS INPUTS

The portable circuit monitor’s I/O modules offer 1, 4, or 8 status inputs (see table 6-1 on the previous page). Status inputs can be used to detect breaker status, count pulses, count motor starts, and so on.

The following are important points about the portable circuit monitor’s status inputs:

• The portable circuit monitor maintains a counter of the total transitions for each status input.

• Status input S2 is a high-speed status input. Input S2 can be tied to an external relay used to trigger the portable circuit monitor’s 12-cycle event capture feature (see 12-Cycle Event Capture in Chapter 9). Note: The IOM-11 module does not have an input S2.

• Status input transitions can be logged as events in the portable circuit monitor’s on-board event log.

• Status input transition events are date and time stamped. For the IOM-11, IOM-18, and IOM-44, the date and time are accurate to within one second—except for input S2 transition events. Input S2 transition events are time stamped with resolution to the millisecond. For the IOM-4411 and IOM-4444, all status input transition events are time stamped with resolution to the millisecond, for sequence of events recording.

• Status input S1 can be configured to accept a demand synch pulse from a utility demand meter (see Demand Synch Pulse Input on the following page).

• Status inputs can be configured to control conditional energy (see Conditional Energy in Chapter 13 for more information).

• Status inputs can be used to count KYZ pulses for demand and energy calculation. By mapping multiple inputs to the same counter register, the portable circuit monitor can totalize pulses from multiple inputs (see Pulse Demand Metering in Chapter 6 for more information).
DEMAND SYNCH PULSE INPUT

The portable circuit monitor can be configured to accept—through status input S1—a demand synch pulse from another demand meter. By accepting the demand synch pulses, the portable circuit monitor can make its demand interval “window” match the other meter’s demand interval “window.” The portable circuit monitor does this by “watching” status input S1 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 portable circuit monitor then uses the same time interval as the other meter for each demand calculation. Figure 6-1 illustrates this point.

When in this mode, the portable 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 portable 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 portable circuit monitor can be used to verify peak demand charges.

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

• The demand synch feature can be activated from the portable circuit monitor’s front panel. To activate the feature, enter a demand interval of zero. (See Setting the Demand Interval in Chapter 4 for instructions.)

• When the portable circuit monitor’s demand interval is set to zero, the portable circuit monitor automatically looks to input S1 for the demand synch pulse. The synch pulse output on the other demand meter must be wired to portable circuit monitor input S1. (See Appendix A—Installing and Wiring Optional I/O Modules for wiring instructions.)

• The maximum allowable interval between pulses is 60 minutes.

![Figure 6-1: Demand synch pulse timing](image-url)
**ANALOG INPUTS**

The portable circuit monitor supports analog inputs through the use of optional input/output modules. I/O module IOM-4411 offers one analog input. I/O module IOM-4444 offers four analog inputs. Table 6-1, on page 67, lists the available input/output modules.

This section describes the portable circuit monitor’s analog input capabilities. For technical specifications and instructions on installing the modules, see Appendix A—Installing and Wiring Optional I/O Modules.

Each analog input can accept either a 0–5 Vdc voltage input, or a 4–20 mA dc current input. By default, the analog inputs accept a 0–5 Vdc input. To change an analog input to accept a 4-20 mA signal, the user must connect a jumper wire to the appropriate terminals on the input module. The jumper wire places a calibrated 250 ohm resistor (located inside the I/O module) into the circuit. When a 4-20 mA current is run through the resistor, the portable circuit monitor measures an input voltage of 1–5 volts across the resistor. See Appendix A—Installing and Wiring Optional I/O Modules for instructions on connecting the jumper wire.

To setup analog inputs, application software is required. Using POWERLOGIC application software, the user must define the following values for each analog input:

- **Units**—A six character label used to identify the units of the monitored analog value (for example, “PSI”).
- **Input Type (0–5 V or 4–20 mA)**—Tells the portable circuit monitor whether to use the default calibration constants, or the alternate calibration constants for the internal 250 ohm resistor.
- **Upper Limit**—The value the portable circuit monitor reports when the input voltage is equal to 5 volts (the maximum input voltage).
- **Lower Limit**—The value the portable circuit monitor reports when the input voltage is equal to the *offset voltage*, defined below.
- **Offset Voltage**—The lowest input voltage (in hundredths of a volt) that represents a valid reading. When the input voltage is equal to this value, the portable circuit monitor reports the *lower limit*, defined above.
- **Precision**—The precision of the measured analog value (for example, *tenths of degrees Celsius*). This value represents what power of 10 to apply to the upper and lower limits.

The following are important facts regarding the portable circuit monitor’s analog input capabilities:

- When the input voltage is below the *offset voltage*, the portable circuit monitor reports -32,768; POWERLOGIC application software indicates that the reading is invalid by displaying N/A or asterisks.
- When the input voltage is above five volts (the maximum input voltage) the portable circuit monitor reports the upper limit.
**Analog Input Example**

Figure 6-2 shows an analog input example. In this example, the analog input has been configured as follows:

- **Upper Limit:** 500
- **Lower Limit:** 100
- **Offset Voltage:** 1 Volt
- **Units:** PSI

The table below shows portable circuit monitor readings at various input voltages.

<table>
<thead>
<tr>
<th>Input Voltage</th>
<th>Portable circuit monitor Reading</th>
</tr>
</thead>
<tbody>
<tr>
<td>.5 V</td>
<td>–32,768 (invalid)</td>
</tr>
<tr>
<td>1 V</td>
<td>100 PSI</td>
</tr>
<tr>
<td>2 V</td>
<td>200 PSI</td>
</tr>
<tr>
<td>2.5 V</td>
<td>250 PSI</td>
</tr>
<tr>
<td>5 V</td>
<td>500 PSI</td>
</tr>
<tr>
<td>5.5 V</td>
<td>500 PSI</td>
</tr>
</tbody>
</table>

**Figure 6-2: Analog Input example**
RELAY OUTPUT OPERATING MODES

Before we describe the 10 available relay operating modes, it is important to understand the difference between a relay configured for remote (external) control and a relay configured for portable circuit monitor (internal) control.

Each mechanical relay output must be configured for one of the following:

1. Remote (external) control—the relay is controlled either from a PC using POWERLOGIC application software, a programmable controller or, in the case of a CM-2450 or CM-2452, a custom program executing in the meter.

2. Portable circuit monitor (internal) control—the relay is controlled by the portable circuit monitor (models CM-2150 and above), in response to a set-point controlled alarm condition, or as a pulse initiator output.

Once you’ve set up a relay for portable circuit monitor control (option 2 above), you can no longer operate the relay remotely. You can, though, temporarily override the relay, using POWERLOGIC application software.

The first three operating modes—normal, latched, and timed—function differently when the relay is remotely controlled versus portable circuit monitor controlled. The descriptions below point out the differences in remote versus portable circuit monitor control. Modes 4 through 10—all pulse initiation modes—are portable circuit monitor control modes; remote control does not apply to these modes.

1. Normal

   Remotely Controlled: The user must 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 portable circuit monitor loses control power.

   Portable 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 portable circuit monitor loses control power.

2. Latched

   Remotely Controlled: The user must 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 portable circuit monitor loses control power.

   Portable 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 P1 alarm log is cleared from the front panel, or until the portable circuit monitor loses control power.
3. Timed
   *Remotely Controlled:* The user must 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 portable circuit monitor loses control power. If a new command to energize the relay is issued before the timer expires, the timer restarts.

   *Portable 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 de-energize and rapidly re-energize; this sequence will repeat until the alarm condition drops out.

4. 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 breaker).

5. 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 breaker).

6. 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, there is only one mode for kVAh pulse.

7. 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.

8. 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.

9. 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.

10. kVARh 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

Input/Output module IOM-44 provides three Form-C 10 A mechanical relays that can be used to open or close circuit breakers, annunciate alarms, and more. Table 6-1 on page 65 lists the available Input/Output modules. Appendix A tells how to install and wire the I/O modules.

Portable circuit monitor mechanical output relays can be configured to operate in one of nine operating modes:

- Normal
- Latched (electrically held)
- Timed
- Absolute kWh pulse
- Absolute kVARh pulse
- kVAh pulse
- kWh in pulse
- kVARH in pulse
- kWh out pulse
- kVAR out pulse

See the previous section for a description of the modes.

The last seven modes in the above list are for pulse initiator applications. Keep in mind that all portable circuit monitor Input/Output modules provide one solid-state KYZ pulse output rated at 96 mA. 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 in this chapter for a description of the solid-state KYZ pulse output.
Setpoint Controlled Relay Functions

The portable circuit monitor can detect over 100 alarm conditions, including over under conditions, status input changes, phase unbalance conditions, and more (see Chapter 7—Alarm Functions). Using POWERLOGIC application software, an alarm condition can be assigned to automatically operate one or more relays. For example, you could setup the alarm condition “Undervoltage Phase A” to operate relays R1, R2, and R3. Then, each time the alarm condition occurs—that is, each time the setpoints and time delays assigned to Undervoltage Phase A are satisfied—the portable circuit monitor automatically operates relays R1, R2, and R3 per their configured mode of operation. (See Relay Operating Modes in this chapter for a description of the operating modes.)

Also, multiple alarm conditions can be assigned to a single relay. For example, the alarm conditions “Undervoltage Phase A” and “Undervoltage Phase B” could both be assigned to operate relay R1. The relay remains energized as long as either “Undervoltage Phase A” or “Undervoltage Phase B” remains true.

NOTE

Setpoint-controlled relay operation can be used for some types of non-time-critical relaying. For more information, see Setpoint Controlled Relay Functions in Chapter 7.
This section describes the portable circuit monitor’s pulse output capabilities. For instructions on wiring the KYZ pulse output, see Appendix A—Installing and Wiring Optional I/O Modules.

Input/Output modules IOM-11, IOM-18, IOM-44, IOM-4411, and IOM-4444 are all equipped with one solid-state KYZ pulse output contact (see table 6-1 on page 69). 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. Since most pulse initiator applications feed solid state receivers with very low burdens, this 96 mA rating is generally adequate. For applications where a rating higher than 96 mA is required, the IOM-44 provides 3 relays with 10 amp ratings. Any of the 10 amp relays can be configured as a pulse initiator output, using POWERLOGIC application software. Keep in mind that the 10 amp relays are mechanical relays with limited life—10 million operations under no load; 100,000 under load.

The watthour-per-pulse value can be set from the portable circuit monitor’s front panel. When setting the kWH/pulse value, set the value based on a 3-wire pulse output basis. See Setting the Watthour Pulse Output in Chapter 4 for instructions. See Calculating the Watthour Per Pulse Value in this chapter for instructions on calculating the correct value.

The portable circuit monitor can be used in 2-wire or 3-wire pulse initiator applications. Each of these applications is described below.

### 2-Wire Pulse Initiator

Most energy management system digital inputs use only two of the three wires provided with a KYZ pulse initiator. This is referred to as a 2-wire pulse initiator application. Figure 6-3 shows a pulse train from a 2-wire pulse initiator application. Refer to this figure when reading the following points:

- In a 2-wire application, the pulse train looks like alternating open and closed states of a Form-A contact.
- Most 2-wire KYZ pulse applications use a Form-C contact, but tie into only one side of the Form-C contact.
- The pulse is defined as the transition from OFF to ON of one side of the Form-C relay.
- In figure 6-3, the transitions are marked as 1 and 2. Each transition represents the time when the relay flip-flops from KZ to KY. At points 1 and 2, the receiver should count a pulse.
- In a 2-wire application, the portable circuit monitor can deliver up to 5 pulses per second.
3-Wire Pulse Initiator

Some pulse initiator applications require all three wires provided with a KYZ pulse initiator. This is referred to as a 3-wire pulse initiator application. Figure 6-4 shows a pulse train for a 3-wire pulse initiator application. Refer to this figure when reading the following points:

- 3-wire KYZ pulses are defined as transitions between KY and KZ.
- These transitions are alternate contact closures or “flip-flops” of a Form-C contact.
- In figure 6-4 the transitions are marked as 1, 2, 3, and 4. Each transition represents the time when the relay flip flops from KY to KZ, or from KZ to KY. At points 1, 2, 3, and 4, the receiver should count a pulse.
- In a 3-wire application, the portable circuit monitor can deliver up to 10 pulses per second.

![Figure 6-3: 2-wire pulse train](image)

![Figure 6-4: 3-wire pulse train](image)
Calculating the Watthour-Per-Pulse Value

This section shows an example of how to calculate the watthour-per-pulse value. 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 1500 kW.
- The KYZ pulses should come in at about two pulses per second at full scale.

**Step 1:** Translate 1500 kW load into kWH/second.

\[
\frac{(1500 \text{ kW}) \times (1 \text{ Hr})}{1 \text{ hour}} = 1500 \text{ kWH} \]

\[
\frac{(1500 \text{ kWH})}{3600 \text{ seconds}} = \frac{“X” \text{ kWH}}{1 \text{ second}}
\]

\[X = \frac{1500}{3600} = 0.4167 \text{ kWH/second}\]

**Step 2:** Calculate the kWH required per pulse.

\[
\frac{0.4167 \text{ kWH/second}}{2 \text{ pulses/second}} = 0.2084 \text{ kWH/pulse}
\]

**Step 3:** Round to nearest tenth, since the portable circuit monitor only accepts 0.1 kWH increments.

\[Ke = 0.2 \text{ kWH/pulse}\]

**Summary:**

- 3-wire basis—0.2 kWH/pulse will provide approximately 2 pulses per second at full scale.
- 2-wire basis—0.1 kWH/pulse will provide approximately 2 pulses per second at full scale. (To convert to the kWh/pulse required on a 2-wire basis, divide Ke by 2. This is necessary since the portable circuit monitor Form C relay generates two pulses—KY and KZ—for every pulse that is counted on a 2-wire basis.)
ANALOG OUTPUTS

The portable circuit monitor supports analog outputs through the use of optional input/output modules. I/O modules IOM-4411-20 and IOM-4444-20 offer one and four 0–20 mA analog outputs, respectively. I/O modules IOM-4411-01 and IOM-4444-01 offer one and four 0–1 mA analog outputs, respectively. Table 6-1, on page 67, lists the available input/output modules.

This section describes the portable circuit monitor’s analog output capabilities. For technical specifications and instructions on installing the modules, see Appendix A—Installing and Wiring Optional I/O Modules.

To setup analog outputs, application software is required. Using POWERLOGIC application software, the user must define the following values for each analog output:

- **Analog Output Label**—A four character label used to identify the output.
- **Output Range**—The range of the output current: 4–20 mA, for the IOM-4411-20 and IOM-4444-20; 0–1 mA, for the IOM-4411-01 and IOM-4444-01.
- **Register Number**—The portable circuit monitor register number assigned to the analog output.
- **Lower Limit**—The register value that is equivalent to the minimum output current (0 or 4 mA).
- **Upper Limit**—The register value that is equivalent to the maximum output current (1 mA or 20 mA).

The following are important facts regarding the portable circuit monitor’s analog output capabilities:

- When the register value is below the *lower limit*, the portable circuit monitor outputs the minimum output current (0 or 4 mA).
- When the register value is above the *upper limit*, the portable circuit monitor outputs the maximum output current (1 mA or 20 mA).

**Analog Output Example**

Figure 6-5 (page 82), illustrates the relationship between the output range and the upper and lower limit. In this example, the analog output has been configured as follows:

- **Output Range:** 4-20 mA
- **Register Number:** 1042 (Real Power, 3-Phase Total)
- **Lower Limit:** 100 kW
- **Upper Limit:** 500 kW
The table below shows the output current at various register readings.

<table>
<thead>
<tr>
<th>Register Reading</th>
<th>Output Current</th>
</tr>
</thead>
<tbody>
<tr>
<td>50 kW</td>
<td>4 mA</td>
</tr>
<tr>
<td>100 kW</td>
<td>4 mA</td>
</tr>
<tr>
<td>200 kW</td>
<td>8 mA</td>
</tr>
<tr>
<td>250 kW</td>
<td>10 mA</td>
</tr>
<tr>
<td>500 kW</td>
<td>20 mA</td>
</tr>
<tr>
<td>550 kW</td>
<td>20 mA</td>
</tr>
</tbody>
</table>

![Figure 6-5: Analog output example](image-url)
CHAPTER 7—ALARM FUNCTIONS

The portable circuit monitor (models CM-2150 and higher) can detect over 100 alarm conditions, including over/under conditions, status input changes, phase unbalance conditions, and more. (See Alarm Conditions and Alarm Codes in Appendix F for a complete list of alarm conditions.) The portable circuit monitor maintains a counter for each alarm to keep track of the total number of occurrences.

These alarm conditions are tools that enable the portable circuit monitor to execute tasks automatically. Using POWERLOGIC application software, each alarm condition can be assigned one or more of the following tasks.

- Force data log entries in up to 14 user-defined data log files (see Data Logging in Chapter 8)
- Operate one or more mechanical relays (see Mechanical Relay Outputs in Chapter 6)
- Perform a 4-cycle waveform capture (see 4-Cycle Waveform Capture in Chapter 9)
- Perform a 12-cycle waveform capture (see 12-cycle Event Capture in Chapter 9)

SETPOINT-DRIVEN ALARMS

Many of the alarm conditions—including all over, under, and phase unbalance alarm conditions—require that you define setpoints. Other alarm conditions, such as status 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 (in seconds)
- Dropout Setpoint
- Dropout Delay (in seconds)

For instructions on setting up alarm/relay functions from the portable circuit monitor front panel, see Setting Up Alarm/Relay Functions in Chapter 4.

To understand how the portable circuit monitor handles setpoint-driven alarms, see figure 7-2. Figure 7-1 shows what the actual event log entries for figure 7-2 might look like, as displayed by POWERLOGIC application software.

Note: The software would not actually display the codes in parentheses—EV1, EV2, M1, M2. These are references to the codes in figure 7-2.
**Figure 7-1: Sample event log entry**

<table>
<thead>
<tr>
<th>Date/Time</th>
<th>Event</th>
<th>Value</th>
<th>Condition</th>
<th>Forced Log Entry</th>
</tr>
</thead>
<tbody>
<tr>
<td>08/23/95 06:49:22 AM</td>
<td>Over Current B</td>
<td>61</td>
<td>Pickup</td>
<td>1, WFC-4</td>
</tr>
<tr>
<td>08/24/95 06:49:22 AM</td>
<td>Over Current C</td>
<td>48</td>
<td>Pickup</td>
<td>1, WFC-4</td>
</tr>
<tr>
<td>08/23/95 06:49:26 AM</td>
<td>Over Current C</td>
<td>48</td>
<td>Dropout</td>
<td></td>
</tr>
<tr>
<td>08/23/95 06:49:37 AM</td>
<td>Over Current B</td>
<td>61</td>
<td>Dropout</td>
<td></td>
</tr>
</tbody>
</table>

**Figure 7-2: How the portable circuit monitor handles setpoint-driven alarms**

**EV1** – Portable circuit monitor records the date/time that the pickup setpoint and time delay were satisfied, and the maximum value reached (Max1) during the pickup delay period ($\Delta T$). Also, the portable circuit monitor performs any tasks—waveform capture, 12-cycle event capture, forced data log entries, relay output operations—assigned to the event.

**EV2** – Portable circuit monitor records the date/time that the dropout setpoint and time delay were satisfied, and the maximum value reached (Max2) during the alarm period.
SETPOINT-CONTROLLED RELAY FUNCTIONS

A portable circuit monitor—model CM-2150 (or higher) equipped with an I/O module—can mimic the functions of certain motor management devices such as phase loss, undervoltage, or reverse phase relays. While the portable 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 portable 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 the user determines that the portable circuit monitor’s performance is acceptable, the output contacts can be used to mimic some functions of a motor management device. When deciding if the portable circuit monitor is acceptable for these applications, keep the following points in mind:

• Portable circuit monitors require control power in order to operate properly.

• Portable 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 portable circuit monitor releases all energized output contacts.

• Standard setpoint-controlled functions may take 2–3 seconds to operate, even if no delay is intended.

• A password is required to program the portable circuit monitor’s setpoint controlled relay functions.

A description of some common motor management functions follows. For detailed instructions on setting up setpoint-controlled functions from the portable circuit monitor’s front panel, see Setting Up Alarm/Relay Functions in Chapter 4, and Appendix F—Alarm Setup Information.

Undervoltage:

• Pickup and dropout setpoints are entered in volts. Very large values may require scale factors. Refer to Setting Scale Factors for Extended Metering Ranges in chapter 13 for more information on scale factors.

• 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).

• When the undervoltage alarm occurs, the portable circuit monitor operates any specified relays.

• Relays configured for normal mode operation remain closed until the under voltage alarm clears. The undervoltage alarm clears when the phase voltage remains above the dropout setpoint for the specified dropout delay period.
Setpoint-Controlled Relay Functions (cont.)

- To release any relays that are in latched mode, enter the portable circuit monitor’s Alarm mode and select the clear option. For detailed instructions, see Clearing the Priority 1 Log in Chapter 4.

Overvoltage:

- Pickup and dropout setpoints are entered in volts. Very large values may require scale factors. Refer to Setting Scale Factors for Extended Metering Ranges in chapter 13 for more information on scale factors.
- 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).
- When the overvoltage alarm occurs, the portable circuit monitor operates any specified relays.
- Relays configured for normal mode operation remain closed until the overvoltage alarm clears. The overvoltage alarm clears when the phase voltage remains below the dropout setpoint for the specified dropout delay period.
- To release any relays that are in latched mode, enter the portable circuit monitor’s Alarm mode and select the Clear option. For detailed instructions, see Clearing the Priority 1 Log in Chapter 4.

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 (in seconds).
- When the unbalance current alarm occurs, the portable circuit monitor operates any specified relays.
- Relays configured for normal mode operation remain closed until the unbalance current alarm clears. The unbalance current 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.
- To release any relays that are in latched mode, enter the portable circuit monitor’s Alarm mode and select the Clear option. For detailed instructions, see Clearing the Priority 1 Log in Chapter 4.

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.
Setpoint-Controlled Relay Functions (cont.)

- 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 (in seconds).

- When the unbalance voltage alarm occurs, the portable circuit monitor operates any specified relays.

- Relays configured for normal mode operation remain closed until the unbalance voltage alarm clears. The unbalance voltage 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).

- To release any relays that are in latched mode, enter the portable circuit monitor’s Alarm mode and select the Clear option. For detailed instructions, see Clearing the Priority 1 Log in Chapter 4.

Phase Loss—Current:

- Pickup and dropout setpoints are entered in tenths of percent, based on a percentage ratio of the smallest current to the largest current. For example, enter 50% as 500.

- The phase loss current alarm occurs when the percentage ratio of the smallest current to the largest current is equal to or below the pickup setpoint for the specified pickup delay (in seconds).

- When the phase loss current alarm occurs, the portable circuit monitor operates any specified relays.

- Relays configured for normal mode operation remain closed until the phase loss current alarm clears. The phase loss current alarm clears when the ratio of the smallest current to the largest current remains above the dropout setpoint for the specified dropout delay (in seconds).

- To release any relays that are in latched mode, enter the portable circuit monitor’s Alarm mode and select the Clear option. For detailed instructions, see Clearing the Priority 1 Log in Chapter 4.

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).

- When the phase loss voltage alarm occurs, the portable circuit monitor operates any specified relays.
Setpoint-Controlled Relay Functions (cont.)

- Relays configured for normal mode operation remain closed until the phase loss voltage alarm clears. 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.

- To release any relays that are in latched mode, enter the circuit monitor’s Alarm mode and select the Clear option. For detailed instructions, see Clearing the Priority 1 Log in Chapter 4.

Reverse Power:

- Pickup and dropout setpoints are entered in kilowatts. Very large values may require scale factors. Refer to Setting Scale Factors for Extended Metering Ranges in chapter 13 for more information on scale factors.

- The reverse power alarm occurs when the 3-phase power flow in the negative direction remains at or below the negative pickup value for the specified pickup delay (in seconds).

- When the reverse power alarm occurs, the portable circuit monitor operates any specified relays.

- Relays configured for normal mode operation remain closed until the reverse power alarm clears. The alarm clears when the 3-phase power reading remains above the dropout setpoint for the specified dropout delay (in seconds).

- To release any relays that are in latched mode, enter the portable circuit monitor’s Alarm mode and select the Clear option. For detailed instructions, see Clearing the Priority 1 Log in Chapter 4.
Setpoint-Controlled Relay Functions (cont.)

Phase Reversal:

- Pickup and dropout setpoints and delays do not apply to phase reversal.
- The phase reversal alarm occurs when the phase voltage waveform rotation differs from the default phase rotation. The portable circuit monitor assumes that an ABC phase rotation is normal. If a CBA phase rotation is normal, the user must change the portable circuit monitor’s phase rotation from ABC (default) to CBA. See Chapter 13—Advanced Topics.
- When the phase reversal alarm occurs, the portable circuit monitor operates any specified relays.
- Relays configured for normal mode operation remain closed until the phase reversal alarm clears.
- To release any relays that are in latched mode, enter the portable circuit monitor’s Alarm mode and select the Clear option. For detailed instructions, see Clearing the Priority 1 Log in Chapter 4.
CHAPTER 8—LOGGING

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EVENT LOGGING

The portable circuit monitor provides an event log file to record the occurrence of important events. The portable circuit monitor can be configured to log the occurrence of any alarm condition as an event. The event log can be configured as first-in-first-out (FIFO) or fill and hold. Using POWERLOGIC application software, the event log can be uploaded for viewing and saved to disk, and the portable circuit monitor’s event log memory can be cleared.

Event Log Storage

Portable circuit monitor models 2150 and higher provide nonvolatile memory for event log storage. The size of the event log (the maximum number of events) is user-definable. When determining the maximum number of events, take the portable circuit monitor’s total storage capacity into consideration. For portable circuit monitor models 2150 and 2250, the total storage capacity must be allocated between the event log and up to 14 data logs. For portable circuit monitor models 2350, 2450, and 2452, the total data storage capacity must be allocated between an event log, a 4-cycle waveform capture log, a 12-cycle event capture log, and up to 14 data logs. See Memory Allocation in Chapter 13 for additional memory considerations.
DATA LOGGING

Portable circuit monitor models CM-2150 and higher are equipped with nonvolatile memory for storing meter readings at regular intervals. The user can configure up to 14 independent data log files. The following items can be configured for each data log file:

- Logging Interval—1 minute to 24 hours
- Offset Time
- First-In-First-Out (FIFO) or Fill & Hold
- Values to be logged—up to 100, including date/time of each log entry

Each data log file can be cleared, independently of the others, using POWERLOGIC application software. For instructions on setting up and clearing data log files, refer to the POWERLOGIC application software instruction bulletin.

