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LaVergne, TN, USA

Instruction Bulletin

POWERLOGIC® Circuit Monitor

Series 4000T

Reference Manual

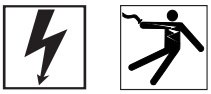
Retain for future use

Merlin Gerin
Modicon
Square D
Telemecanique

Schneider Electric

NOTICE

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



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

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

⚠ DANGER

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

⚠WARNING

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

⚠CAUTION

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

CAUTION

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

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

PLEASE NOTE

Electrical equipment should be installed, operated, serviced, and maintained only by qualified personnel. This document is not intended as an instruction manual for untrained persons. No responsibility is assumed by Square D for any consequences arising out of the use of this manual.

Class A FCC Statement

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

CONTENTS

CHAPTER 1—INTRODUCTION

This chapter offers a general description of the Series 4000 Transient Circuit Monitor (CM4000T), tells how to use this bulletin, and lists related documents.

CHAPTER CONTENTS

WHAT IS THE TRANSIENT CIRCUIT MONITOR?

The CM4000T circuit monitor has the same metering capabilities as the standard CM4000. However, it has the ability to detect and capture sub-microsecond voltage transients up to a peak voltage of 10,000 volts (L-L). It accomplishes this by using the transient version of the current/voltage module. The transient detection module, or CVMT, contains the entire front end of the meter necessary to perform both standard metering, as defined by the CM4000 (refer to the Circuit Monitor Series 4000 installation and reference manuals), and the high-speed data acquisition necessary to perform high-speed impulsive voltage transient detection.

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

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

The circuit monitor is a true rms meter capable of exceptionally accurate measurement of highly nonlinear loads. A sophisticated sampling technique enables accurate, true rms measurement through the 255th harmonic. You can view over 50 metered values plus extensive minimum and maximum data from the display or remotely (using software). With the CVMT attached, you can capture, store, and view sub-microsecond voltage events; and you can log voltage transient peak, average voltage, rise time, and duration. Table 1–1 on page 3 summarizes the readings available from the circuit monitor with a CVMT.

Table 1–1: Summary of Circuit Monitor Instrumentation

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

Accessories and Options for the Transient Circuit Monitor

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

- **Current/voltage transient module (CVMT)**. A standard part of the CM4000T and an optional accessory for the CM4000. This is where all metering data acquisition occurs.
- **Remote display**. The optional remote 4-line display is available with a back-lit Liquid Crystal Display (LCD) or a Vacuum Fluorescent Display (VFD). The VFD model includes an infrared port that can be used to communicate directly with the circuit monitor from a laptop and can be used to download firmware, which keeps the circuit monitor up to date with the latest system enhancements.
- **I/O Extender**. The I/O extender, located on the side of the circuit monitor, enables you to “plug in” up to 8 industry-standard inputs and outputs. Several preconfigured combinations are available, or you can create a custom configuration.
- **Digital I/O Card**. You can further expand the I/O capabilities of the circuit monitor by adding a digital I/O card (4 inputs and 4 outputs). This card fits into one of the option slots on the top of the circuit monitor.
- **Ethernet Communications Card**. The Ethernet communications card provides an Ethernet port that accepts a 100 Mbps fiber optic cable or a 10/100 Mbps UTP and provides an RS-485 master port to extend the circuit monitor communications options. This card is easily installed into option slot A on the top of the circuit monitor.

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

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

Description	Part Number	Instruction Bulletin
Circuit Monitor	CM4000	63230-300-200
Circuit Monitor Transient	CM4000T	63230-300-216
Current/Voltage Transient Module	CVMT	63230-312-201
VFD Display with infrared (IR) port and proximity sensor	CMDVF	63230-305-200
LCD Display	CMDLC	
Optical Communications Interface (for use with the VFD display only)	OCIVF	63230-306-200
I/O Extender Module ①		63230-302-200
with no preinstalled I/Os, accepts up to 8 individual I/O modules with a maximum of 4 analog I/Os	IOX	
with 4 digital inputs (32 Vdc), 2 digital outputs (60 Vdc), 1 analog output (4–20 mA), and 1 analog input (0–5 Vdc)	IOX2411	
with 4 analog inputs (4–20 mA) and 4 digital inputs (120 Vac)	IOX0404	
with 8 digital inputs (120 Vac)	IOX08	
Digital I/O Card Field-installable with 4 digital inputs (120 Vac), 3 (10 A) relay outputs (120Vac), 1 pulse output (KYZ)	IOC44	63230-303-200
Ethernet Communications Card with 100 Mbps fiber or 10/100 Mbps UTP Ethernet port and 1 RS-485 master port	ECC21	63230-304-200
Optical Communications Interface	OCIVG	63230-306-200
Memory Expansion Kit (16 MB and 32 MB kits)	CM4MEM16M CM4MEM32M	63230-300-205
CM4 Mounting Adapter Kit	CM4MA	63230-204-316 63230-300-206 63230-305-201
4-ft display cable (1.2 m)	CAB-4	N/A
12-ft display cable (3.6 m)	CAB-12	
30-ft display cable (9.1 m)	CAB-30	
10-ft RS-232 cable (3 m)	CAB-106	