Alarm-Driven Data Log Entries

The portable circuit monitor can detect over 100 alarm conditions, including over under conditions, status input changes, phase unbalance conditions, and more. (See Chapter 7—Alarm Functions for more information.) Each alarm condition can be assigned one or more tasks, including forced data log entries into any of the 14 log files.

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

Organizing Data Log Files

There are many ways to organize data log files. 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: Voltage logged every minute. File is large enough to hold 60 entries so that you could look back over the last hour's voltage readings.

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

Data Log 3: Energy logged once daily. File is 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 file. File contains data log entries that are forced by the occurrence of an alarm condition. See Alarm-Driven Data Log Entries above. Note: The same data log file can support both scheduled and alarm driven entries.

Data log file 1 is pre-configured at the factory with a sample data log which records several parameters hourly. This sample data log can be reconfigured to meet your specific needs.
Storage Considerations

The following are important storage considerations:

- Portable circuit monitor model CM-2150 or higher is required for on-board data logging.

- For portable circuit monitor models CM-2150 and CM-2250, the total storage capacity must be allocated between the event log and up to 14 data logs. For portable circuit monitor model 2350, the total data storage capacity must be allocated between an event log, a 4-cycle waveform capture log, a 12-cycle event capture log, and up to 14 data logs.

- Portable circuit monitor models CM-2150 and CM-2250 store up to 5,632 logged values. Models CM-2350 and CM-2450 stores up to 51,200 values. Model CM-2452 stores up to 182,272 values. (These numbers assume that you’ve devoted all of the portable circuit monitor’s logging memory to data logging.)

- 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.

- See Memory Allocation in Chapter 12 for additional storage considerations.
MAINTENANCE LOG

The portable circuit monitor stores a maintenance log in nonvolatile memory. This log contains several values that are useful for maintenance purposes.

Table 8-1 below lists the values stored in the maintenance log and a short description of each. The values stored in the maintenance log are cumulative over the life of the portable circuit monitor and cannot be reset.

You can view the maintenance log using POWERLOGIC application software. For specific instructions, refer to the POWERLOGIC software instruction bulletin.

<table>
<thead>
<tr>
<th>Value Stored</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Demand Resets</td>
<td>Number of times demand values have been reset.</td>
</tr>
<tr>
<td>Number of Energy Resets</td>
<td>Number of times energy values have been reset.</td>
</tr>
<tr>
<td>Number of Min/Max Resets</td>
<td>Number of times min/max values have been reset.</td>
</tr>
<tr>
<td>Number of Output Operations</td>
<td>Number of times relay output has operated. This value is stored for each relay output.</td>
</tr>
<tr>
<td>Number of Power Losses</td>
<td>Number of times portable circuit monitor has lost control power.</td>
</tr>
<tr>
<td>Number of Firmware Downloads</td>
<td>Number of times new firmware has been downloaded to the portable circuit monitor over communications.</td>
</tr>
<tr>
<td>Number of Optical Comms Sessions</td>
<td>Number of times the front panel optical communications port has been used.</td>
</tr>
<tr>
<td>Highest Temperature Monitored</td>
<td>Highest temperature reached inside the portable circuit monitor.</td>
</tr>
<tr>
<td>Lowest Temperature Monitored</td>
<td>Lowest temperature reached inside the portable circuit monitor.</td>
</tr>
</tbody>
</table>
CHAPTER 9—WAVEFORM CAPTURE

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4-CYCLE WAVEFORM CAPTURE

Portable circuit monitor models CM-2250 and CM-2350 are equipped with waveform capture. Portable circuit monitors use a sophisticated, high-speed sampling technique to sample 64 times per cycle, simultaneously, on all current and voltage inputs.

There are two ways to initiate a waveform capture:

• Manually, from a remote personal computer, using POWERLOGIC application software
• Automatically, by the portable circuit monitor, when an alarm condition such as “Alarm #55: Over value THD voltage Phase A-B” occurs

Both methods are described below.

Manual Waveform Capture

Using POWERLOGIC application software, you can initiate a manual waveform capture from a remote personal computer. To initiate a manual waveform capture, select a portable circuit monitor equipped with waveform capture and issue the acquire command. The portable circuit monitor captures the waveform, and the software retrieves and displays it.

POWERLOGIC software lets you view all phase voltage and current waveforms simultaneously, or zoom in on a single waveform that includes a data block with extensive harmonic data.

For instructions on performing manual waveform capture using POWERLOGIC software, refer to the application software instruction manual.

Automatic Waveform Capture

The portable circuit monitor can detect over 100 alarm conditions—such as metering setpoint exceeded and status input changes (see Chapter 7—Alarm Functions for more information). The portable circuit monitor can be set up to automatically capture and save four cycles of waveform data associated with an alarm condition.
Setting Up the Portable Circuit Monitor

The portable circuit monitor must be set up for automatic waveform capture using POWERLOGIC application software. To set up the portable circuit monitor for automatic waveform capture, perform the following steps:

1. Select an alarm condition. (See Appendix F for a listing of alarm conditions.)
2. Define the setpoints. (This may not be necessary if the selected alarm is a status input change, for example.)
3. Select the automatic waveform capture option.

Repeat these steps for the desired alarm conditions. For specific instructions on selecting alarm conditions and specifying them for automatic waveform capture, refer to the POWERLOGIC application software instruction manual.

How it Works

At the beginning of every update cycle, the portable circuit monitor acquires four cycles of sample data for metering calculations (see figure 9-1). During the update cycle, the portable circuit monitor performs metering calculations and checks for alarm conditions. If the portable circuit monitor sees an alarm condition, it performs any actions assigned to the alarm condition. These actions can include automatic waveform capture, forced data logs, or output relay operations. For this example, assume that automatic waveform capture has been assigned to the alarm condition. When the portable circuit monitor sees that an alarm condition specified for automatic waveform capture has occurred, it stores the four cycles of waveform data acquired at the beginning of the update cycle.

![Figure 9-1: Flowchart illustrating automatic waveform capture](image-url)
Waveform Storage

Portable circuit monitor model 2250 stores waveforms differently than model 2350. The lists below describe how each model stores waveforms.

CM-2250

- Can store only one captured waveform. Each new waveform capture (either manual or automatic) replaces the last waveform data.
- Stores the captured waveform in volatile memory—the waveform data is lost on power-loss.
- The captured waveform does not affect event log and data log storage space. The captured waveform is stored separately.

CM-2350 (and higher)

- Can store multiple captured waveforms.
- Stores the captured waveforms in nonvolatile memory—the waveform data is retained on power-loss.
- The number of waveforms that can be stored is based on the amount of memory that has been allocated to waveform capture. See Memory Allocation in Chapter 13.
12-CYCLE EVENT CAPTURE

Portable circuit monitor models CM-2250 and CM-2350 are equipped with a feature called 12-cycle event capture. By connecting the portable circuit monitor to an external device, such as an undervoltage relay, the portable circuit monitor can capture and provide valuable information on short duration events such as voltage sags and swells.

Each event capture includes 12 cycles of sample data from each voltage and current input. An adjustable trigger delay lets the user adjust the number of pre-event cycles.

In a CM-2250, there are three ways to initiate a 12-cycle event capture:

• Manually, from a remote personal computer using POWERLOGIC application software
• Automatically, using an external device to trigger the portable circuit monitor
• Automatically, by the portable circuit monitor, when an alarm condition such as “Alarm #55: Over value THD voltage Phase A-B” occurs.

These methods are described below.

Note: Models CM-2350 and higher can trigger on high-speed events, allowing it to perform disturbance monitoring of voltage and current waveforms. See Chapter 10 for a description of the CM-2350’s disturbance monitoring capability.

Manual Event Capture

Using POWERLOGIC application software, you can initiate a manual 12-cycle event capture from a remote personal computer. Manual event captures can store 12 cycles of data for steady-state analysis.

To initiate a manual capture, select a portable circuit monitor equipped with 12-cycle event capture and issue the acquire command. The portable circuit monitor captures the data, and the software retrieves and displays it. POWERLOGIC software lets you view all 12-cycle phase voltage and current waveforms simultaneously, or zoom in on a single 12-cycle waveform.

For instructions on performing manual 12-cycle event capture using POWERLOGIC software, refer to the application software instruction manual.

Automatic Event Capture—High-Speed Trigger

By connecting the portable circuit monitor to an external device, such as an undervoltage relay, the portable circuit monitor can capture and provide valuable information on short duration events such as voltage sags. (The portable circuit monitor must be equipped with an I/O module.) Figure 9-2 on page 97 shows a block diagram that illustrates the relay-to-portable circuit monitor connections. As shown in figure 9-3, the relay must be wired to status input S2. Status input S2 is a high-speed input designed for this application.
Setting Up the Portable Circuit Monitor

The portable circuit monitor must be set up for 12-cycle event capture using POWERLOGIC application software. To set up the portable circuit monitor for event capture, perform the following steps:

1. When setting up the portable circuit monitor, select the alarm condition “Input S2 OFF to ON” (See Appendix F for a listing of alarm conditions.)
2. Select the check box for 12-cycle event capture.

For specific instructions on specifying an alarm condition for 12-cycle event capture, refer to the POWERLOGIC application software instruction manual.

How it Works

The portable circuit monitor maintains a data buffer consisting of 64 data points per cycle, for all current and voltage inputs. As the portable circuit monitor samples data, this buffer is constantly updated. When the portable circuit monitor senses the trigger—that is, when input S2 transitions from off to on—the portable circuit monitor transfers 12 cycles of data from the buffer into the memory allocated for 12-cycle event captures.

The user can specify the number of pre-event cycles. This can range from 2 pre-event and 10 post-event cycles, to 10 pre-event and 2 post-event cycles. For specific instructions on setting the number of pre-event and post-event cycles, refer to the POWERLOGIC application software instruction manual.

Figure 9-3 shows a 12-cycle event capture. In this example, the portable circuit monitor was monitoring a constant load when a motor load started causing a current inrush. The portable circuit monitor was set up to capture 2 pre-event and 10 post-event cycles.
The portable circuit monitor can detect over 100 alarm conditions, such as metering setpoint exceeded and status input changes (see Chapter 7—Alarm Functions). The portable circuit monitor can be set up to save 12 cycles of waveform data associated with the update cycle during which an alarm condition occurs. The 12 cycles of captured data do not correspond with the sample data taken at the beginning of the update cycle. The captured data is taken from later in the update cycle; therefore, the 12 cycles of captured data may not contain the same data that initiated the capture, but rather, the data immediately following. (For automatic recording of disturbances such as sags and swells, see Chapter 10.)

Setting Up the Portable Circuit Monitor

The portable circuit monitor must be set up for automatic, setpoint-controlled waveform capture using POWERLOGIC application software. To set up the portable circuit monitor, you must do three things:

1. Select an alarm condition. (See Appendix F for a listing of alarm conditions.)
2. Define the setpoints.
3. Select the check box for automatic waveform capture.

Repeat these steps for the desired alarm conditions. For specific instructions on selecting alarm conditions, defining setpoints, and specifying an alarm condition for automatic waveform capture, refer to the POWERLOGIC application software instruction manual.
Portable circuit monitor model 2250 stores 12-cycle event capture differently than models 2350 and higher. The lists below describe how each model stores 12-cycle event captures.

**CM-2250:**
- Stores only one captured 12-cycle event. Each new event capture (either manual or automatic) replaces the last captured data.
- Stores the captured data in volatile memory—the data is lost on power-loss.
- The captured data does not affect event log and data log storage space. The captured waveform is stored separately.

**CM-2350 (and higher):**
- Stores multiple captured 12-cycle events.
- Stores the captured data in nonvolatile memory—the data is retained on power-loss.
- The number of 12-cycle event captures that can be stored is based on the amount of memory that has been allocated to 12-cycle event capture. See Memory Allocation in Chapter 13.
CHAPTER 10—DISTURBANCE MONITORING

INTRODUCTION

Chapter 9—Waveform Capture describes the use of portable circuit monitor to make a 12-cycle recording, with 64 points per cycle resolution simultaneously on all channels, when triggered by an external device such as an undervoltage relay. This chapter describes the use of portable circuit monitor models 2350, 2450, and 2452 to monitor continuously for disturbances on its current and voltage inputs.

DESCRIPTION

The PCM can perform continuous monitoring of rms magnitudes of any of the metered channels of current and voltage. These calculations can be used to detect sags or swells on these channels.

Momentary voltage disturbances are becoming an increasing concern for industrial plants, hospitals, data centers, and other commercial facilities. Modern equipment used in many facilities tends to be more sensitive to voltage sags and swells, as well as momentary interruptions. POWERLOGIC Portable circuit monitors can help facility engineers diagnose equipment problems resulting from voltage sags or swells, identify areas of vulnerability, and take corrective action.

The interruption of an industrial process due to an abnormal voltage condition can result in substantial costs to the operation, 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 power problems. After the electrical system is interrupted or shut down, determining the cause may be difficult.

There are several types of voltage disturbances; each may have different origins and require a separate solution. For example, a momentary interruption occurs when a protective device interrupts the circuit feeding the customer’s facility. Swells and overvoltages are also a concern, as they can accelerate equipment failure or cause motors to overheat. Perhaps the biggest power quality problem facing industrial and commercial facilities 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 10-1, the fault not only causes an interruption to plant D, but also results in voltage sags to plants A, B, and C. Thus, 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 waveform in figure 10-2 shows the magnitude of a voltage sag, which persists until the remote fault is cleared.

The disturbance monitoring capabilities of the PCM can be used to:

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

Table 10-1 below shows the capability of the PCM to measure power system electromagnetic phenomena as defined in IEEE Recommended Practice for Monitoring Electric Power Quality.

<table>
<thead>
<tr>
<th>Category</th>
<th>Capability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transients³</td>
<td>N/A</td>
</tr>
<tr>
<td>Impulsive</td>
<td></td>
</tr>
<tr>
<td>Oscillatory</td>
<td>N/A</td>
</tr>
<tr>
<td>Short Duration Variations</td>
<td></td>
</tr>
<tr>
<td>Instantaneous</td>
<td>✓</td>
</tr>
<tr>
<td>Momentary</td>
<td>✓</td>
</tr>
<tr>
<td>Temporary</td>
<td>✓</td>
</tr>
<tr>
<td>Long Duration Variations</td>
<td>✓</td>
</tr>
<tr>
<td>Voltage Imbalance</td>
<td>✓</td>
</tr>
<tr>
<td>Waveform Distortion²</td>
<td>✓</td>
</tr>
<tr>
<td>Voltage Fluctuations</td>
<td>✓</td>
</tr>
<tr>
<td>Power Frequency Variations</td>
<td>✓</td>
</tr>
</tbody>
</table>

³ Portable circuit monitor not intended to detect phenomena in this category.
² Through the 31st harmonic.
OPERATION

The portable circuit monitor calculates rms magnitudes, based on 16 data points per cycle, every 1/2 cycle. This ensures that even single cycle duration rms variations are not missed. When the portable circuit monitor detects a sag or swell, it can perform the following actions:

- The event log can be updated with a sag/swell pickup event date/time stamp with 1 millisecond resolution, and an rms magnitude corresponding to the most extreme value of the sag or swell during the event pickup delay.
- An event capture consisting of up to five back-to-back 12-cycle recordings can be made, for a maximum of 60 continuous cycles of data. The event capture has a resolution of 64 data points per cycle on all metered currents and voltages.
- A forced data log entry can be made in up to 14 independent data logs.
- Any optional output relays can be operated upon detection of the event.
- At the end of the disturbance, these items are stored in the Event Log: a dropout time stamp with 1 millisecond resolution, and a second rms magnitude corresponding to the most extreme value of the sag or swell.
- The front panel can indicate, by a flashing Alarm LED, that a sag or swell event has occurred. A list of up to 10 of the prior alarm codes can be viewed in the P1 Log from the portable circuit monitor’s front panel.

In addition to these features, the PCM includes expanded non-volatile memory for logging. Using POWERLOGIC application software, the user can choose how to allocate the nonvolatile memory among the 14 data logs, the event log, multiple 4-cycle waveform captures and multiple 12-cycle event captures.

MULTIPLE WAVEFORM SETUP

You can configure the PCM to record up to five back-to-back 12-cycle waveform captures. This allows you to record 60 cycles of continuous data on all current and voltage inputs, with 64 points per cycle resolution. To configure the number of back-to-back 12-cycle recordings triggered by a single event, write a 1, 2, 3, 4, or 5 to register 7298 (see table 10-2 below). You must then allocate the on-board memory as shown in table 10-3 to support multiple back-to-back 12-cycle waveform captures. Allocate on-board memory using the on-board data storage setup screen (figure 10-3). Once the memory is properly allocated, you must perform a file “Resize/Clear All.” For information on register writes and file “Resize/Clear All,” refer to the appropriate POWERLOGIC application software instruction bulletin.

<table>
<thead>
<tr>
<th>No. of Back-to-Back 12-Cycle Waveform Captures per Trigger</th>
<th>No. of Continuous Cycles Recorded per Trigger</th>
<th>Required Value in Register 7298</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>12</td>
<td>1</td>
</tr>
<tr>
<td>2½</td>
<td>24</td>
<td>2</td>
</tr>
<tr>
<td>3½</td>
<td>36</td>
<td>3</td>
</tr>
<tr>
<td>4½</td>
<td>48</td>
<td>4</td>
</tr>
<tr>
<td>5½</td>
<td>60</td>
<td>5</td>
</tr>
</tbody>
</table>

Table 10-2
Multiple 12-Cycle Waveform Capture
Requires portable circuit monitor firmware version 15.002 or higher.

Table 10-3

<table>
<thead>
<tr>
<th>No. of Back-to-Back 12-Cycle Waveform Captures Per Trigger</th>
<th>Legal Entries for 12-Cycle Waveform Capture Memory Allocation</th>
<th>Max. No. of Triggered Events Stored</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Multiples of 1: 1, 2, 3…29</td>
<td>29</td>
</tr>
<tr>
<td>2</td>
<td>Multiples of 2: 2, 4, 6…28</td>
<td>14</td>
</tr>
<tr>
<td>3</td>
<td>Multiples of 3: 3, 6, 9…27</td>
<td>9</td>
</tr>
<tr>
<td>4</td>
<td>Multiples of 4: 4, 8, 12…28</td>
<td>7</td>
</tr>
<tr>
<td>5</td>
<td>Multiples of 5: 5, 10, 15, 20, 25</td>
<td>5</td>
</tr>
</tbody>
</table>

Figure 10-3: POWERLOGIC System Manager™ On-board Data Storage setup dialog box
As explained in chapter 9, the event capture has a user-programmable number of pre-event cycles ranging from 2 to 10 cycles. This allows you to tailor the event capture for more or less pre-event data. On event captures consisting of multiple 12-cycle recordings, the pre-event cycles apply only to the first 12-cycle waveform of the series.

**SAG/SWELL ALARMS**

POWERLOGIC application software can be used to set up each of the sag/swell alarms. For each alarm, the user programs the following data:

- Sag/swell alarm priority
- Pickup setpoint in amps or volts
- Pickup delay in cycles
- Dropout setpoint in amps or volts
- Dropout delay in cycles
- Data and waveform logging instructions
- Relay output actions

Note: Relays which are specified to be operated by high speed status input events should not be operated by standard events or high speed surge/sag events. Unpredictable relay operation will result.

**MULTIPLE WAVEFORM RETRIEVAL**

POWERLOGIC application software can be used to retrieve the above information for later analysis. When a set of multiple continuous 12-cycle waveform captures are triggered, they are stored in the portable circuit monitor as individual 12-cycle recordings. POWERLOGIC application software can be used to retrieve and display these individual waveform captures. If POWERLOGIC application software is used to manually acquire a set of multiple continuous 12-cycle waveform captures, the user can retrieve each of these 12-cycle waveform captures using the “retrieve existing on board 12-cycle waveform capture” option.

![Figure 10-4: Three back-to-back 12-cycle waveform captures of a V_a-n sag](image)
Whenever the 12-cycle waveform capture is configured for two or more back-to-back waveform captures, a set of waveform captures can be triggered manually with POWERLOGIC application software. However, to retrieve the set, the “retrieve existing on-board 12-cycle waveform capture” option should be used.

Event log entries 1 and 2 are detailed below and illustrated in figure 10-5.

Event Log Entry 1—For high-speed events, 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 $t_1$. This is calculated using 16 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 $t_1$ and $t_2$ 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.
INTRODUCTION

Portable circuit monitor model CM-2452 is designed to run customized programs written in the circuit monitor programming language. This programming language provides you with the application flexibility to adapt the CM-2452 to your specialized needs. Programs can be designed to work with all other portable circuit monitor features, extending the overall capabilities of the device. A sample CM-2450 program is available from Square D that includes customized features for enhanced data logging. Contact POWERLOGIC Engineering Services for information on using the CM-2450 for other applications.

DESCRIPTION

The CM-2450 circuit monitor programming language uses an easy-to-understand set of programming commands similar to a compiled “BASIC” language. The programming language includes capabilities such as:

- scheduled tasks
- event tasks (based on undervoltage, over kW...)
- math functions: Add, subtract, multiply, divide, sine, cosine, square root...
- support for various data types: 16-bit signed registers, longs, floats, power factor, date/time...
- logical operations: AND, OR, XOR, NOT, shift...
- for...next loops, nested IF...Else statements, =, <, >, <>, <+>, >=
- Subroutine calls
- 1000 nonvolatile SY/MAX read/write registers
- 2000 virtual registers for scratch pad area
- support for tables of up to 256 items

The programs are developed using an ASCII text editor such as DOS “Edit” and saved as “.SRC” files. A circuit monitor programming language compiler is then used to process the text file, looking for syntax errors or illegal commands. Any errors that are found are listed in a report detailing the errors. After program errors are corrected, the compiler generates a “.HEX” file which can be downloaded into the portable circuit monitor using the downloadable firmware utility program. Programs that are downloaded into the portable circuit monitor are secure; they cannot be uploaded. If changes to a program are desired, the new program can be modified from the original program text file, re-compiled, and written over the previous program as a new application.
APPLICATION EXAMPLES

Examples of applications where the CM-2450 can be very valuable are as follows:

• metering of specialized utility rate structures
• data reduction using smart data logging
• automatic monthly logging of kWH and Peak Demand
• synchronization of Demand Intervals to Time of Day
• statistical profile analysis of metered quantities
• CBEMA power quality analysis
• calculations for IEEE-519 verification
• metering of combined utilities: gas, water, steam, electric
• non-critical control output decisions such as Load Control or Power Factor Correction, based on multiple conditions, e.g., Time of Day and Input Status

PROGRAMMING SCHOOL

Square D offers a CM-2450 circuit monitor programming school. Graduates of this school are provided a program developers kit and will be able to write their own programs. Contact your local Square D representative for more information on the CM-2450 programming school.

NOTE

Apply the portable circuit monitor appropriately as a programmable power monitoring device, not as a primary protective device.
APPENDIX F—ALARM SETUP INFORMATION

The portable circuit monitor is designed to handle a wide range of metering requirements. To handle very large and very small metering values, the PCM uses scale factors to act as multipliers. These scale factors range from 0.001 up to 1000 and are expressed at powers of 10—for example, 0.001 = 10^{-3}. These scale factors are necessary because the PCM stores data in registers which are limited to integer values between -32767 and +32767. When a value is either larger than 32767, or is a non-integer, it is expressed as an integer in the range of +/-32767 associated with a multiplier in the range of 10^{-3} to 10^{3}. For more information on scale factors see Setting Scale Factors for Extended Metering Ranges in Chapter 12.

When POWERLOGIC application software is used to set up alarms, it automatically handles the scaling of pickup and dropout setpoints.

When alarm setup is performed from the portable circuit monitor's front panel, the user must:

- 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 the user must 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.

SCALING ALARM SETPOINTS

This section is for users who do not have POWERLOGIC software and must set up alarms from the portable circuit monitor front panel. It tells how to properly scale alarm setpoints.

The PCM is equipped with a 6-digit LED display and a two LED’s to indicate “Kilo” or “Mega” units, when applicable. 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 determine if either the “Kilo” or “Mega” light is turned on. 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. There can be up to 3 digits to the right of the decimal point, indicating whether the quantity is stored in a register as thousandths, hundredths, tenths, or units. The “Kilo” or “Mega” LED indicates the engineering units—Kilowatts or Megawatts—that are applied to the quantity. 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 integer values in thousandths. Therefore, to define a power factor setpoint of 0.85 lagging, enter -850 (the “-” sign indicates lag).

For another example, consider a “Phase A-B Undervoltage” alarm. If the $V_{A-B}$ reading is displayed as 138.00 with the Kilo LED turned on, 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 CODES

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

- **Alarm No.**: A code number used to refer to individual alarms
- **Alarm Description**: A brief description of the alarm condition
- **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 units that apply 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 Setting Scale Factors for Extended Metering Ranges in Chapter 13.
- **Alarm Type**: A reference to a definition providing details on the operation and configuration of the alarm. See Alarm Type Definitions following the list of alarm conditions, for a description of alarm types.

<table>
<thead>
<tr>
<th>Alarm No.</th>
<th>Alarm Description</th>
<th>Test Register</th>
<th>Units</th>
<th>Scale Group</th>
<th>Alarm Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>Over Current Phase A</td>
<td>1003</td>
<td>Amps</td>
<td>A</td>
<td>A</td>
</tr>
<tr>
<td>02</td>
<td>Over Current Phase B</td>
<td>1004</td>
<td>Amps</td>
<td>A</td>
<td>A</td>
</tr>
<tr>
<td>03</td>
<td>Over Current Phase C</td>
<td>1005</td>
<td>Amps</td>
<td>A</td>
<td>A</td>
</tr>
<tr>
<td>04</td>
<td>Over Current Neutral</td>
<td>1006</td>
<td>Amps</td>
<td>B</td>
<td>A</td>
</tr>
<tr>
<td>05</td>
<td>Over Current Ground</td>
<td>1007</td>
<td>Amps</td>
<td>C</td>
<td>A</td>
</tr>
<tr>
<td>06</td>
<td>Under Current Phase A</td>
<td>1003</td>
<td>Amps</td>
<td>A</td>
<td>B</td>
</tr>
<tr>
<td>07</td>
<td>Under Current Phase B</td>
<td>1004</td>
<td>Amps</td>
<td>A</td>
<td>B</td>
</tr>
<tr>
<td>08</td>
<td>Under Current Phase C</td>
<td>1005</td>
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## ALARM TYPE DEFINITIONS

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<td>B</td>
<td>Under Value Alarm</td>
<td>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.</td>
</tr>
<tr>
<td>C</td>
<td>Phase Loss, Current</td>
<td>The unbalance current alarm will occur when the percentage of the smallest phase current divided by the largest phase current is below the percentage pickup value, and remains at or below the pickup value long enough to satisfy the specified pickup delay in seconds. When the percentage of the smallest phase current divided by the largest phase current remains above the dropout value for the specified dropout delay period, the alarm will dropout. Pickup and Dropout setpoints are positive, delays are in seconds.</td>
</tr>
<tr>
<td>D</td>
<td>Phase Loss, Voltage</td>
<td>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.</td>
</tr>
<tr>
<td>E</td>
<td>Lagging P.F.</td>
<td>The Lagging Power Factor alarm will occur when the test register value becomes more lagging than the pickup setpoint (i.e. 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 (i.e. closer to 1.000) and remains less lagging for the dropout delay period, the alarm will dropout. Pickup setpoint must be negative. Dropout setpoint can be negative or positive. 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.</td>
</tr>
<tr>
<td>F</td>
<td>Leading P.F.</td>
<td>The Leading Power Factor alarm will occur when the test register value becomes more leading than the pickup setpoint (i.e. 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 (i.e. closer to 1.000) and remains less leading for the dropout delay period, the alarm will dropout. Pickup setpoint must be positive. Dropout setpoint can be positive or negative. 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.</td>
</tr>
<tr>
<td>G</td>
<td>Over Power Demand</td>
<td>The over power demand alarms will occur when the test register’s absolute value exceeds the pickup setpoint and remains above the pickup setpoint long enough to satisfy the pickup delay period. When the absolute value drops to below the dropout setpoint and remains below the setpoint long enough to satisfy the dropout delay period, the alarm will dropout. Pickup and Dropout setpoints are positive, delays are in seconds.</td>
</tr>
<tr>
<td>Alarm Type</td>
<td>Alarm Description</td>
<td>Alarm Operation</td>
</tr>
<tr>
<td>------------</td>
<td>-----------------------------------</td>
<td>-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>H</td>
<td>Over Lagging Average P.F.</td>
<td>The Over lagging 3-phase Average P.F. will occur when the test register is less leading than the pickup setpoint and remains less leading for the pickup delay period. When the value becomes less lagging than the dropout setpoint and remains less lagging for the dropout delay, the alarm will dropout. If a leading P.F. is selected for the pickup setpoint (that is, a positive P.F.) then the alarm will be active for any lagging P.F. or for any leading P.F. between the pickup setpoint and unity. Pickup and Dropout setpoints can be positive or negative; delays are in seconds. Enter setpoints as integer values representing power factor in thousandths. For example, to define a dropout setpoint of -0.5, enter -500. <strong>Note:</strong> This alarm condition is based on the average power factor over the last demand interval—not instantaneous power factor.</td>
</tr>
<tr>
<td>I</td>
<td>Under Power</td>
<td>The Under power alarm will occur when the test register’s absolute value is below the pickup setpoint and remains below the pickup setpoint long enough to satisfy the pickup delay period. When the absolute value rises above the dropout setpoint and remains above the setpoint long enough to satisfy the dropout delay period, the alarm will dropout. Pickup and Dropout setpoints are positive, delays are in seconds.</td>
</tr>
<tr>
<td>J</td>
<td>Over Reverse Power</td>
<td>The over reverse power alarm will occur when the test register’s absolute value exceeds the pickup setpoint and remains above the pickup setpoint long enough to satisfy the pickup delay period. When the absolute value drops to below the dropout setpoint and remains below the setpoint long enough to satisfy the dropout delay period, the alarm will dropout. This alarm will only hold true for Reverse Power conditions, i.e. any positive power value will not cause the alarm to occur. Pickup and Dropout setpoints are positive, delays are in seconds.</td>
</tr>
<tr>
<td>K</td>
<td>Phase Reversal</td>
<td>Once enabled the phase reversal alarm will occur whenever the phase voltage waveform rotation differs from the default phase rotation. It is assumed that an ABC phase rotation is normal. If a CBA normal phase rotation is normal, the user should reprogram the portable circuit monitor’s phase rotation from ABC (default) to CBA phase rotation. The pickup and dropout setpoints and delays for phase reversal do not apply.</td>
</tr>
<tr>
<td>L</td>
<td>Status Input Transitions Off to On</td>
<td>The Status Input transitions alarms will occur whenever the status input changes from off to on. The alarm requires no pickup or dropout setpoints or delays. The Alarm will dropout when the status input changes back to off from on. The pickup and dropout setpoints and delays do not apply.</td>
</tr>
<tr>
<td>M</td>
<td>Status Input Transitions On to Off</td>
<td>The Status Input transitions alarms will occur whenever the status input changes from on to off. The alarm requires no pickup or dropout setpoints or delays. The alarm will dropout when the status input changes back to on from off. The pickup and dropout setpoints and delays do not apply.</td>
</tr>
<tr>
<td>N</td>
<td>End Of Interval/Update Cycle</td>
<td>The End of Interval alarms mark the end of an interval, or update cycle. The pickup and dropout setpoints and delays do not apply.</td>
</tr>
<tr>
<td>O</td>
<td>Power-Up/Reset</td>
<td>The Power-Up/Reset alarm marks any time the portable circuit monitor powers up or resets. The pickup and dropout setpoints and delays do not apply.</td>
</tr>
<tr>
<td>P</td>
<td>Over Analog</td>
<td>The Over Analog alarms will occur whenever the test register value is more positive than the pickup setpoint (or less negative) and remains greater than the pickup long enough to satisfy the pickup delay. When the value becomes less positive than the dropout setpoint (or more negative) and remains below the setpoint long enough to satisfy the dropout delay, the alarm will dropout. Pickup and Dropout setpoints can be positive or negative, delays are in seconds.</td>
</tr>
<tr>
<td>Alarm Type</td>
<td>Alarm Description</td>
<td>Alarm Operation</td>
</tr>
<tr>
<td>------------</td>
<td>-----------------------</td>
<td>---------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Q</td>
<td>Under Analog</td>
<td>The Under Analog alarms will occur whenever the test register value is less positive than the pickup setpoint (or more negative) and remains less than the pickup long enough to satisfy the pickup delay. When the becomes more positive than the dropout setpoint (or less negative) and remains above the setpoint long enough to satisfy the dropout delay, the alarm will dropout. Pickup and Dropout setpoints can be positive or negative, delays are in seconds.</td>
</tr>
<tr>
<td>R</td>
<td>Voltage/Current Swell</td>
<td>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 drop out. Pickup and Dropout setpoints are positive, delays are in cycles.</td>
</tr>
<tr>
<td>S</td>
<td>Voltage/Current Sag</td>
<td>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, delays are in cycles.</td>
</tr>
</tbody>
</table>
THE COMMAND INTERFACE

The portable circuit monitor provides a command interface that can be used to perform various operations such as manual relay operation.

To use the command interface, do the following:

1. Write related parameters to the command parameter registers—#7701–7709. (Some commands require no parameters. For these commands, write the command code only to register 7700.)

2. Write a command code to the portable circuit monitor’s command interface register—#7700.
The following is a listing of command codes that can be written to the command interface register (7700) and to the command interface parameter registers (7701–7709).

<table>
<thead>
<tr>
<th>Code</th>
<th>Parameter(s)</th>
<th>Description</th>
<th>Reset Req’d</th>
</tr>
</thead>
<tbody>
<tr>
<td>1110</td>
<td>None</td>
<td>Resets the portable circuit monitor.</td>
<td>N/A</td>
</tr>
<tr>
<td>1310</td>
<td>Sec, Min, Hr, Day, Mo, Yr</td>
<td>Command code to set date and time.</td>
<td>N</td>
</tr>
<tr>
<td>2110</td>
<td>Scale Factors A–E</td>
<td>Change scale factors A–E and reset min/max registers/file. Then reset unit.</td>
<td>N</td>
</tr>
<tr>
<td>2120</td>
<td>CT ratio correction factors A, B, C, N</td>
<td>Change CT ratio correction factors</td>
<td>Y</td>
</tr>
<tr>
<td>2130</td>
<td>PT ratio correction factors A, B, C</td>
<td>Change PT ratio correction factors</td>
<td>Y</td>
</tr>
<tr>
<td>2310</td>
<td>Unit Address</td>
<td>Change unit’s address to the address specified and reset unit</td>
<td>N</td>
</tr>
<tr>
<td>2320</td>
<td>Baud Rate</td>
<td>Change unit’s baud rate to the baud rate specified and reset unit</td>
<td>N</td>
</tr>
<tr>
<td>2330</td>
<td>None</td>
<td>Enable unit #01’s response to the SY/MAX enquire transmission (default)</td>
<td>N</td>
</tr>
<tr>
<td>2331</td>
<td>None</td>
<td>Disable unit #01’s response to the SY/MAX enquire transmission</td>
<td>N</td>
</tr>
<tr>
<td>2340</td>
<td>None</td>
<td>Set control of conditional energy to status inputs (default)</td>
<td>N</td>
</tr>
<tr>
<td>2341</td>
<td>None</td>
<td>Set control of conditional energy to command Interface</td>
<td>N</td>
</tr>
<tr>
<td>2350</td>
<td>None</td>
<td>Enable front panel comm port (default)</td>
<td>N</td>
</tr>
<tr>
<td>2351</td>
<td>None</td>
<td>Disable front panel comm port</td>
<td>N</td>
</tr>
<tr>
<td>2360</td>
<td>None</td>
<td>Enable front panel setup (default)</td>
<td>N</td>
</tr>
<tr>
<td>2361</td>
<td>None</td>
<td>Disable front panel setup</td>
<td>N</td>
</tr>
<tr>
<td>2370</td>
<td>None</td>
<td>Set normal phase rotation to ABC (default)</td>
<td>N</td>
</tr>
<tr>
<td>2371</td>
<td>None</td>
<td>Set normal phase rotation to CBA</td>
<td>N</td>
</tr>
<tr>
<td>3310</td>
<td>Bit Map Relay Designation</td>
<td>Place specified relays under external control (default)</td>
<td>N</td>
</tr>
<tr>
<td>3311</td>
<td>Bit Map Relay Designation</td>
<td>Place specified relays under internal control</td>
<td>N</td>
</tr>
<tr>
<td>3320</td>
<td>Bit Map Relay Designation</td>
<td>De-energize designated relays per specified bit map</td>
<td>N</td>
</tr>
<tr>
<td>3321</td>
<td>Bit Map Relay Designation</td>
<td>Energize designated relays per specified bit map</td>
<td>N</td>
</tr>
<tr>
<td>3340</td>
<td>Bit Map Output Designation</td>
<td>Release specified relays from override control</td>
<td>N</td>
</tr>
<tr>
<td>3341</td>
<td>Bit Map Output Designation</td>
<td>Place specified relays under override control.</td>
<td>N</td>
</tr>
<tr>
<td>Code</td>
<td>Parameter(s)</td>
<td>Description</td>
<td>Reset Req’d</td>
</tr>
<tr>
<td>--------</td>
<td>-----------------------</td>
<td>-----------------------------------------------------------------------------</td>
<td>-------------</td>
</tr>
<tr>
<td>3390</td>
<td>Bit Map Input Designation</td>
<td>Set control of conditional energy to indicated status inputs.</td>
<td>N</td>
</tr>
<tr>
<td>4110</td>
<td>None</td>
<td>Reset Min/Max</td>
<td>N</td>
</tr>
<tr>
<td>4310</td>
<td>None</td>
<td>Set VAr sign convention to CM1 convention (default)</td>
<td>Y</td>
</tr>
<tr>
<td>4311</td>
<td>None</td>
<td>Set VAr sign convention to alternate convention</td>
<td>Y</td>
</tr>
<tr>
<td>4910</td>
<td>None</td>
<td>Trigger 4-cycle waveform capture</td>
<td>N</td>
</tr>
<tr>
<td>4911</td>
<td>None</td>
<td>Trigger 12-cycle waveform capture</td>
<td>N</td>
</tr>
<tr>
<td>4920</td>
<td>Bit Map</td>
<td>Trigger Data Log Entry</td>
<td>N</td>
</tr>
<tr>
<td>5110</td>
<td>None</td>
<td>Reset Peak Demand Currents/K Factors</td>
<td>N</td>
</tr>
<tr>
<td>5120</td>
<td>None</td>
<td>Reset Peak Demand Powers and associated average Power Factors</td>
<td>N</td>
</tr>
<tr>
<td>5310</td>
<td>None</td>
<td>Set power demand method to thermal (default)</td>
<td>Y</td>
</tr>
<tr>
<td>5311</td>
<td>None</td>
<td>Set power demand method to block/rolling</td>
<td>Y</td>
</tr>
<tr>
<td>5320</td>
<td>None</td>
<td>Set external demand synch source to input 1</td>
<td>N</td>
</tr>
<tr>
<td>5321</td>
<td>None</td>
<td>Set external demand synch source to the command interface</td>
<td>N</td>
</tr>
<tr>
<td>5910</td>
<td>None</td>
<td>Start new demand interval</td>
<td>N</td>
</tr>
<tr>
<td>5920</td>
<td>None</td>
<td>Set new Status Input Pulse Demand Interval</td>
<td>N</td>
</tr>
<tr>
<td>6210</td>
<td>None</td>
<td>Clear all accumulated energies</td>
<td>N</td>
</tr>
<tr>
<td>6220</td>
<td>None</td>
<td>Clear all conditional energies</td>
<td>N</td>
</tr>
<tr>
<td>6310</td>
<td>None</td>
<td>Set energy accumulation method to absolute</td>
<td>N</td>
</tr>
<tr>
<td>6311</td>
<td>None</td>
<td>Set energy accumulation method to signed</td>
<td>N</td>
</tr>
<tr>
<td>6320</td>
<td>None</td>
<td>Disable conditional energy accumulation</td>
<td>N</td>
</tr>
<tr>
<td>6321</td>
<td>None</td>
<td>Enable conditional energy accumulation</td>
<td>N</td>
</tr>
<tr>
<td>6330</td>
<td>None</td>
<td>Set reactive energy and demand method to include only the fundamental component</td>
<td>N</td>
</tr>
<tr>
<td>6331</td>
<td>None</td>
<td>Set reactive energy and demand method to include the both fundamental and harmonic components</td>
<td>N</td>
</tr>
<tr>
<td>6910</td>
<td>None</td>
<td>Start new incremental energy interval</td>
<td>N</td>
</tr>
</tbody>
</table>
OPERATING RELAYS USING THE COMMAND INTERFACE

By writing commands to the command interface, you can control portable circuit monitor relay outputs. This section tells how to operate the relay outputs. See Appendix E, registers 2500-2521, for information on relay output configuration.

Setting Up Relays for Remote (External) Control

To set up the portable circuit monitor for remote (external) relay operation, you must configure the portable circuit monitor for remote relay control.

To configure the portable circuit monitor for remote relay control:

1. Write a bitmap (see below) to the command parameter register, specifying the relays to be setup for remote control.

<table>
<thead>
<tr>
<th>Reg #</th>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>7701</td>
<td>Bitmap</td>
<td>Bitmap corresponding to relays to be placed under manual control. Bit 1 corresponds to KYZ, Bit 2 corresponds to Relay 1, Bit 3 corresponds to relay 2, Bit 4 corresponds to relay 3.</td>
</tr>
</tbody>
</table>

2. Write a command code (3310) to the portable circuit monitor’s command interface register (7700).

| 7700 | 3310 | Command code to configure relay for remote (external) control |

Energizing a Relay

To energize a relay, do the following:

1. Write a bitmap (see below) to the command parameter register, specifying the relays to be energized.

<table>
<thead>
<tr>
<th>Reg #</th>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>7701</td>
<td>Bitmap</td>
<td>Bitmap corresponding to relays to be energized. Bit 1 corresponds to KYZ, Bit 2 corresponds to Relay 1, Bit 3 corresponds to relay 2, Bit 4 corresponds to relay 3.</td>
</tr>
</tbody>
</table>

2. Write a command code (3321) to the portable circuit monitor’s command interface register (7700).

| 7700 | 3321 | Command code to energize relay |

De-energizing a Relay

To de-energize a relay, do the following:

1. Write a bitmap (see below) to the command parameter register, specifying the relays to be de-energized.

<table>
<thead>
<tr>
<th>Reg #</th>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>7701</td>
<td>Bitmap</td>
<td>Bitmap corresponding to relays to be de-energized. Bit 1 corresponds to KYZ, Bit 2 corresponds to Relay 1, Bit 3 corresponds to relay 2, Bit 4 corresponds to relay 3.</td>
</tr>
</tbody>
</table>

2. Write a command code (3320) to the portable circuit monitor’s command interface register (7700).

| 7700 | 3320 | Command code to de-energize relay |
Setting Up Relays for Portable circuit monitor (Internal) Control

For the portable circuit monitor to automatically control relays based on alarm conditions or as a pulse initiator output, you must configure the relays for portable circuit monitor (internal) control.

To configure relays for portable circuit monitor (internal) control, do the following:

1. Write a bitmap (see below) to the command parameter register, specifying the relays to be setup for internal control.

<table>
<thead>
<tr>
<th>Reg #</th>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>7701</td>
<td>Bitmap</td>
<td>Bitmap corresponding to relays to be placed under internal control. Bit 1 corresponds to KYZ, Bit 2 corresponds to Relay 1, Bit 3 corresponds to relay 2, Bit 4 corresponds to relay 3.</td>
</tr>
</tbody>
</table>

2. Write a command code (3311) to the portable circuit monitor’s command interface register (7700).

<table>
<thead>
<tr>
<th>Reg #</th>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>7700</td>
<td>3311</td>
<td>Command code to configure relay for internal control</td>
</tr>
</tbody>
</table>

Overriding an Output Relay

It is possible to override a portable circuit monitor output relay set up for portable circuit monitor (internal) control. Once overridden, the specified relays will respond to manual control.

To override relays, do the following:

1. Write a bitmap (see below) to the command parameter register, specifying the relays to be overridden.

<table>
<thead>
<tr>
<th>Reg #</th>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>7701</td>
<td>Bitmap</td>
<td>Bitmap corresponding to relays to be placed under override control. Bit 1 corresponds to KYZ, Bit 2 corresponds to Relay 1, Bit 3 corresponds to relay 2, Bit 4 corresponds to relay 3.</td>
</tr>
</tbody>
</table>

2. Write a command code (3341) to the portable circuit monitor’s command interface register (7700).

<table>
<thead>
<tr>
<th>Reg #</th>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>7700</td>
<td>3341</td>
<td>Command Code to place relay under override control</td>
</tr>
</tbody>
</table>

Releasing an Overridden Relay

To return an overridden relay to portable circuit monitor (internal) control, you must release the override.

To release the override, do the following:

1. Write a bitmap (see below) to the command parameter register, specifying the relays to be released from override.

<table>
<thead>
<tr>
<th>Reg #</th>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>7701</td>
<td>Bitmap</td>
<td>Bitmap corresponding to relays to be released from override control. Bit 1 corresponds to KYZ, Bit 2 corresponds to Relay 1, Bit 3 corresponds to relay 2, Bit 4 corresponds to relay 3.</td>
</tr>
</tbody>
</table>

2. Write a command code (3340) to the portable circuit monitor’s command interface register (7700).

<table>
<thead>
<tr>
<th>Reg #</th>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>7700</td>
<td>3340</td>
<td>Command Code to release overridden relays</td>
</tr>
</tbody>
</table>
The portable circuit monitor stores instantaneous metering data in single registers. Each register has a maximum range of 32,767. In order to meter extended ranges, current, voltage, and power readings can accommodate multipliers other than one. Multipliers can be changed from the default value of 1 to other values such as 10, 100, or 1000. These scale factors are automatically selected for the user when setting up the portable circuit monitor, either from the front panel or using POWERLOGIC application software.

The portable 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 $10^2=100$.

If the portable circuit monitor displays “-OFLO-” for any reading, the scale factor may need to be changed to bring the reading back into range. For example, since a portable circuit monitor 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 portable circuit monitor stores this value as 13,800 with a scale factor of 1 (since $10^1=10$). The portable circuit monitor front panel would display the value as 138.00 with the KILO units LED lit.

Scale factors are arranged in scale groups. The abbreviated register list in Appendix E shows the scale group associated with each metered value.

The command interface can be used to change scale factors on a group of metered values. The procedure on the following page tells how.

### NOTE

- It is strongly recommended that the default scale factors which are automatically selected by POWERLOGIC hardware and software not be changed.

- When using custom software to read portable 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 values are reset.
Setting Scale Factors (cont.) To change scale factors, do the following:

1. Determine the required scale factors

There are 5 scale groups. The desired scale factor for each group must be determined. The following is a listing of the available scale factors for each of the 5 user defined scale groups. The factory default for each scale group is 0. If you need either an extended range or more resolution, you can select any of the available scale factors to suit your need.

<table>
<thead>
<tr>
<th>Scale Group A - Phase Current</th>
<th>Scale Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amps 0-327.67 A</td>
<td>-2</td>
</tr>
<tr>
<td>0-3276.7 A</td>
<td>-1</td>
</tr>
<tr>
<td>0-32767 A</td>
<td>0 (default)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Scale Group B - Neutral Current</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amps 0-327.67 A</td>
</tr>
<tr>
<td>0-3276.7 A</td>
</tr>
<tr>
<td>0-32767 A</td>
</tr>
<tr>
<td>0-327.67 kA</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Scale Group C - Ground Current</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amps 0-327.67 A</td>
</tr>
<tr>
<td>0-3276.7 A</td>
</tr>
<tr>
<td>0-32767 A</td>
</tr>
<tr>
<td>0-327.67 kA</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Scale Group D Voltage, L-L, L-N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Voltage 0-3276.7 V</td>
</tr>
<tr>
<td>0-32767 V</td>
</tr>
<tr>
<td>0-327.67 kV</td>
</tr>
<tr>
<td>0-3276.7 kV</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Scale Group E Power kW, kVAR, kVA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power 0-32.767 kW, kVAR, kVA</td>
</tr>
<tr>
<td>0-327.67 kW, kVAR, kVA</td>
</tr>
<tr>
<td>0-3276.7 kW, kVAR, kVA</td>
</tr>
<tr>
<td>0-32767 kW, kVAR, kVA</td>
</tr>
<tr>
<td>0-32.767 MW, MVAR, MVA</td>
</tr>
<tr>
<td>0-327.67 MW, MVAR, MVA</td>
</tr>
<tr>
<td>0-3276.7 MW, MVAR, MVA</td>
</tr>
</tbody>
</table>

2. Using POWERLOGIC application software, read the existing scale factors from registers 2020-2024 and write them down.

Register 2020 Scale Group A
Register 2021 Scale Group B
Register 2022 Scale Group C
Register 2023 Scale Group D
Register 2024 Scale Group E

3. Make note of the changes required to the scale groups.
4. Write the appropriate values (see below) to a series of command parameter registers, one for each scale group.

<table>
<thead>
<tr>
<th>Reg No.</th>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
</table>
| 7701–7705 | Scale Factors | Scale Group A—write to reg. 7701  
Scale Group B—write to reg. 7702  
Scale Group C—write to reg. 7703  
Scale Group D—write to reg. 7704  
Scale Group E—write to reg. 7705 |

Scale Group A: Ammeter Per Phase
-2 = multiplier of 0.01
-1 = multiplier of 0.10
0 = multiplier of 1.00 (default)
1 = multiplier of 10.0

Scale Group B: Ammeter Neutral
-2 = multiplier of 0.01
-1 = multiplier of 0.10
0 = multiplier of 1.00 (default)
1 = multiplier of 10.0

Scale Group C: Ammeter Ground
-2 = multiplier of 0.01
-1 = multiplier of 0.10
0 = multiplier of 1.00 (default)
1 = multiplier of 10.0

Scale Group D: Voltmeter
-1 = multiplier of 0.10
0 = multiplier of 1.00 (default)
1 = multiplier of 10.0
2 = multiplier of 100.

Scale Group E: kWattmeter, kVarmeter, kVA
-3 = multiplier of 0.001
-2 = multiplier of 0.01
-1 = multiplier of 0.10
0 = multiplier of 1.00 (default)
1 = multiplier of 10.0
2 = multiplier of 100.
3 = multiplier of 1000
4 = multiplier of 10,000
5 = multiplier of 100,000

Scale Group F: Frequency (Determined by CM)
-2 = multiplier of 0.01 (for 50/60 Hz)
-1 = multiplier of 0.10 (for 400 Hz)

5. Write a command code (2110) to the portable circuit monitor’s command interface register (7700).
SETTING THE DATE AND TIME USING THE COMMAND INTERFACE

The command interface can be used to set the date and time.

To set the date and time, do the following:

1. Write values to a series of command parameter registers, one for each time parameter, SEC, MO, DA, HR, MN, YR.

<table>
<thead>
<tr>
<th>Reg No.</th>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>7701–7706</td>
<td>Sec, min, hr day, mo, yr</td>
<td>Secs corresponds to Register 7701, Mins corresponds to Register 7702, Hours corresponds to Register 7703, Day corresponds to Register 7704, Month corresponds to Register 7705, Year corresponds to Register 7706</td>
</tr>
</tbody>
</table>

2. Write a command code (1310) to the portable circuit monitor’s command interface register (7700).

<table>
<thead>
<tr>
<th>Reg No.</th>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>7700</td>
<td>1310</td>
<td>Command code to set date and time.</td>
</tr>
</tbody>
</table>

MEMORY ALLOCATION

This section describes memory allocation for nonvolatile logging memory only. It does not apply to nonvolatile memory used to store critical values such as setup parameters, min/max values, and energy and demand values. In all portable circuit monitor models, these critical values are stored in a separate nonvolatile memory area.

Portable circuit monitors are available with different amounts of nonvolatile logging memory. Depending on the portable circuit monitor model, the available nonvolatile logging memory must be allocated among an event log, 1 to 14 data logs, a waveform capture log, and a 12-cycle event capture log.

Specifics for each model are described below.

CM-2050—Provides no nonvolatile logging memory.

CM-2150, CM-2250—Available nonvolatile logging memory must be allocated among an event log and 1 to 14 data logs.

CM-2350, CM-2450, CM-2452—Available nonvolatile logging memory must be allocated among an event log, 1 to 14 data logs, a waveform capture log, and a 12-cycle event capture log.

When using POWERLOGIC application software to set up a portable circuit monitor, 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 97), 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 waveform capture file
- The maximum number of 12-cycle event captures in the 12-cycle event capture file
The number you can enter for each of the above items depends on the amount of the memory that is still available. The amount of memory still available depends on the numbers you’ve already assigned to the other items.

Figure 13-1 below shows how the memory might be allocated in a CM-2350. In this figure, the user has set up a waveform capture log, a 12-cycle event capture log, 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 portable 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.

POWERLOGIC System Manager Software indicates the memory allocation statistics in the On-Board Data Storage dialog box shown in figure 10-3, page 105. The display uses color coding to show the space devoted to each type of log file along with the space still available. For instructions on setting up log files using POWERLOGIC software, refer to the instruction bulletin included with the software.
Table 13-1 shows how a user might configure the available memory for various portable circuit monitor models. In this example, the portable circuit monitors have been set up with one data log that stores the following data hourly: 3-phase average amps, volts (L-L, L-N), PF, kW, kVAR, frequency, 3-phase demand for amps, kW, kVA, kWH and kVARH.

The portable circuit monitors store waveform captures and 12-cycle event captures as follows:

- The CM-2250 can store only one waveform capture and one 12-cycle event capture. It stores these in volatile memory; therefore, they do not reduce the amount of nonvolatile memory available for event and data logs.

- The CM-2350 can store multiple waveform captures and 12-cycle event captures. It stores these in nonvolatile memory; therefore, they do affect the amount of nonvolatile memory available for event and data logs.

For specific instructions on calculating log file sizes, see Appendix G—Calculating Log File Sizes.

### Table 13-1
**Memory Configuration Example**

<table>
<thead>
<tr>
<th>Typical Memory Configuration&lt;sup&gt;1&lt;/sup&gt;</th>
<th>CM-2050</th>
<th>CM-2150</th>
<th>CM-2250</th>
<th>CM-2350/2450</th>
<th>CM-2452</th>
</tr>
</thead>
<tbody>
<tr>
<td>Event Log</td>
<td>N/A</td>
<td>200 Events</td>
<td>200 Events</td>
<td>500 Events</td>
<td>1500 Events</td>
</tr>
<tr>
<td>1 Data Log</td>
<td>N/A</td>
<td>8 Days</td>
<td>8 Days</td>
<td>40 Days</td>
<td>120 Days</td>
</tr>
<tr>
<td>Waveform Captures&lt;sup&gt;2&lt;/sup&gt;</td>
<td>N/A</td>
<td>N/A</td>
<td>1</td>
<td>3&lt;sup&gt;3&lt;/sup&gt;</td>
<td>9&lt;sup&gt;3&lt;/sup&gt;</td>
</tr>
<tr>
<td>12-Cycle Event Captures&lt;sup&gt;2&lt;/sup&gt;</td>
<td>N/A</td>
<td>N/A</td>
<td>1</td>
<td>3&lt;sup&gt;3&lt;/sup&gt;</td>
<td>13&lt;sup&gt;3&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

---

1. The relative size of log files is user-defined. This table illustrates a typical memory configuration with one data log that stores the following data hourly: 3Ø avg amps, volts (L-L, L-N), PF, kW, kVAR, freq, 3Ø demand for amps, kW, kVA, and kWH and kVARH.

2. Waveform and 12-cycle event captures are stored in nonvolatile memory in the CM-2350, CM-2450, and CM-2452. The exact number of waveforms and event captures that can be stored depends on how much memory is allocated to event and data logs.

3. Up to 20 waveform captures or 8 12-cycle event captures can be stored in the CM-2350 and CM-2450, depending on memory allocation.

4. The CM-2452 can store up to 75 waveform captures or 29 12-cycle event captures.

---

**HOW POWER FACTOR IS STORED**

Each power factor value occupies one register. Power factor values are stored using signed magnitude notation (see figure 13-2). Bit number 16, the sign bit, indicates leading/lagging. A positive value (bit 16=0) always indicates leading. A negative value (bit 16=1) always indicates lagging. Bits 1–9 store a value in the range 0–1000 decimal. For example the portable 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 13-2: Power factor register format**
When the power factor is lagging, the portable circuit monitor returns a high negative value—for example, -31,794. This happens because bit 16=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 16. 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

**CHANGING THE VAR SIGN CONVENTION**

The portable circuit monitor offers two VAR sign conventions. Figure 13-3 shows the default sign convention. Figure 13-4 shows the alternate sign convention. The procedures below tell how to change the sign convention using the command interface. For a description of the command interface and a complete listing of command codes, see The Command Interface in this chapter.

To change to the alternate sign convention, complete the following steps:

1. Write command code 4311 to register 7700.
2. Write command code 1110 to register 7700.
   
   This resets the portable circuit monitor, causing it to use the new convention.

To return to the default sign convention, complete the following steps:

1. Write command code 4310 to register 7700.
2. Write command code 1110 to register 7700.

   This resets the portable circuit monitor, causing it to return to the default sign convention.

---

**Figure 13-3: Default VAR sign convention**

**Figure 13-4: Optional VAR sign convention**
CONDITIONAL ENERGY

Portable circuit monitor registers 1629–1648 are conditional energy registers. Conditional energy can be controlled in one of two ways:

- Over the communications link, by writing commands to the portable circuit monitor’s command interface

  OR

- By a status input—for example, conditional energy accumulates when the assigned status input is on, but does not accumulate when the status input is off.

The following procedures tell how to set up conditional energy for command interface control, and for status input control. The procedures refer to register numbers and command codes. For a listing of portable circuit monitor registers, see Appendix E. For a listing of command codes, see The Command Interface in this chapter.

Command Interface Control

To set control of conditional energy to the command interface:

1. Write command code 2341 to register 7700.

   To verify proper setup, read register 2081. Bit 6 should read 1, indicating command interface control. Bit 7 should read 0, indicating that conditional energy accumulation is off.

To start conditional energy accumulation:

1. Write command code 6321 to register 7700.

   While conditional energy is accumulating, bit 7 of register 2081 should read 1, indicating that conditional energy accumulation is on.

To stop conditional energy accumulation:

1. Write command code 6320 to register 7700.

To clear all conditional energy registers (1629–1648):

1. Write command code 6220 to register 7700.

Status Input Control

To configure conditional energy for status input control:

1. Write command code 2340 to register 7700.

2. Specify the status input that will drive conditional energy accumulation by writing a bitmap to register 7701. Set the appropriate bit to 1 to indicate the desired input (input S1=bit 1, S2=bit 2, S3=bit 3, S4=bit 4).

3. Write command code 3390 to register 7700.

   To verify proper setup, read register 2081. Bit 6 should read 0, indicating that conditional energy accumulation is under status input control. Bit 7 should read 0 when the status input is off, indicating that conditional energy accumulation is off. Bit 7 should read 1 when the status input is on, indicating that conditional energy accumulation is on.

To clear all conditional energy registers (1629–1648):

1. Write command code 6220 to register 7700.
The portable circuit monitor’s incremental energy feature allow the user to define a start 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. 1649–1651)
- VARH IN during the last completed interval (reg. 1652–1654)
- WH OUT during the last completed interval (reg. 1655–1657)
- VARH OUT during the last completed interval (reg. 1658–1660)
- VAH during the last completed interval (reg. 1661–1663)
- Date/time of the last completed interval (reg. 1869–1871)
- Peak kW during the last completed interval (reg. 1749)
- Date/Time of Peak kW during the last interval (reg. 1878–1880)
- Peak kVAR during the last completed interval (reg. 1750)
- Date/Time of Peak kVAR during the last interval (reg. 1881–1883)
- Peak kVA during the last completed interval (reg. 1751)
- Date/Time of Peak kVA during the last interval (reg. 1884–1886)

The incremental energy data listed above can be logged by the portable circuit monitor. This logged information provide all the information needed to analyze energy and power usage against present or future utility rates. The information is especially useful for doing “what ifs” with 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 portable circuit monitor clock, it is possible to log this data from multiple circuits and perform accurate totalization.

**Using Incremental Energy**

*To setup incremental energy:*

1. Write a start date and time to registers 1863–1865.
   
   Incremental energy accumulation begins at the specified date and time. Once the date has arrived, each new day’s first incremental energy period begins at the specified time.

2. Write the desired interval length, from 0–1440 minutes, to register 2076.
   
   If incremental energy will be controlled from a remote master, such as a programmable controller, write a value of zero here.

*To start a new incremental energy interval from a remote master:*

- Write command code 6910 to register 7700.
CHANGING THE DEMAND CALCULATION METHOD

The portable circuit monitor can be configured to use one of three demand power calculation methods:

- thermal demand (portable circuit monitor default)
- external pulse synchronized demand
- block interval demand with rolling subinterval (block/rolling)

For a description of the demand power calculation methods, see Demand Power Calculation Methods in Chapter 5.

Changing to the Block/Rolling Method

To change to the block/rolling demand method, the user must write to the command interface over the communications link. (For a description of the command interface and a list of command codes, see The Command Interface in this chapter.)

To change to the block/rolling method, complete the following steps:
1. Write command code 5311 to register 7700.
2. Write command code 1110 to command interface register 7700.
   This resets the portable circuit monitor, causing it to recognize the new demand calculation method.
3. Write a subinterval value in minutes into register 2078. If the subinterval is set equal to the demand interval, the demand calculation will update once each demand interval (block mode). If the subinterval equals zero, the demand calculation will update every 15 seconds (sliding window).

SETTING UP A DEMAND SYNCH PULSE INPUT

The external pulse synchronized demand method allows a portable circuit monitor, equipped with an I/O module, to accept a demand synch pulse from another demand meter. When this method is used, the portable circuit monitor watches input S1 for a pulse that signals the start of a new demand interval. This allows the portable circuit monitor’s demand interval “window” to match the other meter’s demand interval “window.” For a detailed description of this feature, see Demand Synch Pulse Input in Chapter 6.

To set up the portable circuit monitor to accept a demand synch pulse input:

- Set the demand interval to 0 from the portable circuit monitor front panel. See Setting the Demand Interval in Chapter 4 for instructions on setting the demand interval using the portable circuit monitor’s front panel.

  OR

1. Using application software, write a value of zero to register 2077, the demand interval configuration register.
2. Using application software, write command code 5311 to register 7700 to select block demand mode.
3. Using application software, write command code 5320 to register 7700 to set the external synch source to S1.
The portable circuit monitor’s demand interval can be controlled over the communications link. For example, a programmable controller can signal the start of each new demand interval.

The portable circuit monitor’s command interface is used to control the demand interval over the communications link. For a description of the command interface and a list of command codes, see The Command Interface in this chapter.

To set demand control to the command interface:
1. Using application software, write a value of zero to register 2077, the demand interval configuration register.
2. Using application software, write command code 5311 to register 7700 to select block demand mode.
3. Using application software, write command code 5321 to register 7700.

To start a new demand interval:
- Write command code 5910 to register 7700.
**SETTING UP INDIVIDUAL HARMONIC CALCULATIONS**

Portable circuit monitor models 2350 and higher can perform harmonic magnitude and angle calculations for each metered input. The harmonic magnitude can be formatted as either a percentage of the fundamental or as a percentage of the rms values. The harmonic magnitude and angles are stored in a set of registers: 4002–4447. The portable circuit monitor updates the values in these registers over a 10-metering update cycle period. During the time that the portable circuit monitor is refreshing harmonic data, the portable circuit monitor posts a value of 0 in register 2037. When the whole set of harmonic registers is updated with new data, the portable circuit monitor posts a value of 1 in register 2037. The portable 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.

There are 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.

Write to the following registers to configure the harmonic data processing:

<table>
<thead>
<tr>
<th>Reg. No.</th>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>2033</td>
<td>1–60</td>
<td>Number of metering update cycles between harmonic data updates</td>
</tr>
<tr>
<td>2034</td>
<td>0, 1</td>
<td>Harmonic magnitude formatting; 0=% of fundamental (default); 1=% of rms</td>
</tr>
<tr>
<td>2035</td>
<td>0, 1, 2</td>
<td>Harmonic processing; 0=disabled; 1=voltage harmonics only enabled; 2=voltage and current harmonics enabled</td>
</tr>
</tbody>
</table>

Register 2037 indicates whether harmonic data processing is complete.

<table>
<thead>
<tr>
<th>Reg. No.</th>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>2037</td>
<td>0, 1</td>
<td>0=processing incomplete; 1=processing complete</td>
</tr>
</tbody>
</table>

Register 2036 shows the number of metering update cycles remaining before the next harmonic data update begins.

<table>
<thead>
<tr>
<th>Reg. No.</th>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>2036</td>
<td>0–60</td>
<td>Number of metering update cycles remaining before the next update.</td>
</tr>
</tbody>
</table>
STATUS INPUT PULSE DEMAND METERING

When equipped with an I/O module, the portable circuit monitor can count pulses from an external source, such as a watthour meter equipped with a pulse initiator. This allows the portable circuit monitor to keep track of demand information by counting pulses.

The portable circuit monitor provides ten input pulse demand channels (see figure 13-5). Each channel maintains pulse count data taken from one or more status inputs assigned to that channel. For each channel, the portable circuit monitor maintains the following information:

- Present Interval Pulse Count—the number of pulses counted so far during the present interval.
- Last Completed Interval Pulse Count—the number of pulses counted during the last completed interval.
- Peak Interval Pulse Count—the maximum number of pulses counted during a completed interval since the last power demand reset.
- Date/Time of Peak—the date and time of the peak interval pulse count (described above) since the last power demand reset.

For each channel, utility registers are provided which can be defined by custom application software as storage locations for:

- Units—for example, kWH, kVARH, or kVAH.
- Weight factor—a weight factor for each pulse. For example, you might define that each pulse is equal to 10.0 kW.
- Scale Code—a scale factor to indicate what power of 10 to apply to the weight factor.

Pulse Counting Example

Figure 13-5, on the following page, shows how a user might apply the pulse demand metering feature. In the example, channels 1, 2 have been assigned to count pulses from inputs S1 and S2, respectively. Channel 10 has been assigned inputs S1 and S2. Therefore, channel 10 will totalize the pulses from S1 and S2.

Refer to Appendix E—Abbreviated Register Listing, for information on registers 2898–2999.
Figure 13-5: Pulse demand metering example
Appendix A—Installing and Wiring Optional I/O Modules

**APPENDIX A—INSTALLING AND WIRING OPTIONAL I/O MODULES**

POWERLOGIC offers a number of input/output (I/O) modules for POWERLOGIC portable circuit monitors. Modules are available that provide KYZ pulse outputs, status inputs, relay outputs, analog inputs, and analog outputs. All input/output modules must be factory installed and some limitations may apply.

This appendix lists technical specifications and shows typical I/O wiring connections. For a description of the portable circuit monitor’s I/O capabilities, see Chapter 6—Input/Output Capabilities.

![Diagram of Portable Circuit Monitor Connections]

Figure A-1: Portable circuit monitor connections
**SPECIFICATIONS**

**Status Inputs**
- Type of isolation: Optical
- Voltage operating range: 20-138 Vac/Vdc
- Input current draw (maximum): 1 mA @ 20 volts; 6 mA @ 138 volts
- Must turn on voltage: 20 volts rms
- Must turn on current: 1 mA (at 20 volts)
- Must turn off voltage: 9 volts rms
- Must turn off current (maximum): 0.3 mA (at 9 volts)
- Input impedance: 27.2K ohms resistive
- Turn on time (maximum): 0.5 msec (dc); 8 msec (ac)
- Turn off time (maximum): 16 msec

**Relay Output Ratings**
- KYZ: 96 mA max. at 240 Vac/300 Vdc
- R1-R3: 10 A max. at 240 Vac/30 Vdc

**Analog Input Ratings**
- Default Input Range: 0–5 Vdc
- Optional Input Range: 0-20 mA
- Accuracy: 0.25% full scale

**Analog Output Ratings**
- Output Range, 4-20 mA models: 4–20 mA (20 mA into 600 ohms max.)
- Output Range, 0-1 mA models: 0-1 mA (1 mA into 10,000 ohms max.)
- Accuracy: 1% full scale

---

1. The IOM-4444 provides 1 shield for all four inputs, and 1 shield for all four outputs. Isolation is provided between the analog input section, the analog output section, and the portable circuit monitor.

2. To accept a 0-20 mA signal, you must connect a jumper wire to the appropriate terminals on the input module (see Analog Input Connections in this appendix). The jumper wire places an internal 250 ohm resistor into the circuit.
STATUS INPUT CONNECTIONS

The IOM-4411 and IOM-4444 modules offer 4 status inputs each. Status inputs can be used to sense the state of external contacts.

Figure A-2 shows typical status input connections. Figure A-8 on page 143 shows the cable labeling for each module.

![Figure A-2: Typical status input connections](image)

RELAY OUTPUT CONNECTIONS

The IOM-4411 and IOM-4444 modules offer 3 relay outputs each. Relay outputs can be used to open or close circuit breakers or contactors, annunciate alarms, and so on.

Each relay output provides three terminals—normally closed, normally open, and common. Figure A-8, page 143, shows the terminal labels for the I/O modules. Figure A-3 shows a typical relay output connection. When wiring the module, use only 14 to 18 gauge stranded wire. Strip 0.25" (6 mm) from the end of each wire being connected to the module.

![Figure A-3: Typical relay output connections](image)
PULSE OUTPUT CONNECTIONS

Each I/O module provides one solid-state, KYZ pulse output. See Solid State KYZ Pulse Output in Chapter 6 for a description of the portable circuit monitor’s pulse output capabilities.

The pulse output can be wired 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 A-4).

![Figure A-4: Pulse output](image-url)
ANALOG INPUT
CONNECTIONS

Analog inputs can be used to monitor analog quantities such as oil pressure, water temperature, and so on.

Figure A-5 shows analog input wiring connections for a 0–5 Vdc input signal. Figure A-6 shows analog input wiring connections for a 4-20 mA signal.

To configure an analog input to accept a 4–20 mA signal, do the following:

1. Connect the jumper to the IN1 (r) and IN1 - terminals (see figure A-6).
   This places a 250 ohm resistor (located inside the I/O module) into the Circuit. When a 4–20 mA current is run through the resistor, the portable circuit monitor measures an input voltage of 1–5 volts across the resistor.

2. Using application software, configure the analog input to accept a 4–20 mA input signal.
   This instructs the portable circuit monitor to use a separate set of calibration constants specifically for the 250 ohm internal resistor. (See the POWERLOGIC software instruction bulletin for instructions.)
ANALOG OUTPUT CONNECTIONS

I/O modules IOM-4411 and IOM-4444 offer one and four analog outputs, respectively. Each analog output can be associated with a portable circuit monitor register to output an analog signal in direct proportion to the register contents.

Figure A-7 shows typical analog output connections. Figure A-8 on page 143 shows the terminal label for each module.

![Figure A-7: Typical analog output wiring connections](image-url)
### Figure A-8: I/O module terminal labels

<table>
<thead>
<tr>
<th>IOM-11 Label</th>
<th>IOM-18 Label</th>
<th>IOM-44 Label</th>
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<tbody>
<tr>
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<td>A</td>
<td>A</td>
</tr>
<tr>
<td>(35) Z</td>
<td>(35) Z</td>
<td>(35) Z</td>
</tr>
<tr>
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<td>(34) Y</td>
<td>(34) Y</td>
</tr>
<tr>
<td>(33) K</td>
<td>(33) K</td>
<td>(33) K</td>
</tr>
<tr>
<td>(32) SCOM</td>
<td>(32) SCOM</td>
<td>(32) SCOM</td>
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<td>(30) S3</td>
<td>(30) S3</td>
</tr>
<tr>
<td>(29) S2</td>
<td>(29) S2</td>
<td>(29) S2</td>
</tr>
<tr>
<td>(28) S1</td>
<td>(28) S1</td>
<td>(28) S1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(36) S5</td>
</tr>
<tr>
<td></td>
<td>(37) S6</td>
<td>(36) S5</td>
</tr>
</tbody>
</table>

ALL RELAYS SHOWN IN DE-ENERGIZED STATE

### Figure A-9: Portable circuit monitor connections

Connections to the I/O module are made by connecting to the "I/O Module Status Inputs & Relays" connector on the PCM. Each lead in the I/O cable is labeled S1, S2, ... R1 C, R1 NO, R1 INC, etc., as shown in figures A-8 and A-10.
Figure A-10: IOM-4411 and IOM-4444 terminal markings
# APPENDIX B—COMMUNICATION CABLE PINOUTS

## PCMCAB-107

<table>
<thead>
<tr>
<th>Circuit Monitor Terminal</th>
<th>Male DB-9 Connector</th>
</tr>
</thead>
<tbody>
<tr>
<td>IN- (21)—White</td>
<td>1</td>
</tr>
<tr>
<td>IN+ (20)—Green</td>
<td>2</td>
</tr>
<tr>
<td>OUT- (23)—Black</td>
<td>3</td>
</tr>
<tr>
<td>OUT+ (22)—Red</td>
<td>4</td>
</tr>
<tr>
<td>SHLD (24) Shield</td>
<td>9</td>
</tr>
</tbody>
</table>

## PCMCAB-108

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>TXA—White</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>TXB—Green</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>RXA—Black</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>RXB—Red</td>
<td>4</td>
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</tr>
<tr>
<td>SHLD—Shield</td>
<td>9</td>
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</tr>
</tbody>
</table>

## PCMCAB-102, PCMCAB-104

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<tr>
<td>3</td>
<td></td>
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<tr>
<td>22</td>
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</tr>
</tbody>
</table>
APPENDIX C—ABBREVIATED REGISTER LISTING

This appendix contains an abbreviated listing of portable circuit monitor registers. The following values are included in this register listing:

- Real-Time Metered Values
- Real-Time Meter Values Minimum
- Real-Time Meter Values Maximum
- Energy Values
- Demand Values
- Dates and Times
- Status Inputs
- Relay Outputs
- Portable circuit monitor Configuration Values

In this appendix, the following information is provided for each register:

- Register Number (see note below)
- Register Description
- Units
- Range

NOTE

Some registers in this section apply only to portable circuit monitors with firmware version 15.002 or higher. To determine a portable circuit monitor’s firmware version from the front panel, see Viewing Configuration Data In Protected Mode, page 39. Step 3 tells how to determine the firmware version.

To determine the firmware version over comms, follow these steps:

1. Read register 2094. The two digits on the left in the 4-digit decimal value represent the reset code revision; the two digits on the right represent the portable circuit monitor firmware version.

2. Read register 2093. The decimal value represents the portable circuit monitor firmware sub-revision level, as in firmware version 16.001.
<table>
<thead>
<tr>
<th>Reg. No.</th>
<th>Description</th>
<th>Units</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>1000</td>
<td>Update Interval</td>
<td>In 1000ths of a second</td>
<td>0 to 10,000</td>
</tr>
<tr>
<td>1001</td>
<td>Frequency</td>
<td>Hertz/Scale Factor F</td>
<td>2300 to 6700 (50/60)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>3500 to 4500 (400)</td>
</tr>
<tr>
<td>1002</td>
<td>Temperature inside CM enclosure</td>
<td>Degrees C in 100ths</td>
<td>-1000 to +1000</td>
</tr>
<tr>
<td>1003</td>
<td>Current, Phase A</td>
<td>Amps/Scale Factor A</td>
<td>0 to 32,767</td>
</tr>
<tr>
<td>1004</td>
<td>Current, Phase B</td>
<td>Amps/Scale Factor A</td>
<td>0 to 32,767</td>
</tr>
<tr>
<td>1005</td>
<td>Current, Phase C</td>
<td>Amps/Scale Factor A</td>
<td>0 to 32,767</td>
</tr>
<tr>
<td>1006</td>
<td>Current, Neutral</td>
<td>Amps/Scale Factor B</td>
<td>0 to 32,767</td>
</tr>
<tr>
<td>1007</td>
<td>Current, Ground</td>
<td>Amps/Scale Factor C</td>
<td>0 to 32,767</td>
</tr>
<tr>
<td>1008</td>
<td>Current, 3-Phase Average</td>
<td>Amps/Scale Factor A</td>
<td>0 to 32,767</td>
</tr>
<tr>
<td>1009</td>
<td>Current, Apparent rms</td>
<td>Amps/Scale Factor A</td>
<td>0 to 32,767</td>
</tr>
<tr>
<td>1010</td>
<td>Current Unbalance, Phase A</td>
<td>Percent in 10ths</td>
<td>0 to ±1000</td>
</tr>
<tr>
<td>1011</td>
<td>Current Unbalance, Phase B</td>
<td>Percent in 10ths</td>
<td>0 to ±1000</td>
</tr>
<tr>
<td>1012</td>
<td>Current Unbalance, Phase C</td>
<td>Percent in 10ths</td>
<td>0 to ±1000</td>
</tr>
<tr>
<td>1013</td>
<td>Current Unbalance, Worst</td>
<td>Percent in 10ths</td>
<td>0 to ±1000</td>
</tr>
<tr>
<td>1014</td>
<td>Voltage, Phase A to B</td>
<td>Volts/Scale Factor D</td>
<td>0 to 32,767</td>
</tr>
<tr>
<td>1015</td>
<td>Voltage, Phase B to C</td>
<td>Volts/Scale Factor D</td>
<td>0 to 32,767</td>
</tr>
<tr>
<td>1016</td>
<td>Voltage, Phase C to A</td>
<td>Volts/Scale Factor D</td>
<td>0 to 32,767</td>
</tr>
<tr>
<td>1017</td>
<td>Voltage L-L, 3-Phase Average</td>
<td>Volts/Scale Factor D</td>
<td>0 to 32,767</td>
</tr>
<tr>
<td>1018</td>
<td>Voltage, Phase A to Neutral</td>
<td>Volts/Scale Factor D</td>
<td>0 to 32,767</td>
</tr>
<tr>
<td>1019</td>
<td>Voltage, Phase B to Neutral</td>
<td>Volts/Scale Factor D</td>
<td>0 to 32,767</td>
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<tr>
<td>1020</td>
<td>Voltage, Phase C to Neutral</td>
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<tr>
<td>1021</td>
<td>Voltage L-N, 3-Phase Average</td>
<td>Volts/Scale Factor D</td>
<td>0 to 32,767</td>
</tr>
<tr>
<td>1022</td>
<td>Voltage Unbalance, Phase A-B</td>
<td>Percent in 10ths</td>
<td>0 to ±1000</td>
</tr>
<tr>
<td>1023</td>
<td>Voltage Unbalance, Phase B-C</td>
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</tr>
<tr>
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<td>Voltage Unbalance, Phase C-A</td>
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<td>0 to ±1000</td>
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<tr>
<td>1025</td>
<td>Voltage Unbalance, L-L Worst</td>
<td>Percent in 10ths</td>
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<tr>
<td>1026</td>
<td>Voltage Unbalance, Phase A</td>
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</tr>
<tr>
<td>1027</td>
<td>Voltage Unbalance, Phase B</td>
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</tr>
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<td>Voltage Unbalance, Phase C</td>
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</tr>
<tr>
<td>1029</td>
<td>Voltage Unbalance, L-N Worst</td>
<td>Percent in 10ths</td>
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</tr>
<tr>
<td>1030</td>
<td>True Power Factor, Phase A</td>
<td>In 1000ths</td>
<td>-100 to +1000 to +100(1)</td>
</tr>
<tr>
<td>1031</td>
<td>True Power Factor, Phase B</td>
<td>In 1000ths</td>
<td>-100 to +1000 to +100(1)</td>
</tr>
<tr>
<td>1032</td>
<td>True Power Factor, Phase C</td>
<td>In 1000ths</td>
<td>-100 to +1000 to +100(1)</td>
</tr>
<tr>
<td>1033</td>
<td>True Power Factor, 3-Phase Total</td>
<td>In 1000ths</td>
<td>-100 to +1000 to +100(1)</td>
</tr>
<tr>
<td>1034</td>
<td>Displacement Power Factor, Phase A</td>
<td>In 1000ths</td>
<td>-100 to +1000 to +100(1)</td>
</tr>
<tr>
<td>1035</td>
<td>Displacement Power Factor, Phase B</td>
<td>In 1000ths</td>
<td>-100 to +1000 to +100(1)</td>
</tr>
<tr>
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<td>Displacement Power Factor, Phase C</td>
<td>In 1000ths</td>
<td>-100 to +1000 to +100(1)</td>
</tr>
<tr>
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<td>Displacement Power Factor, 3-Phase Total</td>
<td>In 1000ths</td>
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<tr>
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<td>kW/Scale Factor E</td>
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<td>1039</td>
<td>Real Power, Phase B</td>
<td>kW/Scale Factor E</td>
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<td>1040</td>
<td>Real Power, Phase C</td>
<td>kW/Scale Factor E</td>
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<tr>
<td>1041</td>
<td>Reactive Power, Phase A</td>
<td>kVar/Scale Factor E</td>
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</tr>
<tr>
<td>1042</td>
<td>Reactive Power, Phase B</td>
<td>kVar/Scale Factor E</td>
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</tr>
<tr>
<td>1043</td>
<td>Reactive Power, Phase C</td>
<td>kVar/Scale Factor E</td>
<td>0 to ±32,767</td>
</tr>
<tr>
<td>1044</td>
<td>Reactive Power, 3-Phase Total</td>
<td>kVar/Scale Factor E</td>
<td>0 to ±32,767</td>
</tr>
<tr>
<td>1045</td>
<td>Apparent Power, Phase A</td>
<td>kVA/Scale Factor E</td>
<td>0 to +32,767</td>
</tr>
<tr>
<td>1046</td>
<td>Apparent Power, Phase B</td>
<td>kVA/Scale Factor E</td>
<td>0 to +32,767</td>
</tr>
<tr>
<td>1047</td>
<td>Apparent Power, Phase C</td>
<td>kVA/Scale Factor E</td>
<td>0 to +32,767</td>
</tr>
<tr>
<td>1048</td>
<td>Apparent Power, 3-Phase Total</td>
<td>kVA/Scale Factor E</td>
<td>0 to +32,767</td>
</tr>
</tbody>
</table>

(1) See How Power Factor is Stored in Chapter 12 for a description of the power factor register format.
<table>
<thead>
<tr>
<th>Reg. No.</th>
<th>Description</th>
<th>Units</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>1051</td>
<td>THD Phase A Current</td>
<td>% in 10ths</td>
<td>0 to 32,767</td>
</tr>
<tr>
<td>1052</td>
<td>THD Phase B Current</td>
<td>% in 10ths</td>
<td>0 to 32,767</td>
</tr>
<tr>
<td>1053</td>
<td>THD Phase C Current</td>
<td>% in 10ths</td>
<td>0 to 32,767</td>
</tr>
<tr>
<td>1054</td>
<td>THD Phase Neutral Current</td>
<td>% in 10ths</td>
<td>0 to 32,767</td>
</tr>
<tr>
<td>1055</td>
<td>THD Phase A Voltage</td>
<td>% in 10ths</td>
<td>0 to 32,767</td>
</tr>
<tr>
<td>1056</td>
<td>THD Phase B Voltage</td>
<td>% in 10ths</td>
<td>0 to 32,767</td>
</tr>
<tr>
<td>1057</td>
<td>THD Phase C Voltage</td>
<td>% in 10ths</td>
<td>0 to 32,767</td>
</tr>
<tr>
<td>1058</td>
<td>THD Phase A-B Voltage</td>
<td>% in 10ths</td>
<td>0 to 32,767</td>
</tr>
<tr>
<td>1059</td>
<td>THD Phase B-C Voltage</td>
<td>% in 10ths</td>
<td>0 to 32,767</td>
</tr>
<tr>
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<td>THD Phase C-A Voltage</td>
<td>% in 10ths</td>
<td>0 to 32,767</td>
</tr>
<tr>
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<td>thd Phase A Current</td>
<td>% in 10ths</td>
<td>0 to 32,767</td>
</tr>
<tr>
<td>1062</td>
<td>thd Phase B Current</td>
<td>% in 10ths</td>
<td>0 to 32,767</td>
</tr>
<tr>
<td>1063</td>
<td>thd Phase C Current</td>
<td>% in 10ths</td>
<td>0 to 32,767</td>
</tr>
<tr>
<td>1064</td>
<td>thd Phase Neutral Current</td>
<td>% in 10ths</td>
<td>0 to 32,767</td>
</tr>
<tr>
<td>1065</td>
<td>thd Phase A Voltage</td>
<td>% in 10ths</td>
<td>0 to 32,767</td>
</tr>
<tr>
<td>1066</td>
<td>thd Phase B Voltage</td>
<td>% in 10ths</td>
<td>0 to 32,767</td>
</tr>
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<td>thd Phase C Voltage</td>
<td>% in 10ths</td>
<td>0 to 32,767</td>
</tr>
<tr>
<td>1068</td>
<td>thd Phase A-B Voltage</td>
<td>% in 10ths</td>
<td>0 to 32,767</td>
</tr>
<tr>
<td>1069</td>
<td>thd Phase B-C Voltage</td>
<td>% in 10ths</td>
<td>0 to 32,767</td>
</tr>
<tr>
<td>1070</td>
<td>thd Phase C-A Voltage</td>
<td>% in 10ths</td>
<td>0 to 32,767</td>
</tr>
<tr>
<td>1071</td>
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<td>0 to 10,000</td>
</tr>
<tr>
<td>1072</td>
<td>K-Factor, Phase B</td>
<td>In 10ths</td>
<td>0 to 10,000</td>
</tr>
<tr>
<td>1073</td>
<td>K-Factor, Phase C</td>
<td>In 10ths</td>
<td>0 to 10,000</td>
</tr>
<tr>
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<td>Crest Factor, Phase A</td>
<td>In 100ths</td>
<td>0 to 10,000</td>
</tr>
<tr>
<td>1075</td>
<td>Crest Factor, Phase B</td>
<td>In 100ths</td>
<td>0 to 10,000</td>
</tr>
<tr>
<td>1076</td>
<td>Crest Factor, Phase C</td>
<td>In 100ths</td>
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</tr>
<tr>
<td>1077</td>
<td>Crest Factor, Neutral</td>
<td>In 100ths</td>
<td>0 to 10,000</td>
</tr>
<tr>
<td>1078</td>
<td>Phase A Current, Fundamental rms Magnitude</td>
<td>Amps/Scale Factor A</td>
<td>0 to 32,767</td>
</tr>
<tr>
<td>1079</td>
<td>Phase A Current, Fundamental Coincident Angle</td>
<td>In 10ths of degrees</td>
<td>0 to 3,599</td>
</tr>
<tr>
<td>1080</td>
<td>Phase B Current, Fundamental rms Magnitude</td>
<td>Amps/Scale Factor A</td>
<td>0 to 32,767</td>
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<tr>
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<td>Phase B Current, Fundamental Coincident Angle</td>
<td>In 10ths of degrees</td>
<td>0 to 3,599</td>
</tr>
<tr>
<td>1082</td>
<td>Phase C Current, Fundamental rms Magnitude</td>
<td>Amps/Scale Factor A</td>
<td>0 to 32,767</td>
</tr>
<tr>
<td>1083</td>
<td>Phase C Current, Fundamental Coincident Angle</td>
<td>In 10ths of degrees</td>
<td>0 to 3,599</td>
</tr>
<tr>
<td>1084</td>
<td>Neutral Current, Fundamental rms Magnitude</td>
<td>Amps/Scale Factor B</td>
<td>0 to 32,767</td>
</tr>
<tr>
<td>1085</td>
<td>Neutral Current, Fundamental Coincident Angle</td>
<td>In 10ths of degrees</td>
<td>0 to 3,599</td>
</tr>
<tr>
<td>1086</td>
<td>Ground Current, Fundamental rms Magnitude</td>
<td>Amps/Scale Factor C</td>
<td>0 to 32,767</td>
</tr>
<tr>
<td>1087</td>
<td>Ground Current, Fundamental Coincident Angle</td>
<td>In 10ths of degrees</td>
<td>0 to 3,599</td>
</tr>
<tr>
<td>1088</td>
<td>Phase A Voltage, Fundamental rms Magnitude</td>
<td>Volts/Scale Factor D</td>
<td>0 to 32,767</td>
</tr>
<tr>
<td>1089</td>
<td>Phase A Voltage, Fundamental Coincident Angle</td>
<td>In 10ths of degrees</td>
<td>0 to 3,599</td>
</tr>
<tr>
<td>1090</td>
<td>Phase B Voltage, Fundamental rms Magnitude</td>
<td>Volts/Scale Factor D</td>
<td>0 to 32,767</td>
</tr>
<tr>
<td>1091</td>
<td>Phase B Voltage, Fundamental Coincident Angle</td>
<td>In 10ths of degrees</td>
<td>0 to 3,599</td>
</tr>
<tr>
<td>1092</td>
<td>Phase C Voltage, Fundamental rms Magnitude</td>
<td>Volts/Scale Factor D</td>
<td>0 to 32,767</td>
</tr>
<tr>
<td>1093</td>
<td>Phase C Voltage, Fundamental Coincident Angle</td>
<td>In 10ths of degrees</td>
<td>0 to 3,599</td>
</tr>
<tr>
<td>1094</td>
<td>Phase A-B Voltage, Fundamental rms Magnitude</td>
<td>Volts/Scale Factor D</td>
<td>0 to 32,767</td>
</tr>
<tr>
<td>1095</td>
<td>Phase A-B Voltage, Fundamental Coincident Angle</td>
<td>In 10ths of degrees</td>
<td>0 to 3,599</td>
</tr>
<tr>
<td>1096</td>
<td>Phase B-C Voltage, Fundamental rms Magnitude</td>
<td>Volts/Scale Factor D</td>
<td>0 to 32,767</td>
</tr>
<tr>
<td>1097</td>
<td>Phase B-C Voltage, Fundamental Coincident Angle</td>
<td>In 10ths of degrees</td>
<td>0 to 3,599</td>
</tr>
<tr>
<td>1098</td>
<td>Phase C-A Voltage, Fundamental rms Magnitude</td>
<td>Volts/Scale Factor D</td>
<td>0 to 32,767</td>
</tr>
<tr>
<td>1099</td>
<td>Phase C-A Voltage, Fundamental Coincident Angle</td>
<td>In 10ths of degrees</td>
<td>0 to 3,599</td>
</tr>
<tr>
<td>1100</td>
<td>Phase A Fundamental Real Power</td>
<td>KW/Scale Factor E</td>
<td>0 to ±32,767</td>
</tr>
</tbody>
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### ANALOG INPUT PRESENT VALUE REGISTERS

<table>
<thead>
<tr>
<th>Reg. No.</th>
<th>Description</th>
<th>Units</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>1191</td>
<td>Analog Input 1 Present Value</td>
<td>None</td>
<td>-32767 to +32767</td>
</tr>
<tr>
<td>1192</td>
<td>Analog Input 2 Present Value</td>
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<td>-32767 to +32767</td>
</tr>
<tr>
<td>1193</td>
<td>Analog Input 3 Present Value</td>
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</tr>
<tr>
<td>1194</td>
<td>Analog Input 4 Present Value</td>
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<td>-32767 to +32767</td>
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### REAL TIME METERED VALUES MINIMUM

<table>
<thead>
<tr>
<th>Reg. No.</th>
<th>Description</th>
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<th>Range</th>
</tr>
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<tbody>
<tr>
<td>1200</td>
<td>Minimum Update Interval</td>
<td>In 1000ths of a second</td>
<td>0 to 10,000</td>
</tr>
<tr>
<td>1201</td>
<td>Minimum Freq.</td>
<td>Hertz/Scale Factor F</td>
<td>2300 to 6700 (50/60) 3500 to 4500 (400)</td>
</tr>
<tr>
<td>1202</td>
<td>Minimum Temp.</td>
<td>Degrees Cent.</td>
<td>±10,000 in 100ths</td>
</tr>
<tr>
<td>1203</td>
<td>Minimum Current Phase A</td>
<td>Amps/Scale Factor A</td>
<td>0 to 32,767</td>
</tr>
<tr>
<td>1204</td>
<td>Minimum Current Phase B</td>
<td>Amps/Scale Factor A</td>
<td>0 to 32,767</td>
</tr>
<tr>
<td>1205</td>
<td>Minimum Current Phase C</td>
<td>Amps/Scale Factor A</td>
<td>0 to 32,767</td>
</tr>
<tr>
<td>1206</td>
<td>Minimum Current Neutral (I4)</td>
<td>Amps/Scale Factor A</td>
<td>0 to 32,767</td>
</tr>
<tr>
<td>1207</td>
<td>Minimum Current Ground (I5)</td>
<td>Amps/Scale Factor A</td>
<td>0 to 32,767</td>
</tr>
<tr>
<td>1208</td>
<td>Minimum Current 3-Phase Average</td>
<td>Amps/Scale Factor A</td>
<td>0 to 32,767</td>
</tr>
<tr>
<td>1209</td>
<td>Minimum Current Apparent rms</td>
<td>Amps/Scale Factor A</td>
<td>0 to 32,767</td>
</tr>
<tr>
<td>1210</td>
<td>Minimum Current Unbalance, Phase A</td>
<td>Percent in 10ths</td>
<td>0 to ±1000</td>
</tr>
<tr>
<td>1211</td>
<td>Minimum Current Unbalance, Phase B</td>
<td>Percent in 10ths</td>
<td>0 to ±1000</td>
</tr>
<tr>
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<td>Minimum Current Unbalance, Phase C</td>
<td>Percent in 10ths</td>
<td>0 to ±1000</td>
</tr>
<tr>
<td>1213</td>
<td>Minimum Current Unbalance Worst</td>
<td>Percent in 10ths</td>
<td>0 to ±1000</td>
</tr>
<tr>
<td>1214</td>
<td>Minimum Volt. Phase A to B</td>
<td>Volts/Scale Factor D</td>
<td>0 to 32,767</td>
</tr>
<tr>
<td>1215</td>
<td>Minimum Volt. Phase B to C</td>
<td>Volts/Scale Factor D</td>
<td>0 to 32,767</td>
</tr>
<tr>
<td>1216</td>
<td>Minimum Volt. Phase C to A</td>
<td>Volts/Scale Factor D</td>
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</tr>
<tr>
<td>1217</td>
<td>Minimum Volt L-L, 3-Phase Average</td>
<td>Volts/Scale Factor D</td>
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</tr>
<tr>
<td>1218</td>
<td>Minimum Volt. Phase A to Neutral</td>
<td>Volts/Scale Factor D</td>
<td>0 to 32,767</td>
</tr>
<tr>
<td>1219</td>
<td>Minimum Volt. Phase B to Neutral</td>
<td>Volts/Scale Factor D</td>
<td>0 to 32,767</td>
</tr>
<tr>
<td>1220</td>
<td>Minimum Volt. Phase C to Neutral</td>
<td>Volts/Scale Factor D</td>
<td>0 to 32,767</td>
</tr>
<tr>
<td>Reg. No.</td>
<td>Description</td>
<td>Units</td>
<td>Range</td>
</tr>
<tr>
<td>---------</td>
<td>-------------------------------------------------</td>
<td>-------------------------</td>
<td>---------------</td>
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<tr>
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<td>Volts/Scale Factor D</td>
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</tr>
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<td>1223</td>
<td>Minimum Volt Unbalance Phase B-C</td>
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<td>Percent in 10ths</td>
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</tr>
<tr>
<td>1225</td>
<td>Minimum Volt Unbalance L-L Worst</td>
<td>Percent in 10ths</td>
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</tr>
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<td>1227</td>
<td>Minimum Volt Unbalance Phase B</td>
<td>Percent in 10ths</td>
<td>0 to ±1000</td>
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<td>Minimum Volt Unbalance Phase C</td>
<td>Percent in 10ths</td>
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</tr>
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<td>1229</td>
<td>Minimum Volt L-N Unbalance Worst</td>
<td>Percent in 10ths</td>
<td>0 to ±1000</td>
</tr>
<tr>
<td>1231</td>
<td>Minimum True, Power Factor A</td>
<td>In 1000ths</td>
<td>−100 to +1000 to +100</td>
</tr>
<tr>
<td>1232</td>
<td>Minimum True, Power Factor B</td>
<td>In 1000ths</td>
<td>−100 to +1000 to +100</td>
</tr>
<tr>
<td>1233</td>
<td>Minimum True, Power Factor C</td>
<td>In 1000ths</td>
<td>−100 to +1000 to +100</td>
</tr>
<tr>
<td>1234</td>
<td>Minimum True, Power Factor, 3 Total</td>
<td>In 1000ths</td>
<td>−100 to +1000 to +100</td>
</tr>
<tr>
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<td>Minimum Displ. Power Factor, A</td>
<td>In 1000ths</td>
<td>−100 to +1000 to +100</td>
</tr>
<tr>
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<td>Minimum Displ. Power Factor, B</td>
<td>In 1000ths</td>
<td>−100 to +1000 to +100</td>
</tr>
<tr>
<td>1237</td>
<td>Minimum Displ. Power Factor, C</td>
<td>In 1000ths</td>
<td>−100 to +1000 to +100</td>
</tr>
<tr>
<td>1238</td>
<td>Minimum Displ. Power Factor, 3-phase Total</td>
<td>In 1000ths</td>
<td>−100 to +1000 to +100</td>
</tr>
<tr>
<td>1239</td>
<td>Minimum Real Power, Phase A</td>
<td>kW/Scale Factor E</td>
<td>0 to ±32,767</td>
</tr>
<tr>
<td>1240</td>
<td>Minimum Real Power, Phase B</td>
<td>kW/Scale Factor E</td>
<td>0 to ±32,767</td>
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<td>1241</td>
<td>Minimum Real Power, Phase C</td>
<td>kW/Scale Factor E</td>
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</tr>
<tr>
<td>1242</td>
<td>Minimum Real Power 3-Phase Total</td>
<td>kW/Scale Factor E</td>
<td>0 to ±32,767</td>
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<tr>
<td>1243</td>
<td>Minimum Reactive Power Phase A</td>
<td>kVAR/Scale Factor E</td>
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</tr>
<tr>
<td>1244</td>
<td>Minimum Reactive Power Phase B</td>
<td>kVAR/Scale Factor E</td>
<td>0 to ±32,767</td>
</tr>
<tr>
<td>1245</td>
<td>Minimum Reactive Power Phase C</td>
<td>kVAR/Scale Factor E</td>
<td>0 to ±32,767</td>
</tr>
<tr>
<td>1246</td>
<td>Minimum Reactive Power 3-Phase Total</td>
<td>kVAR/Scale Factor E</td>
<td>0 to ±32,767</td>
</tr>
<tr>
<td>1247</td>
<td>Minimum Apparent Power Phase A</td>
<td>kVA/Scale Factor E</td>
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<td>Minimum Apparent Power Phase B</td>
<td>kVA/Scale Factor E</td>
<td>0 to ±32,767</td>
</tr>
<tr>
<td>1249</td>
<td>Minimum Apparent Power Phase C</td>
<td>kVA/Scale Factor E</td>
<td>0 to ±32,767</td>
</tr>
<tr>
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<td>Minimum Apparent Power 3-Phase Total</td>
<td>kVA/Scale Factor E</td>
<td>0 to ±32,767</td>
</tr>
<tr>
<td>1251</td>
<td>Minimum THD Phase B Current</td>
<td>% in 10ths</td>
<td>0 to 32,767</td>
</tr>
<tr>
<td>1252</td>
<td>Minimum THD Phase B Current</td>
<td>% in 10ths</td>
<td>0 to 32,767</td>
</tr>
<tr>
<td>1253</td>
<td>Minimum THD Phase C Current</td>
<td>% in 10ths</td>
<td>0 to 32,767</td>
</tr>
<tr>
<td>1254</td>
<td>Minimum THD Neutral Current</td>
<td>% in 10ths</td>
<td>0 to 32,767</td>
</tr>
<tr>
<td>1255</td>
<td>Minimum THD Phase A Voltage</td>
<td>% in 10ths</td>
<td>0 to 32,767</td>
</tr>
<tr>
<td>1256</td>
<td>Minimum THD Phase B Voltage</td>
<td>% in 10ths</td>
<td>0 to 32,767</td>
</tr>
<tr>
<td>1257</td>
<td>Minimum THD Phase C Voltage</td>
<td>% in 10ths</td>
<td>0 to 32,767</td>
</tr>
<tr>
<td>1258</td>
<td>Minimum THD A-B Voltage</td>
<td>% in 10ths</td>
<td>0 to 32,767</td>
</tr>
<tr>
<td>1259</td>
<td>Minimum THD B-C Voltage</td>
<td>% in 10ths</td>
<td>0 to 32,767</td>
</tr>
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<td>1260</td>
<td>Minimum THD C-A Voltage</td>
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<td>0 to 32,767</td>
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<tr>
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<td>Minimum K-Factor A</td>
<td>In 10ths</td>
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</tr>
<tr>
<td>1272</td>
<td>Minimum K-Factor B</td>
<td>In 10ths</td>
<td>0 to 10,000</td>
</tr>
<tr>
<td>1273</td>
<td>Minimum K-Factor C</td>
<td>In 10ths</td>
<td>0 to 10,000</td>
</tr>
</tbody>
</table>

**ANALOG INPUT MIN REGISTERS**

- **Reg. No. 1391**: Analog Input 1 Minimum Value
  - Minimum Value: -32767 to +32767
  - Description: The minimum scaled value of analog input 1 since the last reset of min/max values.

- **Reg. No. 1392**: Analog Input 2 Minimum Value
  - Minimum Value: -32767 to +32767
  - Description: The minimum scaled value of analog input 2 since the last reset of min/max values.

- **Reg. No. 1393**: Analog Input 3 Minimum Value
  - Minimum Value: -32767 to +32767
  - Description: The minimum scaled value of analog input 3 since the last reset of min/max values.

- **Reg. No. 1394**: Analog Input 4 Minimum Value
  - Minimum Value: -32767 to +32767
  - Description: The minimum scaled value of analog input 4 since the last reset of min/max values.
<table>
<thead>
<tr>
<th>Reg. No.</th>
<th>Description</th>
<th>Units</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>1400</td>
<td>Maximum Update Interval</td>
<td>In 1000ths of a second</td>
<td>0 to 10,000</td>
</tr>
<tr>
<td>1401</td>
<td>Maximum Freq.</td>
<td>Hertz/Scale Factor F</td>
<td>2300 to 6700, (50/60)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>3500 to 4500 (400)</td>
</tr>
<tr>
<td>1402</td>
<td>Maximum Temp.</td>
<td>Degrees Cent. in 100ths</td>
<td>–10,000 to +10,000</td>
</tr>
<tr>
<td>1403</td>
<td>Maximum Current Phase A</td>
<td>Amps/Scale Factor A</td>
<td>0 to 32,767</td>
</tr>
<tr>
<td>1404</td>
<td>Maximum Current Phase B</td>
<td>Amps/Scale Factor A</td>
<td>0 to 32,767</td>
</tr>
<tr>
<td>1405</td>
<td>Maximum Current Phase C</td>
<td>Amps/Scale Factor A</td>
<td>0 to 32,767</td>
</tr>
<tr>
<td>1406</td>
<td>Maximum Current Neutral (I4)</td>
<td>Amps/Scale Factor B</td>
<td>0 to 32,767</td>
</tr>
<tr>
<td>1407</td>
<td>Maximum Current Ground (I5)</td>
<td>Amps/Scale Factor C</td>
<td>0 to 32,767</td>
</tr>
<tr>
<td>1408</td>
<td>Maximum Current 3-Phase Average</td>
<td>Amps/Scale Factor A</td>
<td>0 to 32,767</td>
</tr>
<tr>
<td>1409</td>
<td>Maximum Current, Apparent rms</td>
<td>Amps/Scale Factor A</td>
<td>0 to 32,767</td>
</tr>
<tr>
<td>1410</td>
<td>Maximum Current Unbalance, Phase A</td>
<td>Percent in 10ths</td>
<td>0 to ±1000</td>
</tr>
<tr>
<td>1411</td>
<td>Maximum Current Unbalance, Phase B</td>
<td>Percent in 10ths</td>
<td>0 to ±1000</td>
</tr>
<tr>
<td>1412</td>
<td>Maximum Current Unbalance, Phase C</td>
<td>Percent in 10ths</td>
<td>0 to ±1000</td>
</tr>
<tr>
<td>1413</td>
<td>Maximum Current Unbalance Worst</td>
<td>Percent in 10ths</td>
<td>0 to ±1000</td>
</tr>
<tr>
<td>1414</td>
<td>Maximum Voltage Phase A to B</td>
<td>Volts/Scale Factor D</td>
<td>0 to 32,767</td>
</tr>
<tr>
<td>1415</td>
<td>Maximum Voltage Phase B to C</td>
<td>Volts/Scale Factor D</td>
<td>0 to 32,767</td>
</tr>
<tr>
<td>1416</td>
<td>Maximum Voltage Phase C to A</td>
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</tr>
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<td>Maximum Volt L-L, 3-Phase Average</td>
<td>Volts/Scale Factor D</td>
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</tr>
<tr>
<td>1418</td>
<td>Maximum Voltage Phase A to Neutral</td>
<td>Volts/Scale Factor D</td>
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<tr>
<td>1419</td>
<td>Maximum Voltage Phase B to Neutral</td>
<td>Volts/Scale Factor D</td>
<td>0 to 32,767</td>
</tr>
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<td>Maximum Voltage Phase C to Neutral</td>
<td>Volts/Scale Factor D</td>
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<tr>
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<td>Maximum Volt Unbalance Phase A-B</td>
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</tr>
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<td>0 to ±1000</td>
</tr>
<tr>
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<td>0 to ±1000</td>
</tr>
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<td>1427</td>
<td>Maximum Volt Unbal. Phase B</td>
<td>Percent in 10ths</td>
<td>0 to ±1000</td>
</tr>
<tr>
<td>1428</td>
<td>Maximum Volt Unbal. Phase C</td>
<td>Percent in 10ths</td>
<td>0 to ±1000</td>
</tr>
<tr>
<td>1429</td>
<td>Maximum Volt L-N. Unbal. Worst</td>
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<td>0 to ±1000</td>
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<td>1431</td>
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<td>in 1000ths</td>
<td>–100 to +1000 to +100</td>
</tr>
<tr>
<td>1432</td>
<td>Maximum True, Power Factor B</td>
<td>In 1000ths</td>
<td>–100 to +1000 to +100</td>
</tr>
<tr>
<td>1433</td>
<td>Maximum True, Power Factor C</td>
<td>In 1000ths</td>
<td>–100 to +1000 to +100</td>
</tr>
<tr>
<td>1434</td>
<td>Maximum True, Power Factor 3-Phase Total</td>
<td>In 1000ths</td>
<td>–100 to +1000 to +100</td>
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<td>Maximum Displ. Power Factor Phase A</td>
<td>In 1000ths</td>
<td>–100 to +1000 to +100</td>
</tr>
<tr>
<td>1436</td>
<td>Maximum Displ. Power Factor, Phase B</td>
<td>In 1000ths</td>
<td>–100 to +1000 to +100</td>
</tr>
<tr>
<td>1437</td>
<td>Maximum Displ. Power Factor Phase C</td>
<td>In 1000ths</td>
<td>–100 to +1000 to +100</td>
</tr>
<tr>
<td>1438</td>
<td>Maximum Displ. Power Factor 3-Phase Total</td>
<td>Percent</td>
<td>–100 to +1000 to +100</td>
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<tr>
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<td>kW/Scale Factor E</td>
<td>0 to ±32,767</td>
</tr>
<tr>
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<td>Maximum Real Power Phase B</td>
<td>kW/Scale Factor E</td>
<td>0 to ±32,767</td>
</tr>
<tr>
<td>1441</td>
<td>Maximum Real Power Phase C</td>
<td>kW/Scale Factor E</td>
<td>0 to ±32,767</td>
</tr>
<tr>
<td>1442</td>
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<td>kW/Scale Factor E</td>
<td>0 to ±32,767</td>
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<td>1443</td>
<td>Maximum Reactive Power Phase A</td>
<td>kVar/Scale Factor E</td>
<td>0 to ±32,767</td>
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<td>Maximum Reactive Power Phase B</td>
<td>kVar/Scale Factor E</td>
<td>0 to ±32,767</td>
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<td>Maximum Reactive Power Phase C</td>
<td>kVar/Scale Factor E</td>
<td>0 to ±32,767</td>
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<td>kVar/Scale Factor E</td>
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<tr>
<td>1451</td>
<td>Maximum THD Phase A Current</td>
<td>% in 10ths</td>
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</tr>
<tr>
<td>1452</td>
<td>Maximum THD Phase B Current</td>
<td>% in 10ths</td>
<td>0 to 32,767</td>
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</tbody>
</table>
### Appendix C—Abbreviated Register Listing

<table>
<thead>
<tr>
<th>Reg. No.</th>
<th>Description</th>
<th>Units</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>1453</td>
<td>Maximum THD Phase C Current</td>
<td>% in 10ths</td>
<td>0 to 32,767</td>
</tr>
<tr>
<td>1454</td>
<td>Maximum THD Neutral Current</td>
<td>% in 10ths</td>
<td>0 to 32,767</td>
</tr>
<tr>
<td>1455</td>
<td>Maximum THD Phase A Voltage</td>
<td>% in 10ths</td>
<td>0 to 32,767</td>
</tr>
<tr>
<td>1456</td>
<td>Maximum THD Phase B Voltage</td>
<td>% in 10ths</td>
<td>0 to 32,767</td>
</tr>
<tr>
<td>1457</td>
<td>Maximum THD Phase C Voltage</td>
<td>% in 10ths</td>
<td>0 to 32,767</td>
</tr>
<tr>
<td>1458</td>
<td>Maximum THD A-B Voltage</td>
<td>% in 10ths</td>
<td>0 to 32,767</td>
</tr>
<tr>
<td>1459</td>
<td>Maximum THD B-C Voltage</td>
<td>% in 10ths</td>
<td>0 to 32,767</td>
</tr>
<tr>
<td>1460</td>
<td>Maximum THD C-A Voltage</td>
<td>% in 10ths</td>
<td>0 to 32,767</td>
</tr>
<tr>
<td>1471</td>
<td>Maximum K-Factor Phase A</td>
<td>In 10ths</td>
<td>0 to 10,000</td>
</tr>
<tr>
<td>1472</td>
<td>Maximum K-Factor Phase B</td>
<td>In 10ths</td>
<td>0 to 10,000</td>
</tr>
<tr>
<td>1473</td>
<td>Maximum K-Factor Phase C</td>
<td>In 10ths</td>
<td>0 to 10,000</td>
</tr>
</tbody>
</table>

### ANALOG INPUT MAX REGISTER

<table>
<thead>
<tr>
<th>Reg. No.</th>
<th>Description</th>
<th>Units</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>1591</td>
<td>Analog Input 1 Maximum Value</td>
<td>-32767 to +32767</td>
<td>The maximum scaled value of analog input 1 since the last reset of min/max values.</td>
</tr>
<tr>
<td>1592</td>
<td>Analog Input 2 Maximum Value</td>
<td>-32767 to +32767</td>
<td>The maximum scaled value of analog input 2 since the last reset of min/max values.</td>
</tr>
<tr>
<td>1593</td>
<td>Analog Input 3 Maximum Value</td>
<td>-32767 to +32767</td>
<td>The maximum scaled value of analog input 3 since the last reset of min/max values.</td>
</tr>
<tr>
<td>1594</td>
<td>Analog Input 4 Maximum Value</td>
<td>-32767 to +32767</td>
<td>The maximum scaled value of analog input 4 since the last reset of min/max values.</td>
</tr>
</tbody>
</table>

### ENERGY VALUES

Each energy is kept in 4 registers, except Incremental, which is kept in 3 registers; modulo 10,000 per register

#### ACCUMULATED ENERGY

<table>
<thead>
<tr>
<th>Reg. No.</th>
<th>Description</th>
<th>Units</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>1601</td>
<td>Real Energy In 3-Phase Total</td>
<td>WH</td>
<td>0 to 9,999,999,999,999</td>
</tr>
<tr>
<td>1605</td>
<td>Reactive Energy In 3-Phase Total</td>
<td>VArH</td>
<td>0 to 9,999,999,999,999</td>
</tr>
<tr>
<td>1609</td>
<td>Real Energy Out 3-Phase Total</td>
<td>WH</td>
<td>0 to 9,999,999,999,999</td>
</tr>
<tr>
<td>1613</td>
<td>Reactive Energy Out 3-Phase Total</td>
<td>VArH</td>
<td>0 to 9,999,999,999,999</td>
</tr>
<tr>
<td>1617</td>
<td>Apparent Energy, 3-Phase Total</td>
<td>VAH</td>
<td>0 to 9,999,999,999,999</td>
</tr>
<tr>
<td>1621</td>
<td>Real Energy Signed/Absolute 3-Phase Total</td>
<td>WH</td>
<td>0 to ±9,999,999,999,999</td>
</tr>
<tr>
<td>1625</td>
<td>Reactive Energy Signed/Absolute 3-Phase Total</td>
<td>VArH</td>
<td>0 to ±9,999,999,999,999</td>
</tr>
</tbody>
</table>

#### CONDITIONAL ACCUMULATED ENERGY

<table>
<thead>
<tr>
<th>Reg. No.</th>
<th>Description</th>
<th>Units</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>1629</td>
<td>Conditional Real Energy In, 3-Phase Total</td>
<td>WH</td>
<td>0 to 9,999,999,999,999</td>
</tr>
<tr>
<td>1633</td>
<td>Conditional Reactive Energy In 3-Phase Total</td>
<td>VArH</td>
<td>0 to 9,999,999,999,999</td>
</tr>
<tr>
<td>1637</td>
<td>Conditional Real Energy Out, 3-Phase Total</td>
<td>WH</td>
<td>0 to 9,999,999,999,999</td>
</tr>
<tr>
<td>1641</td>
<td>Conditional Reactive Energy Out 3-Phase Total</td>
<td>VArH</td>
<td>0 to 9,999,999,999,999</td>
</tr>
<tr>
<td>1645</td>
<td>Conditional Apparent Energy 3-Phase Total</td>
<td>VAH</td>
<td>0 to 9,999,999,999,999</td>
</tr>
</tbody>
</table>

#### INCREMENTAL ACCUMULATED ENERGY

<table>
<thead>
<tr>
<th>Reg. No.</th>
<th>Description</th>
<th>Units</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>1649</td>
<td>Incremental Real Energy In, 3-Phase Total</td>
<td>WH</td>
<td>0 to 999,999,999,999</td>
</tr>
<tr>
<td>1652</td>
<td>Incremental Reactive Energy In 3-Phase Total</td>
<td>VArH</td>
<td>0 to 999,999,999,999</td>
</tr>
<tr>
<td>1655</td>
<td>Incremental Real Energy Out, 3-Phase Total</td>
<td>WH</td>
<td>0 to 999,999,999,999</td>
</tr>
<tr>
<td>1658</td>
<td>Incremental Reactive Energy Out 3-Phase Total</td>
<td>VArH</td>
<td>0 to 999,999,999,999</td>
</tr>
<tr>
<td>1661</td>
<td>Incremental Apparent Energy 3-Phase Total</td>
<td>VAH</td>
<td>0 to 999,999,999,999</td>
</tr>
</tbody>
</table>
### DEMAND VALUES

#### CURRENT DEMAND

<table>
<thead>
<tr>
<th>Reg. No.</th>
<th>Description</th>
<th>Units</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>1700</td>
<td>Present Current Demand 3-Phase Average</td>
<td>Amps/Scale Factor A</td>
<td>0 to 32,767</td>
</tr>
<tr>
<td>1701</td>
<td>Present Current Demand Phase A</td>
<td>Amps/Scale Factor A</td>
<td>0 to 32,767</td>
</tr>
<tr>
<td>1702</td>
<td>Present Current Demand Phase B</td>
<td>Amps/Scale Factor A</td>
<td>0 to 32,767</td>
</tr>
<tr>
<td>1703</td>
<td>Present Current Demand Phase C</td>
<td>Amps/Scale Factor A</td>
<td>0 to 32,767</td>
</tr>
<tr>
<td>1704</td>
<td>Present Current Demand Neutral</td>
<td>Amps/Scale Factor A</td>
<td>0 to 32,767</td>
</tr>
<tr>
<td>1705</td>
<td>Thermal K-Factor Demand, Phase A</td>
<td>In 10ths</td>
<td>0 to 10,000</td>
</tr>
<tr>
<td>1706</td>
<td>Thermal K-Factor Demand, Phase B</td>
<td>In 10ths</td>
<td>0 to 10,000</td>
</tr>
<tr>
<td>1707</td>
<td>Thermal K-Factor Demand, Phase C</td>
<td>In 10ths</td>
<td>0 to 10,000</td>
</tr>
<tr>
<td>1708</td>
<td>Peak Current Demand 3-Phase Average</td>
<td>Amps/Scale Factor A</td>
<td>0 to 32,767</td>
</tr>
<tr>
<td>1709</td>
<td>Peak Current Demand Phase A</td>
<td>Amps/Scale Factor A</td>
<td>0 to 32,767</td>
</tr>
<tr>
<td>1710</td>
<td>Peak Current Demand Phase B</td>
<td>Amps/Scale Factor A</td>
<td>0 to 32,767</td>
</tr>
<tr>
<td>1711</td>
<td>Peak Current Demand Phase C</td>
<td>Amps/Scale Factor A</td>
<td>0 to 32,767</td>
</tr>
<tr>
<td>1712</td>
<td>Peak Current Demand Neutral</td>
<td>Amps/Scale Factor A</td>
<td>0 to 32,767</td>
</tr>
<tr>
<td>1713</td>
<td>K-Factor Demand Phase A Coincident Peak Product</td>
<td>In 10ths</td>
<td>0 to 10,000</td>
</tr>
<tr>
<td>1714</td>
<td>Current Demand Phase A Coincident Peak Product</td>
<td>Amps/Scale Factor A</td>
<td>0 to 32,767</td>
</tr>
<tr>
<td>1715</td>
<td>K-Factor Demand Phase B Coincident Peak Product</td>
<td>In 10ths</td>
<td>0 to 10,000</td>
</tr>
<tr>
<td>1716</td>
<td>Current Demand Phase B Coincident Peak Product</td>
<td>Amps/Scale Factor A</td>
<td>0 to 32,767</td>
</tr>
<tr>
<td>1717</td>
<td>K-Factor Demand Phase C Coincident Peak Product</td>
<td>In 10ths</td>
<td>0 to 10,000</td>
</tr>
<tr>
<td>1718</td>
<td>Current Demand Phase C Coincident Peak Product</td>
<td>Amps/Scale Factor A</td>
<td>0 to 32,767</td>
</tr>
</tbody>
</table>

#### POWER DEMAND

Reactive Demand may be calculated using either the fundamental only (default), or total harmonics (user selectable).

<table>
<thead>
<tr>
<th>Reg. No.</th>
<th>Description</th>
<th>Units</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>1730</td>
<td>Average Power Factor Over Interval</td>
<td>In 1000ths</td>
<td>−100 to 1000 to +100</td>
</tr>
<tr>
<td>1731</td>
<td>Present Real Power, Demand, 3-Phase Total</td>
<td>kW/Scale Factor E</td>
<td>0 to ±32,767</td>
</tr>
<tr>
<td>1732</td>
<td>Present Reactive Power, Demand, 3 Phase Total</td>
<td>kVAR/Scale Factor E</td>
<td>0 to ±32,767</td>
</tr>
<tr>
<td>1733</td>
<td>Present Apparent Power Demand 3-Phase Total</td>
<td>kVA/Scale Factor E</td>
<td>0 to 32,767</td>
</tr>
<tr>
<td>1734</td>
<td>Peak Real Power Demand 3-Phase Total</td>
<td>kW/Scale Factor E</td>
<td>0 to ±32,767</td>
</tr>
<tr>
<td>1735</td>
<td>Average Power Factor for Peak Real</td>
<td>Percent in 1000ths</td>
<td>−100 to 1000 to +100</td>
</tr>
<tr>
<td>1736</td>
<td>Reactive Power Demand for Peak Real</td>
<td>kVAR/Scale Factor E</td>
<td>0 to ±32,767</td>
</tr>
<tr>
<td>1737</td>
<td>Apparent Power Demand for Peak Real</td>
<td>kVA/Scale Factor E</td>
<td>0 to 32,767</td>
</tr>
<tr>
<td>1738</td>
<td>Peak Reactive Power Demand, 3-Phase Total</td>
<td>kVAR/Scale Factor E</td>
<td>0 to ±32,767</td>
</tr>
<tr>
<td>1739</td>
<td>Average Reactive Power Factor for Peak Reactive</td>
<td>Percent in 1000ths</td>
<td>−100 to 1000 to +100</td>
</tr>
<tr>
<td>1740</td>
<td>Real Power Demand for Peak Reactive</td>
<td>kW/Scale Factor E</td>
<td>0 to ±32,767</td>
</tr>
<tr>
<td>1741</td>
<td>Apparent Power Demand for Peak Reactive</td>
<td>kVA/Scale Factor E</td>
<td>0 to 32,767</td>
</tr>
<tr>
<td>1742</td>
<td>Peak Apparent Power Demand, 3-Phase Total</td>
<td>kVA/Scale Factor E</td>
<td>0 to 32,767</td>
</tr>
<tr>
<td>1743</td>
<td>Average Apparent Power Factor for Peak Apparent</td>
<td>Percent in 1000ths</td>
<td>−100 to 1000 to +100</td>
</tr>
<tr>
<td>1744</td>
<td>Real Power Demand for Peak Apparent</td>
<td>kW/Scale Factor E</td>
<td>0 to ±32,767</td>
</tr>
<tr>
<td>1745</td>
<td>Reactive Power Demand for Peak Apparent</td>
<td>kVAR/Scale Factor E</td>
<td>0 to ±32,767</td>
</tr>
<tr>
<td>1746</td>
<td>Predicted Real Power Demand, 3 Phase Total</td>
<td>kW/Scale Factor E</td>
<td>0 to ±32,767</td>
</tr>
<tr>
<td>1747</td>
<td>Predicted Reactive Power Demand, 3-Phase Total</td>
<td>kVAR/Scale Factor E</td>
<td>0 to ±32,767</td>
</tr>
<tr>
<td>1748</td>
<td>Predicted Apparent Power Demand, 3-Phase Total</td>
<td>kVA/Scale Factor E</td>
<td>0 to ±32,767</td>
</tr>
<tr>
<td>1749</td>
<td>Maximum Real Power 3-Phase Demand</td>
<td>kW/Scale Factor E</td>
<td>0 to ±32,767</td>
</tr>
<tr>
<td></td>
<td>Over Last Inc. Energy Interval</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1750</td>
<td>Maximum Reactive Power 3-Phase</td>
<td>kVAR/Scale Factor E</td>
<td>0 to ±32,767</td>
</tr>
<tr>
<td></td>
<td>Demand Over Last Inc. Energy Interval</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1751</td>
<td>Maximum Apparent Power 3-Phase</td>
<td>kVA/Scale Factor E</td>
<td>0 to ±32,767</td>
</tr>
<tr>
<td></td>
<td>Demand Over Last Inc. Energy Interval</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1752</td>
<td>Time Remaining in Demand Interval</td>
<td>Seconds</td>
<td>0 to 3600</td>
</tr>
</tbody>
</table>
### Appendix C—Abbreviated Register Listing

The date and time in registers 1800–1802 are stored as follows. Other dates and times (through register 1877) are stored in an identical manner.

*Register 1800, Month (byte 1) = 1–12, Day (byte 2) = 1–31
Register 1801, Year (byte 1) = 0–199, Hour (byte 2) = 0–23,
Register 1802, Minutes (byte 1) = 0–59, Seconds (byte 2) = 0–59

The year is zero based on the year 1900 in anticipation of the 21st century, (e.g., 1989 would be represented as 89 and 2009 would be represented as 109).

<table>
<thead>
<tr>
<th>Reg. No.</th>
<th>Description</th>
<th>Units</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>1800–1802</td>
<td>Last Restart Date/Time</td>
<td>Month, Day, Yr., Hr., Min., Sec.</td>
<td>*See Above</td>
</tr>
<tr>
<td>1803–1805</td>
<td>Date/Time Demand of Peak Current Phase A</td>
<td>Month, Day, Yr., Hr., Min., Sec.</td>
<td>Same as Regs. 1800–1802</td>
</tr>
<tr>
<td>1806–1808</td>
<td>Date/Time Demand of Peak Current Phase B</td>
<td>Month, Day, Yr., Hr., Min., Sec.</td>
<td>Same as Regs. 1800–1802</td>
</tr>
<tr>
<td>1809–1811</td>
<td>Date/Time Demand of Peak Current Phase C</td>
<td>Month, Day, Yr., Hr., Min., Sec.</td>
<td>Same as Regs. 1800–1802</td>
</tr>
<tr>
<td>1812–1814</td>
<td>Date/Time of Peak Demand (Average Real Power)</td>
<td>Month, Day, Yr., Hr., Min., Sec.</td>
<td>Same as Regs. 1800–1802</td>
</tr>
<tr>
<td>1815–1817</td>
<td>Date/Time of Last Reset of Peak Demand Current</td>
<td>Month, Day, Yr., Hr., Min., Sec.</td>
<td>Same as Regs. 1800–1802</td>
</tr>
<tr>
<td>1818–1820</td>
<td>Date/Time of last Min/Max Clear of Instantaneous Values</td>
<td>Month, Day, Yr., Hr., Min., Sec.</td>
<td>Same as Regs. 1800–1802</td>
</tr>
<tr>
<td>1821–1823</td>
<td>Date/Time of Last Write to Circuit Tracker™ Setpoint Register</td>
<td>Month, Day, Yr., Hr., Min., Sec.</td>
<td>Same as Regs. 1800–1802</td>
</tr>
<tr>
<td>1824–1826</td>
<td>Date/Time when Peak Demand was last cleared</td>
<td>Month, Day, Yr., Hr., Min., Sec.</td>
<td>Same as Regs. 1800–1802</td>
</tr>
<tr>
<td>1827–1829</td>
<td>Date/Time When Accumulated Energy Last Cleared</td>
<td>Month, Day, Yr., Hr., Min., Sec.</td>
<td>Same as Regs. 1800–1802</td>
</tr>
<tr>
<td>1830–1832</td>
<td>Date/Time When Control Power Failed Last</td>
<td>Month, Day, Yr., Hr., Min., Sec.</td>
<td>Same as Regs. 1800–1802</td>
</tr>
<tr>
<td>1833–1835</td>
<td>Date/Time When Level 1 Energy Mgmt. Setpt. Alarm Period Was Last Entered</td>
<td>Month, Day, Yr., Hr., Min., Sec.</td>
<td>Same as Regs. 1800–1802</td>
</tr>
<tr>
<td>1836–1838</td>
<td>Date/Time When Level 2 Energy Mgmt. Setpt. Alarm Period Was Last Entered</td>
<td>Month, Day, Yr., Hr., Min., Sec.</td>
<td>Same as Regs. 1800–1802</td>
</tr>
<tr>
<td>1839–1841</td>
<td>Date/Time When Level 3 Energy Mgmt. Setpt. Alarm Period Was Last Entered</td>
<td>Month, Day, Yr., Hr., Min., Sec.</td>
<td>Same as Regs. 1800–1802</td>
</tr>
<tr>
<td>1842–1844</td>
<td>Present/Set Date/Time</td>
<td>Month, Day, Yr., Hr., Min., Sec.</td>
<td>Same as Regs. 1800–1802</td>
</tr>
<tr>
<td>1845–1847</td>
<td>Date/Time of Calibration</td>
<td>Month, Day, Yr., Hr., Min., Sec.</td>
<td>Same as Regs. 1800–1802</td>
</tr>
<tr>
<td>1848–1850</td>
<td>Date/Time of Peak K-Factor Demand A Product</td>
<td>Month, Day, Yr., Hr., Min., Sec.</td>
<td>Same as Regs. 1800–1802</td>
</tr>
</tbody>
</table>
### DATE/TIME Expanded (6 registers)

The date and time in registers 700–705 are stored as follows. Other dates and times through register 795 are stored in an identical manner.

*Seconds (Reg. 700) = 0–59, Minutes (Reg. 701) = 0–59, Hours (Reg. 702) = 0–23, Day (Reg. 703) 1–31, Month (Reg. 704) = 1–12, Year (Reg. 705) = 1900–2099*

The date and time are mapped from CM Registers 1800–1802.

<table>
<thead>
<tr>
<th>Reg. No.</th>
<th>Description</th>
<th>Units</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>[700–705]</td>
<td>Last Restart Date/Time</td>
<td>Sec, Min, Day, Month, Yr.</td>
<td>*See above</td>
</tr>
<tr>
<td>[706–711]</td>
<td>Date/Time Demand of Peak Current Phase A</td>
<td>Sec, Min, Day, Month, Yr.</td>
<td>Same as Regs. # 700–705</td>
</tr>
</tbody>
</table>
### Appendix C—Abbreviated Register Listing

<table>
<thead>
<tr>
<th>Reg. No.</th>
<th>Description</th>
<th>Units</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>[712–717]</td>
<td>Date/Time Demand of Peak Current Phase B</td>
<td>Sec, Min, Hour Day, Month, Yr.</td>
<td>Same as Regs. # 700–705</td>
</tr>
<tr>
<td>[718–723]</td>
<td>Date/Time Demand of Peak Current Phase C</td>
<td>Sec, Min, Hour Day, Month, Yr.</td>
<td>Same as Regs. # 700–705</td>
</tr>
<tr>
<td>[724–729]</td>
<td>Date/Time of Peak Demand (Average Real Power)</td>
<td>Sec, Min, Hour Day, Month, Yr.</td>
<td>Same as Regs. # 700–705</td>
</tr>
<tr>
<td>[730–735]</td>
<td>Date/Time of Last Reset of Peak Demand Current</td>
<td>Sec, Min, Hour Day, Month, Yr.</td>
<td>Same as Regs. # 700–705</td>
</tr>
<tr>
<td>[736–741]</td>
<td>Date/Time of last Min/Max Clear of Instantaneous Values</td>
<td>Sec, Min, Hour Day, Month, Yr.</td>
<td>Same as Regs. # 700–705</td>
</tr>
<tr>
<td>[742–747]</td>
<td>Date/Time of Last Write to Circuit Tracker™ Setpoint Register</td>
<td>Sec, Min, Hour Day, Month, Yr.</td>
<td>Same as Regs. # 700–705</td>
</tr>
<tr>
<td>[748–753]</td>
<td>Date/Time when Peak Demand was Last Cleared</td>
<td>Sec, Min, Hour Day, Month, Yr.</td>
<td>Same as Regs. # 700–705</td>
</tr>
<tr>
<td>[754–759]</td>
<td>Date/Time when Accumulated Energy was Last Cleared</td>
<td>Sec, Min, Hour Day, Month, Yr.</td>
<td>Same as Regs. # 700–705</td>
</tr>
<tr>
<td>[760–765]</td>
<td>Date/Time when Control Power Failed Last</td>
<td>Day, Month, Yr. Sec, Min, Hour</td>
<td>Regs. # 700–705 Same as</td>
</tr>
<tr>
<td>[766–771]</td>
<td>Date/Time When Level 1 Energy Mgmt. Setpt. Alarm Period was Last Entered</td>
<td>Sec, Min, Hour Day, Month, Yr.</td>
<td>Same as Regs. # 700–705</td>
</tr>
<tr>
<td>[772–777]</td>
<td>Date/Time When Level 2 Energy Mgmt. Setpt. Alarm Period was Last Entered</td>
<td>Sec, Min, Hour Day, Month, Yr.</td>
<td>Same as Regs. # 700–705</td>
</tr>
<tr>
<td>[778–783]</td>
<td>Date/Time When Level 3 Energy Mgmt. Setpt. Alarm Period was Last Entered</td>
<td>Sec, Min, Hour Day, Month, Yr.</td>
<td>Same as Regs. # 700–705</td>
</tr>
<tr>
<td>[784–789]</td>
<td>Present/Set Date/Time</td>
<td>Sec, Min, Hour Day, Month, Yr.</td>
<td>Same as Regs. # 700–705</td>
</tr>
<tr>
<td>[790–795]</td>
<td>Date/Time of Calibration</td>
<td>Sec, Min, Hour Day, Month, Yr.</td>
<td>Same as Regs. # 700–705</td>
</tr>
</tbody>
</table>

#### STATUS INPUTS

<table>
<thead>
<tr>
<th>Reg. No.</th>
<th>Description</th>
<th>Units</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>2400</td>
<td>Input Status</td>
<td>None</td>
<td>0000 to 00FF Hex</td>
</tr>
<tr>
<td>2401</td>
<td>Input Conditional Energy Control</td>
<td>None</td>
<td>0000 to 00FF Hex</td>
</tr>
<tr>
<td>2402–2403</td>
<td>Input 1 Label</td>
<td>None</td>
<td>Alpha-Numeric 4 Chars.</td>
</tr>
<tr>
<td>2404–2405</td>
<td>Input 1 Count</td>
<td>Counts</td>
<td>0 to 99,999,999</td>
</tr>
<tr>
<td>2406</td>
<td>Input 1 On-Timer</td>
<td>Seconds</td>
<td>0 to 32,767</td>
</tr>
<tr>
<td>2407–2408</td>
<td>Input 2 Label</td>
<td>None</td>
<td>Alpha-Numeric 4 Chars.</td>
</tr>
<tr>
<td>2409–2410</td>
<td>Input 2 Count</td>
<td>Counts</td>
<td>0 to 99,999,999</td>
</tr>
<tr>
<td>2411</td>
<td>Input 2 On-Timer</td>
<td>Seconds</td>
<td>0 to 32,767</td>
</tr>
</tbody>
</table>

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### Input Settings

<table>
<thead>
<tr>
<th>Reg. No.</th>
<th>Description</th>
<th>Units</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>2412–2413</td>
<td>Input 3 Label</td>
<td>None</td>
<td>Alpha-Numeric 4 Chars.</td>
</tr>
<tr>
<td>2414–2415</td>
<td>Input 3 Count</td>
<td>Counts</td>
<td>0 to 9,999,999,999</td>
</tr>
<tr>
<td>2416</td>
<td>Input 3 On-Timer</td>
<td>Seconds</td>
<td>0 to 32,767</td>
</tr>
<tr>
<td>2417–2418</td>
<td>Input 4 Label</td>
<td>None</td>
<td>Alpha-Numeric 4 Chars.</td>
</tr>
<tr>
<td>2419–2420</td>
<td>Input 4 Count</td>
<td>Counts</td>
<td>0 to 9,999,999,999</td>
</tr>
<tr>
<td>2421</td>
<td>Input 4 On-Timer</td>
<td>Seconds</td>
<td>0 to 32,767</td>
</tr>
<tr>
<td>2422–2423</td>
<td>Input 5 Label</td>
<td>None</td>
<td>Alpha-Numeric 4 Chars.</td>
</tr>
<tr>
<td>2424–2425</td>
<td>Input 5 Count</td>
<td>Counts</td>
<td>0 to 9,999,999,999</td>
</tr>
<tr>
<td>2426</td>
<td>Input 5 On-Timer</td>
<td>Seconds</td>
<td>0 to 32,767</td>
</tr>
<tr>
<td>2427–2428</td>
<td>Input 6 Label</td>
<td>None</td>
<td>Alpha-Numeric 4 Chars.</td>
</tr>
<tr>
<td>2429–2430</td>
<td>Input 6 Count</td>
<td>Counts</td>
<td>0 to 9,999,999,999</td>
</tr>
<tr>
<td>2431</td>
<td>Input 6 On-Timer</td>
<td>Seconds</td>
<td>0 to 32,767</td>
</tr>
<tr>
<td>2432–2433</td>
<td>Input 7 Label</td>
<td>None</td>
<td>Alpha-Numeric 4 Chars.</td>
</tr>
<tr>
<td>2434–2435</td>
<td>Input 7 Count</td>
<td>Counts</td>
<td>0 to 9,999,999,999</td>
</tr>
<tr>
<td>2436</td>
<td>Input 7 On-Timer</td>
<td>Seconds</td>
<td>0 to 32,767</td>
</tr>
<tr>
<td>2437–2438</td>
<td>Input 8 Label</td>
<td>None</td>
<td>Alpha-Numeric 4 Chars.</td>
</tr>
<tr>
<td>2439–2440</td>
<td>Input 8 Count</td>
<td>Counts</td>
<td>0 to 9,999,999,999</td>
</tr>
<tr>
<td>2441</td>
<td>Input 8 On-Timer</td>
<td>Seconds</td>
<td>0 to 32,767</td>
</tr>
</tbody>
</table>

### KYZ and RELAY OUTPUTS

<table>
<thead>
<tr>
<th>Reg. No.</th>
<th>Description</th>
<th>Units</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>2500</td>
<td>Output Status</td>
<td>None</td>
<td>0000 to 00FF Hex</td>
</tr>
<tr>
<td>2501</td>
<td>Output Control</td>
<td>None</td>
<td>0000 to FFFF Hex</td>
</tr>
<tr>
<td>2502–2503</td>
<td>KYZ Output Label</td>
<td>Alpha-Numeric 4 Chars. (2 Regs.)</td>
<td>Label for KYZ output.</td>
</tr>
<tr>
<td>2504</td>
<td>KYZ Output Mode Reg.</td>
<td>None</td>
<td>0 to 9</td>
</tr>
<tr>
<td>2505</td>
<td>KYZ Output Parameter Register</td>
<td>Seconds</td>
<td>0 to 32,767</td>
</tr>
</tbody>
</table>

**KYZ and RELAY OUTPUTS**

- **Output Status**
  - None
  - Units: 0000 to 00FF Hex
  - Description: Bit Map of the states of the Outputs. A 1=On, a 0=Off.
  - Notes: Bit 1 represents the KYZ Output, bits 2–4 represent relays R1–R3, respectively. Register 235 is ghosted as Read Only and does not provide control.

- **Output Control**
  - None
  - Units: 0000 to FFFF Hex
  - Description: Bit Map indicating active Relay Control states.
  - Notes: The lower byte indicates the status of internal/external control. A 1=Relay Control is under internal control and a 0=Relay Control is under external control. The upper byte indicates the status of override control. A 1=Relay Control is in override and a 0=Relay Control is not in override. For each byte, Bit 1 represents the KYZ pulse output, and bits 2–4 represent relays R1–R3, respectively.

- **KYZ Output Label**
  - None
  - Units: Alpha-Numeric 4 Chars. (2 Regs.)
  - Description: Label for KYZ output.

- **KYZ Output Mode Reg.**
  - None
  - Units: 0 to 9
  - Description: KYZ Output Mode Register: 0=Normal, 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=kVARH out pulse

- **KYZ Output Parameter Register**
  - Seconds
  - Units: 0 to 32,767
  - Description: This register specifies the time the KYZ output is to remain closed for timed mode.
<table>
<thead>
<tr>
<th>Reg. No.</th>
<th>Name</th>
<th>Units</th>
<th>Range</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>2506</td>
<td>KYZ Output</td>
<td>kWh/Pulse or kVArH/Pulse</td>
<td>0 to 32,767</td>
<td>This register specifies the kWh, kVArH or kVArH per pulse for the KYZ output when in those modes.</td>
</tr>
<tr>
<td>2507–2508</td>
<td>Relay R1 Label</td>
<td>None</td>
<td>Alpha-Numeric (2 Regs.)</td>
<td>Label for relay R1.</td>
</tr>
<tr>
<td>2509</td>
<td>Relay R1 Mode Reg.</td>
<td>None</td>
<td>0 to 9</td>
<td>Relay R1 Mode Register: 0=Normal, 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=kVArH out pulse</td>
</tr>
<tr>
<td>2510</td>
<td>Relay R1 Parameter Register</td>
<td>Seconds</td>
<td>0 to 32,767</td>
<td>This register specifies the time relay R1 is to remain closed for timed mode.</td>
</tr>
<tr>
<td>2511</td>
<td>Relay R1 kWh, kVArH or kVAH/Pulse Register</td>
<td>kWh/Pulse or kVArH/Pulse</td>
<td>0 to 32,767</td>
<td>This register specifies the kWh, kVArH or kVArH per pulse for relay R1 when in those modes.</td>
</tr>
<tr>
<td>2512–2513</td>
<td>Relay R2 Label</td>
<td>None</td>
<td>Alpha-Numeric (2 Regs.)</td>
<td>Label for relay R2.</td>
</tr>
<tr>
<td>2514</td>
<td>Relay R2 Mode Reg.</td>
<td>None</td>
<td>0 to 9</td>
<td>Relay R2 Mode Register: 0=Normal, 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=kVArH out pulse</td>
</tr>
<tr>
<td>2515</td>
<td>Relay R2 Parameter Register</td>
<td>Seconds</td>
<td>0 to 32,767</td>
<td>This register specifies the time relay R2 is to remain closed for timed mode.</td>
</tr>
<tr>
<td>2516</td>
<td>Relay R2 kWh, kVArH or kVAH/Pulse Register</td>
<td>kWh/Pulse or kVArH/Pulse</td>
<td>0 to 32,767</td>
<td>This register specifies the kWh, kVArH or kVArH per pulse for relay R2 when in those modes.</td>
</tr>
<tr>
<td>2517–2518</td>
<td>Relay R3 Label</td>
<td>None</td>
<td>Alpha-Numeric (2 Regs.)</td>
<td>Label for relay R3.</td>
</tr>
<tr>
<td>2519</td>
<td>Relay R3 Mode Reg.</td>
<td>None</td>
<td>0 to 9</td>
<td>Relay R3 Mode Register: 0=Normal, 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=kVArH out pulse</td>
</tr>
<tr>
<td>2520</td>
<td>Relay R3 Parameter Register</td>
<td>Seconds</td>
<td>0 to 32,767</td>
<td>This register specifies the time relay R3 is to remain closed for timed mode.</td>
</tr>
<tr>
<td>2521</td>
<td>Relay R3 kWh, kVArH or kVAH/Pulse Register</td>
<td>kWh/Pulse or kVArH/Pulse</td>
<td>0 to 32,767</td>
<td>This register specifies the kWh, kVArH or kVArH per pulse for relay R3 when in those modes.</td>
</tr>
<tr>
<td>Reg. No.</td>
<td>Description</td>
<td>Units</td>
<td>Range</td>
<td></td>
</tr>
<tr>
<td>---------</td>
<td>--------------------------------------------------</td>
<td>---------</td>
<td>--------------------------------------------</td>
<td></td>
</tr>
<tr>
<td>2001</td>
<td>System Connection</td>
<td>None</td>
<td>30=3-wire mode</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>40=4-wire with calculated neutral</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>41=4-wire with metered neutral</td>
<td></td>
</tr>
<tr>
<td>2002</td>
<td>CT Ratio 3-Phase Primary Ratio Term</td>
<td>None</td>
<td>1 to 32,767</td>
<td></td>
</tr>
<tr>
<td>2003</td>
<td>CT Ratio 3-Phase Secondary Ratio Term</td>
<td>None</td>
<td>1 to 5</td>
<td></td>
</tr>
<tr>
<td>2004</td>
<td>CT Ratio Neutral Primary Ratio Term</td>
<td>None</td>
<td>1 to 32,767</td>
<td></td>
</tr>
<tr>
<td>2005</td>
<td>CT Ratio Neutral Secondary Ratio Term</td>
<td>None</td>
<td>1 to 5</td>
<td></td>
</tr>
<tr>
<td>2006</td>
<td>PT Ratio 3-Phase Primary Ratio Term</td>
<td>None</td>
<td>1 to 32,767</td>
<td></td>
</tr>
<tr>
<td>2007</td>
<td>PT Ratio 3-Phase Primary Scale Factor</td>
<td>None</td>
<td>0 to 2</td>
<td></td>
</tr>
<tr>
<td>2008</td>
<td>PT Ratio 3-Phase Secondary Ratio Term</td>
<td>None</td>
<td>1 to 600</td>
<td></td>
</tr>
<tr>
<td>2009</td>
<td>CT Ratio Correction Factors Phase A</td>
<td>In 10,000ths</td>
<td>5,000–20,000</td>
<td></td>
</tr>
<tr>
<td>2010</td>
<td>CT Ratio Correction Factors Phase B</td>
<td>In 10,000ths</td>
<td>5,000–20,000</td>
<td></td>
</tr>
<tr>
<td>2011</td>
<td>CT Ratio Correction Factors Phase C</td>
<td>In 10,000ths</td>
<td>5,000–20,000</td>
<td></td>
</tr>
<tr>
<td>2012</td>
<td>CT Ratio Correction Factors Neutral /Ground</td>
<td>In 10,000ths</td>
<td>5,000–20,000</td>
<td></td>
</tr>
<tr>
<td>2013</td>
<td>PT Ratio Correction Factors Phase A</td>
<td>In 10,000ths</td>
<td>5,000–20,000</td>
<td></td>
</tr>
<tr>
<td>2014</td>
<td>PT Ratio Correction Factors Phase B</td>
<td>In 10,000ths</td>
<td>5,000–20,000</td>
<td></td>
</tr>
<tr>
<td>2015</td>
<td>PT Ratio Correction Factors Phase C</td>
<td>In 10,000ths</td>
<td>5,000–20,000</td>
<td></td>
</tr>
<tr>
<td>2016</td>
<td>Nominal System Frequency</td>
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<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Reg. No.</th>
<th>Name</th>
<th>Units</th>
<th>Range</th>
<th>Description</th>
</tr>
</thead>
</table>
| 2020     | Scale Group A: Ammeter Per Phase                | None    | -2 to 1 | Scale Group A: Ammeter Per Phase  
|          |                                                 |         | -2= scale by 0.01                               |
|          |                                                 |         | -1=scale by 0.10                                |
|          |                                                 |         | 0=scale by 1.00 (default)                        |
|          |                                                 |         | 1=scale by 10.0                                 |
| 2021     | Scale Group B: Ammeter Neutral                  | None    | -2 to 1 | Scale Group B: Ammeter Neutral  
|          |                                                 |         | -2=scale by 0.01                               |
|          |                                                 |         | -1=scale by 0.10                                |
|          |                                                 |         | 0=scale by 1.00 (default)                        |
|          |                                                 |         | 1=scale by 10.0                                 |
### Appendix C—Abbreviated Register Listing

<table>
<thead>
<tr>
<th>Reg. No.</th>
<th>Name</th>
<th>Units</th>
<th>Range</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>2022</td>
<td>Scale Group C:</td>
<td>None</td>
<td>-2 to 1</td>
<td>Scale Group C: Ammeter Ground</td>
</tr>
<tr>
<td></td>
<td>Ammeter Ground</td>
<td></td>
<td></td>
<td>-2=scale by 0.01</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>-1=scale by 0.10</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0=scale by 1.00 (default)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1=scale by 10.0</td>
</tr>
<tr>
<td>2023</td>
<td>Scale Group D:</td>
<td>None</td>
<td>-1 to 2</td>
<td>Scale Group D: Voltmeter</td>
</tr>
<tr>
<td></td>
<td>Voltmeter</td>
<td></td>
<td></td>
<td>-1=scale by 0.10</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0=scale by 1.00 (default)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1=scale by 10.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2=scale by 100</td>
</tr>
<tr>
<td>2024</td>
<td>Scale Group E:</td>
<td>None</td>
<td>-3 to 3</td>
<td>Scale Group E: kWattmeter, kVarmeter, kVA</td>
</tr>
<tr>
<td></td>
<td>kwattmeter,</td>
<td></td>
<td></td>
<td>-3=scale by .001</td>
</tr>
<tr>
<td></td>
<td>kVarmeter, kVa</td>
<td></td>
<td></td>
<td>-2=scale by 0.01</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>-1=scale by 0.10</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0=scale by 1.00 (default)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1=scale by 10.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2=scale by 100</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3=scale by 1000</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>4=scale by 10,000</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>5=scale by 100,000</td>
</tr>
<tr>
<td>2025</td>
<td>Scale Group F:</td>
<td>None</td>
<td>-1 to 2</td>
<td>Scale Group F: Frequency (Determined by CM)</td>
</tr>
<tr>
<td></td>
<td>Frequency</td>
<td></td>
<td></td>
<td>-2=scale by 0.01 (50/60)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>-1=scale by 0.10 (400)</td>
</tr>
<tr>
<td>2028</td>
<td>Command Password</td>
<td>None</td>
<td>0 to 998</td>
<td>Full Access Front Panel Reset Password</td>
</tr>
<tr>
<td>2029</td>
<td>Display Setup Password</td>
<td>None</td>
<td>0 to 998</td>
<td>Full Access Front Panel Reset Password</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Full Access Front Panel Reset Password. When set to -32,768, the Configuration password is used to access Resets.</td>
</tr>
<tr>
<td>2031</td>
<td>Reset Access Password</td>
<td>None</td>
<td>0 to 998</td>
<td>Limited Front Panel Reset Password. When set to -32,768, the Configuration password is used to access Resets.</td>
</tr>
<tr>
<td>2032</td>
<td>Limited Access</td>
<td>None</td>
<td>0 to F (Hex)</td>
<td>Limited Front Panel Reset Disable Bit Mask. A 1=Disable.</td>
</tr>
<tr>
<td></td>
<td>Disable Bit Mask</td>
<td></td>
<td></td>
<td>Bit 0=Disable Demand Amps Reset Capability</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Bit 1=Disable Demand Power Reset Capability</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Bit 2=Disable Energy Reset Capability</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Bit 3=Disable Min/Max Reset Capability</td>
</tr>
<tr>
<td>2040–2041</td>
<td>CM Label</td>
<td>None</td>
<td>Any Valid Alpha-Numeric</td>
<td>Any Valid Alpha-Numeric</td>
</tr>
<tr>
<td>2042–2049</td>
<td>CM Nameplate</td>
<td>None</td>
<td>Any Valid Alpha-Numeric</td>
<td>Any Valid Alpha-Numeric</td>
</tr>
<tr>
<td>2076</td>
<td>Incremental Energy Interval</td>
<td>Minutes</td>
<td>0 to 440 minutes</td>
<td>Incremental Energy Interval</td>
</tr>
<tr>
<td>2077</td>
<td>Power Demand Interval</td>
<td>Minutes</td>
<td>0 to 60 @5min. Multiples</td>
<td>Power Demand Interval</td>
</tr>
<tr>
<td>2078</td>
<td>Power Demand Sub-Interval</td>
<td>Minutes</td>
<td>0 to 60 @5min. Multiples</td>
<td>Power Demand Sub-Interval</td>
</tr>
<tr>
<td>2079</td>
<td>Current Demand K-Factor</td>
<td>Minutes</td>
<td>0 to 60 @5min. Multiples</td>
<td>Current Demand K-Factor</td>
</tr>
<tr>
<td></td>
<td>Demand Interval in minutes</td>
<td></td>
<td></td>
<td>Demand Interval in minutes</td>
</tr>
</tbody>
</table>

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<table>
<thead>
<tr>
<th>Reg. No.</th>
<th>Name</th>
<th>Units</th>
<th>Range</th>
<th>Description</th>
</tr>
</thead>
</table>
| 2080    | Energy Accum.                              | None  | 0 or 1| Portable circuit monitor Energy Accumulation Mode Selections Bit map. Bit 1 indicates real & reactive method:  
a 0 indicates absolute  
a 1 indicates signed                                           |
| 2081    | Operating Mode                             | None  | 0 to 7F| Portable circuit monitor Operating Mode Selections Bit map. Bit 1 indicates real & reactive energy accumulation method:  
0 indicates absolute (default)  
1 indicates signed  
Bit 2 indicates Reactive Energy and Demand accumulation method:  
0 specifies fundamental only (default)  
1 specifies to include harmonic cross products - (displacement & distortion)  
Bit 3 indicates VAr/PF sign convention:  
0 indicates CM1 convention (default)  
1 indicates alternate convention  
Bit 4 indicates Demand Power calculation method:  
0 indicates Thermal Demand (default)  
1 indicates a Block/Rolling Interval Demand  
Bit 5 indicates external power demand synch. driver source if applicable:  
0 Specifies Input 1 as the source (default)  
1 Specifies Command Interface as the source  
Bit 6 indicates which mechanism controls cond. energy  
0 indicates status inputs (default)  
1 indicates command I/F  
Bit 7 indicates status of conditional energy accumulation:  
0 indicates Cond Energy Accum is off (default)  
1 indicates Cond Energy Accum is on  
Bit 8 is unused.  
Bit 9 indicates status of Unit #1 response to enquire  
0 indicates response is enabled (default)  
1 indicates response is disabled  
Bit 10 indicates whether front comm port is enabled  
0 indicates front comm port is enabled (default)  
1 indicates front comm port is disabled  
Bit 11 indicates whether front panel setup is enabled  
0 indicates front panel setup is enabled (default)  
1 indicates front panel setup is disabled  
Bit 12 indicates status of log and wfc files master enable  
0 indicates files are enabled (default)  
1 indicates files are disabled  
All other bits are unused. |
| 2085    | Square D Product I.D. Number               | None  | 0 to 3000| Square D Product I.D. Number equal to:  
460 for 2050  
461 for 2150  
462 for 2250  
463 for 2350  
464 for 2450  
465 for 2452 |
### Appendix C—Abbreviated Register Listing

<table>
<thead>
<tr>
<th>Reg. No.</th>
<th>Name</th>
<th>Units</th>
<th>Range</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>2091</td>
<td>Prior PLOS Rev. Sub-Level</td>
<td>None</td>
<td>0 to 9999</td>
<td>Prior PLOS revision sublevel before last firmware download. Zero if not applicable.</td>
</tr>
<tr>
<td>2092</td>
<td>Prior PLOS Revision Level</td>
<td>None</td>
<td>01:00 to 99:99</td>
<td>Prior PLOS revision level before last firmware download. Zero if not applicable.</td>
</tr>
<tr>
<td>2093</td>
<td>PLOS Rev. Sublevel</td>
<td>None</td>
<td>0 to 9999</td>
<td>PLOS revision sublevel—used for diagnostic purposes only</td>
</tr>
<tr>
<td>2094</td>
<td>Firmware Revision Level</td>
<td>None</td>
<td>01:00 to 99:99</td>
<td>Firmware Revision Level in decimal. The first two digits after the equal sign represent the revision of the reset/boot code. The last two digits represent the revision of the downloadable PLOS code.</td>
</tr>
</tbody>
</table>

#### REGISTERS 2300–2341
Registers 2300–2341 apply to portable circuit monitor models CM-2350 and higher only.

<table>
<thead>
<tr>
<th>Reg. No.</th>
<th>Name</th>
<th>Units</th>
<th>Range</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>2300</td>
<td>Last Voltage A Swell Extreme Value</td>
<td>Units/Scale Factor D</td>
<td>0–32767</td>
<td>Voltage A swell extreme value</td>
</tr>
<tr>
<td>2301–2302</td>
<td>Last Voltage A Swell Event Duration</td>
<td>Cycles</td>
<td>1–99999999</td>
<td>Voltage A swell event duration</td>
</tr>
<tr>
<td>2303</td>
<td>Last Voltage B Swell Extreme Value</td>
<td>Volts/Scale Factor D</td>
<td>0–32767</td>
<td>Voltage B swell extreme value</td>
</tr>
<tr>
<td>2304–2305</td>
<td>Last Voltage B Swell Event Duration</td>
<td>Cycles</td>
<td>1–99999999</td>
<td>Voltage B swell event duration</td>
</tr>
<tr>
<td>2306</td>
<td>Last Voltage C Swell Extreme Value</td>
<td>Volts/Scale Factor D</td>
<td>0–32767</td>
<td>Voltage C swell extreme value</td>
</tr>
<tr>
<td>2307–2308</td>
<td>Last Voltage C Swell Event Duration</td>
<td>Cycles</td>
<td>1–99999999</td>
<td>Voltage C swell event duration</td>
</tr>
<tr>
<td>2309</td>
<td>Last Current A Swell Extreme Value</td>
<td>Amps/Scale Factor A</td>
<td>0–32767</td>
<td>Current A swell extreme value</td>
</tr>
<tr>
<td>2310–2311</td>
<td>Last Current A Swell Event Duration</td>
<td>Cycles</td>
<td>1–99999999</td>
<td>Current A swell event duration</td>
</tr>
<tr>
<td>2312</td>
<td>Last Current B Swell Extreme Value</td>
<td>Amps/Scale Factor A</td>
<td>0–32767</td>
<td>Current B swell extreme value</td>
</tr>
<tr>
<td>2313–2314</td>
<td>Last Current B Swell Event Duration</td>
<td>Cycles</td>
<td>1–99999999</td>
<td>Current B swell event duration</td>
</tr>
<tr>
<td>2315</td>
<td>Last Current C Swell Extreme Value</td>
<td>Amps/Scale Factor A</td>
<td>0–32767</td>
<td>Current C swell extreme value</td>
</tr>
<tr>
<td>2316–2317</td>
<td>Last Current C Swell Event Duration</td>
<td>Cycles</td>
<td>1–99999999</td>
<td>Current C swell event duration</td>
</tr>
<tr>
<td>2318</td>
<td>Last Current N Swell Extreme Value</td>
<td>Amps/Scale Factor B</td>
<td>0–32767</td>
<td>Current N swell extreme value</td>
</tr>
<tr>
<td>2319–2320</td>
<td>Last Current N Swell Event Duration</td>
<td>Cycles</td>
<td>1–99999999</td>
<td>Current N swell event duration</td>
</tr>
<tr>
<td>2321</td>
<td>Last Voltage A Sag Extreme Value</td>
<td>Volts/Scale Factor D</td>
<td>0–32767</td>
<td>Voltage A sag extreme value</td>
</tr>
<tr>
<td>2322–2323</td>
<td>Last Voltage A Sag Event Duration</td>
<td>Cycles</td>
<td>1–99999999</td>
<td>Voltage A sag event duration</td>
</tr>
<tr>
<td>2324</td>
<td>Last Voltage B Sag Extreme Value</td>
<td>Volts/Scale Factor D</td>
<td>0–32767</td>
<td>Voltage B sag event duration</td>
</tr>
<tr>
<td>2325–2326</td>
<td>Last Voltage B Sag Event Duration</td>
<td>Cycles</td>
<td>1–99999999</td>
<td>Voltage B sag event duration</td>
</tr>
<tr>
<td>2327</td>
<td>Last Voltage C Sag Extreme Value</td>
<td>Volts/Scale Factor D</td>
<td>0–32767</td>
<td>Voltage C sag event duration</td>
</tr>
<tr>
<td>2328–2329</td>
<td>Last Voltage C Sag Event Duration</td>
<td>Cycles</td>
<td>1–99999999</td>
<td>Voltage C sag event duration</td>
</tr>
<tr>
<td>2330</td>
<td>Last Current A Sag Extreme Value</td>
<td>Amps/Scale Factor A</td>
<td>0–32767</td>
<td>Current A sag extreme value</td>
</tr>
<tr>
<td>2331–2332</td>
<td>Last Current A Sag Event Duration</td>
<td>Cycles</td>
<td>1–99999999</td>
<td>Current A sag event duration</td>
</tr>
<tr>
<td>2333</td>
<td>Last Current B Sag Extreme Value</td>
<td>Amps/Scale Factor A</td>
<td>0–32767</td>
<td>Current B sag event duration</td>
</tr>
<tr>
<td>2334–2335</td>
<td>Last Current B Sag Event Duration</td>
<td>Cycles</td>
<td>1–99999999</td>
<td>Current B sag event duration</td>
</tr>
<tr>
<td>2336</td>
<td>Last Current C Sag Extreme Value</td>
<td>Amps/Scale Factor A</td>
<td>0–32767</td>
<td>Current C sag event duration</td>
</tr>
<tr>
<td>2337–2338</td>
<td>Last Current C Sag Event Duration</td>
<td>Cycles</td>
<td>1–99999999</td>
<td>Current C sag event duration</td>
</tr>
<tr>
<td>2339</td>
<td>Last Current N Sag Extreme Value</td>
<td>Amps/Scale Factor B</td>
<td>0–32767</td>
<td>Current N sag extreme value</td>
</tr>
<tr>
<td>2340–2341</td>
<td>Last Current N Sag Event Duration</td>
<td>Cycles</td>
<td>1–99999999</td>
<td>Current N sag event duration</td>
</tr>
</tbody>
</table>
### ANALOG OUTPUT CONFIGURATION REGISTERS

<table>
<thead>
<tr>
<th>Reg. No.</th>
<th>Name</th>
<th>Units</th>
<th>Range</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>2600-2601</td>
<td>Analog Output 1 Label</td>
<td>None</td>
<td>Alphanumeric (4 chars)</td>
<td>A four character label used to identify this output.</td>
</tr>
<tr>
<td>2602</td>
<td>Analog Output 1 Enable</td>
<td>None</td>
<td>0 or 1</td>
<td>Enables or disables this output. 0 = Off; 1 = On.</td>
</tr>
<tr>
<td>2603</td>
<td></td>
<td>None</td>
<td>Any valid reg</td>
<td>The portable circuit monitor register number assigned to analog output.</td>
</tr>
<tr>
<td>2604</td>
<td>Analog Output 1 Lower Limit</td>
<td>None</td>
<td>-32767 to Upper Limit</td>
<td>The register value that is equivalent to the minimum output current (0 or 4 mA).</td>
</tr>
<tr>
<td>2605</td>
<td>Analog Output 1 Upper Limit</td>
<td>None</td>
<td>Lower Limit to 32,767</td>
<td>The register value that is equivalent to the maximum output current (1 mA or 20 mA).</td>
</tr>
</tbody>
</table>

(The description for registers 2608–2613 is the same as 2600–2605)

2608–2609 Analog Output 2 Label
2610 Analog Output 2 Enable
2611 Analog Output 2 Register Number
2612 Analog Output 2 Lower Limit
2613 Analog Output 2 Upper Limit

(The description for registers 2616–2621 is the same as 2600–2605)

2616–2617 Analog Output 3 Label
2618 Analog Output 3 Enable
2619 Analog Output 3 Register Number
2620 Analog Output 3 Lower Limit
2621 Analog Output 3 Upper Limit

(The description for registers 2624–2629 is the same as 2600–2605)

2624–2625 Analog Output 4 Label
2626 Analog Output 4 Enable
2627 Analog Output 4 Register Number
2628 Analog Output 4 Lower Limit
2629 Analog Output 4 Upper Limit

### ANALOG INPUT CONFIGURATION REGISTERS

<table>
<thead>
<tr>
<th>Reg. No.</th>
<th>Name</th>
<th>Units</th>
<th>Range</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>2700–2702</td>
<td>Analog Input 1 Units</td>
<td>None</td>
<td>Alphanumeric (6 chars)</td>
<td>A six character label used to identify this input.</td>
</tr>
<tr>
<td>2703</td>
<td>Analog Input 1 Precision</td>
<td>None</td>
<td>-3 to +3</td>
<td>The precision of the measured analog value.</td>
</tr>
<tr>
<td>2704</td>
<td>Analog Input 1 Input Type</td>
<td>None</td>
<td>0 or 1</td>
<td>Specifies whether the input is wired to a 0-5 V source, or a 4-20 mA source using the internal 250 ohm resistor. 0 = 0-5; 1 = 4-20.</td>
</tr>
<tr>
<td>2705</td>
<td>Analog Input 1 Offset Voltage</td>
<td>in 100ths</td>
<td>0 to 500</td>
<td>The lowest input voltage (in hundredths of a volt) that represents a valid reading. When the input voltage is equal to this value, the portable circuit monitor reports the <em>lower limit</em>, defined in register 2706.</td>
</tr>
</tbody>
</table>
### Appendix C—Abbreviated Register Listing

<table>
<thead>
<tr>
<th>Reg. No.</th>
<th>Name</th>
<th>Units</th>
<th>Range</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>2706</td>
<td>Analog Input 1 Lower Limit</td>
<td>None</td>
<td>-32767 to Upper Limit</td>
<td>The value the portable circuit monitor reports when the input voltage is equal to the offset voltage, defined in register 2705.</td>
</tr>
<tr>
<td>2707</td>
<td>Analog Input 1 Upper Limit</td>
<td>None</td>
<td>Lower Limit to 32767</td>
<td>The value the portable circuit monitor reports when the input voltage is equal to 5 volts (the maximum input voltage)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(The description for registers 2710–2717 is the same as 2700–2707)</td>
</tr>
<tr>
<td>2710–2712</td>
<td>Analog Input 2 Units</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2713</td>
<td>Analog Input 2 Precision</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2714</td>
<td>Analog Input 2 Input Type</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2715</td>
<td>Analog Input 2 Offset Voltage</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2716</td>
<td>Analog Input 2 Lower Limit</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2717</td>
<td>Analog Input 2 Upper Limit</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(The description for registers 2720–2727 is the same as 2700–2707)</td>
</tr>
<tr>
<td>2720–2722</td>
<td>Analog Input 3 Units</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2723</td>
<td>Analog Input 3 Precision</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2724</td>
<td>Analog Input 3 Input Type</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2725</td>
<td>Analog Input 3 Offset Voltage</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2726</td>
<td>Analog Input 3 Lower Limit</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2727</td>
<td>Analog Input 3 Upper Limit</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(The description for registers 2730–2737 is the same as 2700–2707)</td>
</tr>
<tr>
<td>2730–2732</td>
<td>Analog Input 4 Units</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2733</td>
<td>Analog Input 4 Precision</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2734</td>
<td>Analog Input 4 Input Type</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2735</td>
<td>Analog Input 4 Offset Voltage</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2736</td>
<td>Analog Input 4 Lower Limit</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2737</td>
<td>Analog Input 4 Upper Limit</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**NOTE**

Registers 2898–2999 apply to portable circuit monitor models CM-2150 and higher only.

<table>
<thead>
<tr>
<th>Reg. No.</th>
<th>Name</th>
<th>Units</th>
<th>Range</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>2898</td>
<td>Pulse Demand Interval Mode</td>
<td>None</td>
<td>0 to 3</td>
<td>0=Slave to power demand interval (must be block interval mode) 1=Slave to incremental energy interval 2=Synch to status input 1 3=Ext comms synch to command interface</td>
</tr>
<tr>
<td>2899</td>
<td>No. of Pulse Demand Intervals</td>
<td>None</td>
<td>0 to 32,767</td>
<td></td>
</tr>
<tr>
<td>2900</td>
<td>Channel 1 Status Input Pulse Demand Bit Map</td>
<td>None</td>
<td>0 to FF</td>
<td>Demand meter bit map specifying which status inputs totalize for this demand channel. Bit 0 represents input 1, etc. Bit 0 represents input 1, etc. 0=exclude 1=include Default value is 0.</td>
</tr>
</tbody>
</table>
### PORTABLE CIRCUIT MONITOR UTILITY REGISTERS

<table>
<thead>
<tr>
<th>Reg. No.</th>
<th>Name</th>
<th>Units</th>
<th>Range</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>2901–2903</td>
<td>Utility Registers</td>
<td>None</td>
<td>-32,767 to +32,767</td>
<td>Utility registers can be defined by custom application software as storage locations for pulse constant, scale factor, unit code, or other.</td>
</tr>
<tr>
<td>2904</td>
<td>Present Interval Pulse Count Channel 1</td>
<td>Counts</td>
<td>0 to 32,767</td>
<td>Total number of pulses counted on all specified inputs during present demand interval on this channel.</td>
</tr>
<tr>
<td>2905</td>
<td>Last Interval Pulse Count Channel 1</td>
<td>Counts</td>
<td>0 to 32,767</td>
<td>Total number of pulses counted during the last completed interval on this channel.</td>
</tr>
<tr>
<td>2906</td>
<td>Peak Interval Pulse Count Channel 1</td>
<td>Counts</td>
<td>0 to 32,767</td>
<td>Peak value of last interval pulse count on this channel since last demand reset.</td>
</tr>
<tr>
<td>2907–2909</td>
<td>Date/Time of Peak Interval Pulse Count Channel 1</td>
<td>Month, Day, Yr., Hr., Min., Sec.</td>
<td>Same as Regs. No.1800–1802</td>
<td>Date/time of peak interval pulse count since last reset.</td>
</tr>
<tr>
<td>2910–2919</td>
<td>(The definitions for registers 2910–2919 are the same as for 2900–2909, except that they apply to channel 2.)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2920–2929</td>
<td>(The definitions for registers 2920–2929 are the same as for 2900–2909, except that they apply to channel 3.)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2930–2939</td>
<td>(The definitions for registers 2930–2939 are the same as for 2900–2909, except that they apply to channel 4.)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2940–2949</td>
<td>(The definitions for registers 2940–2949 are the same as for 2900–2909, except that they apply to channel 5.)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2950–2959</td>
<td>(The definitions for registers 2950–2959 are the same as for 2900–2909, except that they apply to channel 6.)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2960–2969</td>
<td>(The definitions for registers 2960–2969 are the same as for 2900–2909, except that they apply to channel 7.)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2970–2979</td>
<td>(The definitions for registers 2970–2979 are the same as for 2900–2909, except that they apply to channel 8.)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2980–2989</td>
<td>(The definitions for registers 2980–2989 are the same as for 2900–2909, except that they apply to channel 9.)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2990–2999</td>
<td>(The definitions for registers 2990–2999 are the same as for 2900–2909, except that they apply to channel 10.)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### PORTABLE CIRCUIT MONITOR UTILITY REGISTERS

<table>
<thead>
<tr>
<th>Reg. No.</th>
<th>Description</th>
<th>Reg. No.</th>
<th>Description</th>
<th>Reg. No.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>5611</td>
<td>Event Counter No. 201</td>
<td>5622</td>
<td>Event Counter No. 212</td>
<td>5789</td>
<td>Event Counter No. 10</td>
</tr>
<tr>
<td>5612</td>
<td>Event Counter No. 202</td>
<td>5623</td>
<td>Event Counter No. 213</td>
<td>5790</td>
<td>Event Counter No. 11</td>
</tr>
<tr>
<td>5613</td>
<td>Event Counter No. 203</td>
<td>5624</td>
<td>Event Counter No. 214</td>
<td>5791</td>
<td>Event Counter No. 12</td>
</tr>
<tr>
<td>5614</td>
<td>Event Counter No. 204</td>
<td>5780</td>
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These read/write registers can be used by the application programmer as required. They are saved in non-volatile memory when the portable circuit monitor loses control power.
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NOTE

Registers 4000–4447 apply to portable circuit monitor models CM-2350 and higher only.

**SPECTRAL COMPONENTS**

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**Phase A Current**

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**Phase B Voltage**

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**Phase C Voltage**

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### Appendix C—Abbreviated Register Listing

<table>
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**Phase C Current**

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<th>Range</th>
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<td>H21 angle with reference to H21 Va angle</td>
<td>In 10ths of degrees</td>
<td>0</td>
</tr>
<tr>
<td>4364</td>
<td>H22 magnitude as a percent of H1 magnitude</td>
<td>% in 100ths</td>
<td>0 to 32767</td>
</tr>
<tr>
<td>4365</td>
<td>H22 angle with reference to H22 Va angle</td>
<td>In 10ths of degrees</td>
<td>0</td>
</tr>
<tr>
<td>4366</td>
<td>H23 magnitude as a percent of H1 magnitude</td>
<td>% in 100ths</td>
<td>0 to 32767</td>
</tr>
<tr>
<td>4367</td>
<td>H23 angle with reference to H23 Va angle</td>
<td>In 10ths of degrees</td>
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<tr>
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<td>H24 magnitude as a percent of H1 magnitude</td>
<td>% in 100ths</td>
<td>0 to 32767</td>
</tr>
<tr>
<td>4369</td>
<td>H24 angle with reference to H24 Va angle</td>
<td>In 10ths of degrees</td>
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<td>4370</td>
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<td>% in 100ths</td>
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</tr>
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<td>H26 magnitude as a percent of H1 magnitude</td>
<td>% in 100ths</td>
<td>0 to 32767</td>
</tr>
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<td>% in 100ths</td>
<td>0 to 32767</td>
</tr>
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<td>In 10ths of degrees</td>
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<td>% in 100ths</td>
<td>0 to 32767</td>
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<td>% in 100ths</td>
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<td>4382</td>
<td>H31 magnitude as a percent of H1 magnitude</td>
<td>% in 100ths</td>
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</tr>
<tr>
<td>4383</td>
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<td>In 10ths of degrees</td>
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**Neutral Current**

<table>
<thead>
<tr>
<th>Reg. No.</th>
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<th>Units</th>
<th>Range</th>
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</thead>
<tbody>
<tr>
<td>4384-4385</td>
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</tr>
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<td>% in 100ths</td>
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<td>H11 angle with reference to H1 Va angle</td>
<td>In 10ths of degrees</td>
<td>0</td>
</tr>
<tr>
<td>4388</td>
<td>H12 magnitude as a percent of H1 magnitude</td>
<td>% in 100ths</td>
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</tr>
<tr>
<td>4389</td>
<td>H12 angle with reference to H2 Va angle</td>
<td>In 10ths of degrees</td>
<td>0</td>
</tr>
<tr>
<td>4390</td>
<td>H13 magnitude as a percent of H1 magnitude</td>
<td>% in 100ths</td>
<td>0 to 32767</td>
</tr>
<tr>
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</tr>
<tr>
<td>4392</td>
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<td>% in 100ths</td>
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</tr>
<tr>
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</tr>
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<td>% in 100ths</td>
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<td>% in 100ths</td>
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<td>% in 100ths</td>
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<td>% in 100ths</td>
<td>0 to 32767</td>
</tr>
<tr>
<td>Reg. No.</td>
<td>Description</td>
<td>Units</td>
<td>Range</td>
</tr>
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<td>---------</td>
<td>-------------------------------------------------------</td>
<td>-----------------</td>
<td>--------</td>
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</tr>
<tr>
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</tr>
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<td>% in 100ths</td>
<td>0 to 32767</td>
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<td>% in 100ths</td>
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<td>% in 100ths</td>
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<td>% in 100ths</td>
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</tr>
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<td>4418</td>
<td>H17 magnitude as a percent of H1 magnitude</td>
<td>% in 100ths</td>
<td>0 to 32767</td>
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<tr>
<td>4419</td>
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<td>% in 100ths</td>
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<td>In 10ths of degrees</td>
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<td>% in 100ths</td>
<td>0 to 32767</td>
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<td>% in 100ths</td>
<td>0 to 32767</td>
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</tr>
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<td>4427</td>
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<td>% in 100ths</td>
<td>0 to 32767</td>
</tr>
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<td>% in 100ths</td>
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<td>% in 100ths</td>
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<td>% in 100ths</td>
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<tr>
<td>4439</td>
<td>H27 angle with reference to H27 Va angle</td>
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<td>4440</td>
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<td>% in 100ths</td>
<td>0 to 32767</td>
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<td>% in 100ths</td>
<td>0 to 32767</td>
</tr>
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<td>4443</td>
<td>H29 angle with reference to H29 Va angle</td>
<td>In 10ths of degrees</td>
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</tr>
<tr>
<td>4444</td>
<td>H30 magnitude as a percent of H1 magnitude</td>
<td>% in 100ths</td>
<td>0 to 32767</td>
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<td>4445</td>
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<td>In 10ths of degrees</td>
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<td>4446</td>
<td>H31 magnitude as a percent of H1 magnitude</td>
<td>% in 100ths</td>
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</tr>
<tr>
<td>4447</td>
<td>H31 angle with reference to H31 Va angle</td>
<td>In 10ths of degrees</td>
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**APPENDIX D—SPECIFICATIONS**

**Metering Specifications**

<table>
<thead>
<tr>
<th>Specification</th>
<th>Details</th>
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<tbody>
<tr>
<td><strong>Current Inputs (Each Channel)</strong></td>
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</tr>
<tr>
<td>Current Range</td>
<td>0–7.4 A ac</td>
</tr>
<tr>
<td>Nominal Current</td>
<td>5 A ac</td>
</tr>
<tr>
<td><strong>Voltage Inputs (Each Channel)</strong></td>
<td></td>
</tr>
<tr>
<td>Voltage Range</td>
<td>0–600 Vac</td>
</tr>
<tr>
<td>Frequency Range</td>
<td>23 to 65 Hz</td>
</tr>
<tr>
<td><strong>Harmonic Response—Phase Voltages and Currents</strong></td>
<td></td>
</tr>
<tr>
<td>Frequency 23 Hz to 67 Hz</td>
<td>31st Harmonic</td>
</tr>
<tr>
<td><strong>Data Update Rate</strong></td>
<td>1 second typical</td>
</tr>
<tr>
<td><strong>Accuracy</strong></td>
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</tr>
<tr>
<td>Current</td>
<td>±0.20% reading + 0.05% full scale</td>
</tr>
<tr>
<td>Voltage</td>
<td>±0.20% reading + 0.05% full scale</td>
</tr>
<tr>
<td>Power</td>
<td>±0.40% reading + 0.05% full scale</td>
</tr>
<tr>
<td>True Power Factor</td>
<td>±1% (0.5 lag to 0.5 lead)</td>
</tr>
<tr>
<td>Displacement Power Factor</td>
<td>±1% (0.5 lag to 0.5 lead)</td>
</tr>
<tr>
<td>Energy</td>
<td>±0.40%</td>
</tr>
<tr>
<td>Demand</td>
<td>±0.40%</td>
</tr>
<tr>
<td>Frequency 50/60 Hz</td>
<td>±0.01 Hz</td>
</tr>
<tr>
<td>Temperature (Unit Temperature –25°C to 75°C)</td>
<td>±1°C</td>
</tr>
<tr>
<td>Time of Day Clock (At 25°C)</td>
<td>±1.5 second in 24 hours</td>
</tr>
<tr>
<td>THD</td>
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<tr>
<td>K-Factor</td>
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<tr>
<td>Crest Factor</td>
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**Metering Input**

**Electrical Specifications**

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<tbody>
<tr>
<td>Current Inputs</td>
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</tr>
<tr>
<td>Nominal Full Scale</td>
<td>5.0 Amps rms</td>
</tr>
<tr>
<td>Metering Over-range</td>
<td>145%</td>
</tr>
<tr>
<td>Overcurrent Withstand</td>
<td>15 A rms Continuous</td>
</tr>
<tr>
<td></td>
<td>50 A rms 10 seconds in 1 hour</td>
</tr>
<tr>
<td></td>
<td>500 A rms 1 second in 1 hour</td>
</tr>
<tr>
<td>Input Impedance</td>
<td>Less than 0.1 Ohm</td>
</tr>
<tr>
<td>Burden</td>
<td>Less than 0.15 VA</td>
</tr>
<tr>
<td>Isolation</td>
<td>1500 V, 1 MIN</td>
</tr>
<tr>
<td>Voltage Inputs</td>
<td></td>
</tr>
<tr>
<td>Nominal Full Scale</td>
<td>600 Vac Line-to-Line</td>
</tr>
<tr>
<td>Metering Over-range</td>
<td>150%</td>
</tr>
<tr>
<td>Dielectric Withstand</td>
<td>600 V Continuous</td>
</tr>
<tr>
<td>Input Impedance</td>
<td>Greater than 2 Megohm</td>
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</tbody>
</table>
Control Power Input Specifications

120 Vac Nominal

Environmental Specifications

Operating Temperature ............................................................... –25 to +70°C
Storage Temperature .................................................................. –40 to +85°C
Humidity Rating ................................................................. 5–95% Relative Humidity (non-condensing)
Optional Modem requires:
    Operating Temperature .......................................................... 10 to +40°C
    Storage Temperature ................................................................. 1 to +60°C
    Humidity Rating .................................................. 8-80%RH(non-condensing)

Physical Specification

Weight (approximate, without add-on modules) ..................... 22 lbs.
Weight (with modem and input/output module) ...................... 28 lbs.
Dimensions ................................................................. 12"x14"x8.5"
APPENDIX E—CALCULATING LOG FILE SIZES

This appendix tells how to calculate the approximate size of log files. To see if the log files you’ve set up will fit in the available logging memory, calculate the size of each event log, data log, waveform capture log, and 12-cycle event capture log using the worksheet on the following page. Then sum all log files to find the total space required. The total space required must be smaller than the numbers listed below:

- **CM-2150** and **CM-2250**—Sum of event log file and all data log files must be smaller than 5632.
- **CM-2350** and **CM-2450**—Sum of event log file, waveform capture log file, 12-cycle event capture, and all data log files must be smaller than 51,200.
- **CM-2452**—Sum of event log file, waveform capture log file, 12-cycle event capture, and all data log files must be smaller than 182,272.

**NOTE**

The log file worksheet will provide a close approximation of the required memory allocation. The memory allocation worksheet results may differ slightly from actual memory allocation requirements.
Calculate the Size of the Event Log File
1. Multiply the maximum number of events by 8.

Calculate the Sizes of the Data Log Files
Repeat steps 2–7 for each data log file.
2. Multiply the number of cumulative energy readings by 4.
3. Multiply the number of incremental energy readings by 3.
4. Enter the number of non-energy meter readings.
5. Add lines 2, 3, and 4.
6. Add 3 to the value on line 5. (For date/time of each entry.)
7. Multiply line 6 by the maximum number of records in the data log file. Enter the result in the data log box to the left.
8. Repeat steps 2–7 for each data log file.
9. Total all data log files and enter the result here.

Calculate the Size of the Waveform Capture Log File
10. For CM-2350s and higher only, multiply the maximum number of waveform captures by 2,560. For CM-2150s and CM-2250s enter zero here.\(^a\)

Calculate the Size of the 12-Cycle Event Capture Log File
11. For CM-2350s and higher only, multiply the maximum number of 12-cycle event captures by 6,400. For CM-2150s and CM-2250s enter zero here.\(^a\)

Total All Log Files
12. Add lines 1, 9, 10, and 11. For CM-2150s and CM-2250s, the total cannot exceed 5632. For CM-2350s and CM-2450s, the total cannot exceed 51,200. For CM-2452s, the total cannot exceed 182,272.

\(^a\) The CM-2150 does not provide waveform capture. The CM-2250 can store one 4-cycle waveform capture and one 12-cycle event capture, but these are stored in separate memory locations and do not affect the amount of memory available for event and data logging.
APPENDIX G—USING THE OPTICAL COMMUNICATIONS INTERFACE

GENERAL

All Series 2000 portable circuit monitors are equipped with a front panel optical communications port. A portable computer, equipped with POWER-LOGIC software, can communicate through the optical port using a POWER-LOGIC Optical Communications Interface (Class 3090 Type OCI-2000). Any communications that can be done over the RS-485 communications link—including portable circuit monitor setup and firmware upgrades—can also be done through the optical communications port using the OCI-2000. This appendix tells how to use the OCI-2000.

The OCI-2000 mounts magnetically to the portable circuit monitor and provides a standard 9-pin RS-232 interface. The 9-pin connector at the end of the OCI-2000’s 10 foot cable, plugs into the serial port on a personal computer. If the computer has a 25-pin serial port, but no 9-pin serial port, you’ll need a 9-pin to 25-pin serial converter (not supplied with the OCI-2000).

The OCI-2000 is powered by a standard 9 volt alkaline battery, or by a 9 volt/100mA dc converter that plugs into a standard 120 Vac receptacle. The battery and dc converter are not supplied with the OCI-2000. Use a 9 volt/100mA dc converter with a 3.5 millimeter mono jack.

ATTACHING THE OCI-2000 TO THE PCM

Position the OCI-2000 so that the optical sensors on the OCI-2000 line up with the optical port on the portable circuit monitor. To do this, place the OCI-2000 in the lower left-hand corner of the portable circuit monitor front panel, so that the bottom edge of the OCI-2000 butts up flat against the inside, bottom edge of the portable circuit monitor bezel. Figure G-1 shows the correct placement of the OCI-2000. The OCI-2000 is shown in grey.

USING THE OCI-2000

To use the OCI-2000, complete the following steps:

1. Connect the OCI-2000 cable to the serial port of your computer.
2. Supply the OCI-2000 with power (using either a 9 volt battery or a 9 volt dc converter).
3. Attach the OCI-2000 to the portable circuit monitor as described above.
4. Turn the OCI-2000 on.

The OCI-2000 has a two-position power switch: |=On and O=Off.

After completing steps 1 to 4 above, you should be able to communicate to the portable circuit monitor using POWERLOGIC software. If you cannot communicate, see troubleshooting on the following page.
TROUBLESHOOTING

If you are unable to communicate with the portable circuit monitor via the OCI-2000, perform the following checks:

1. Check to see that the OCI-2000 cable is securely connected to the computer’s serial port.
2. Check to see that the OCI-2000 power switch is in the On (|) position.
3. Check to see that the OCI-2000 is properly placed as shown in figure J-1.
4. If using a 9 volt DC adapter, check to see that the jack is plugged all the way into the OCI-2000.
5. If using a battery, replace it with a fresh 9 volt alkaline battery.

![Diagram of OCI-2000 placement](image)

*Figure G-1: Correct placement of the OCI-2000*