① For parts list of individual inputs and outputs, see Table 5–1 on page 70 of the **POWERLOGIC Circuit Monitor Series 4000 Reference Manual**.

Features

Some of the circuit monitor's many features include:

- True rms metering to the 255th harmonic
- Accepts standard CT and PT inputs
- 600 volt direct connection on metering inputs
- Certified ANSI C12.20 and IEC687, 0.2 class revenue accuracy
- Min/max readings of metered data
- Power quality readings—THD, K-factor, crest factor
- Real-time harmonic magnitudes and angles to the 63rd harmonic
- Current and voltage sag/swell detection and recording
- Impulsive voltage transient (600 ns) detection and recording
- Downloadable firmware
- Easy setup through the optional remote display (password protected) where you can view metered values
- Setpoint-controlled alarm and relay functions
- Onboard alarm and data logging
- Wide operating temperature range –25° to 65°C
- Modular, field-installable digital and analog I/O modules
- Flexible communications—RS-485 and RS-232 communications are standard, optional Ethernet communications card available with fiber optic connection
- Two option card slots for field-installable I/O and Ethernet capabilities
- Standard 8MB onboard logging memory (field-upgradable to 16 MB, 32 MB, and higher)
- CT and PT wiring diagnostics
- Revenue security with utility sealing capability

WHAT ARE TRANSIENTS?

A transient is a disturbance in the electrical system lasting less than one cycle. There are two types of transients: impulsive and oscillatory. An impulsive transient is a sudden, non-power frequency change in the steady state condition of voltage or current that is unidirectional in polarity. Lightning strikes are a common cause of impulsive transients. Oscillatory, also known as switching transients, include both positive and negative polarity values. Energizing capacitor banks will typically result in an oscillatory transient on one or more phases.

Each type of transient is divided into three categories related to the frequencies. Table 1–3 lists the transients and their three categories.

Table 1–3: Transient Categories

Transient Categories	Spectral Components	Duration
Impulsive		
Millisecond (Low Frequency)	0.1 ms rise	> 1 ms
Microsecond (Medium Frequency)	1 µs rise	50 ns to 1 ms
Nanosecond (High Frequency)	5 ns rise	< 50 ns
Oscillatory		
Low Frequency	< 5 kHz	0.3 to 50 ms
Medium Frequency	5 to 500 kHz	5 µs to 20 µs
High Frequency	0.5 to 5 MHz	5 µs

NOTE: Impulsive transients are characterized by their rise-time, amplitude, and duration. Oscillatory transients are characterized by their frequency duration.

Low frequency transients are the most common, followed by medium frequency transients. While damage can be immediate in cases such as lightning, the CM4000T monitors and alerts you to the lower-to-medium frequency transients which can slowly damage components. Early detection of these transients allows you to take action before your components are damaged.

FIRMWARE

This instruction bulletin is written to be used with circuit monitor firmware version 12.040 or higher and CVMT firmware version 10.010 or higher. See “Identifying the Firmware Version” on page 124 of the Circuit Monitor Series 4000 reference manual for instructions on how to determine the firmware version.

TOPICS NOT COVERED IN THIS BULLETIN

Because the CM4000T has the same metering capabilities as the CM4000, the common features and capabilities of the two circuit monitors are not covered in this instruction bulletin. That information is located in the **POWERLOGIC Cicuit Monitor Series 4000 Installation Manual** and the **POWERLOGIC Cicuit Monitor Series 4000 Reference Manual**. This instruction bulletin focuses only on the transient capabilities of the CM4000T or a CM4000 retrofitted with a CVMT. For information about related instruction bulletins, see Table 1–2 on page 4. For instructions on using SMS, refer to the SMS online help and the SMS-3000 Setup Guide.

CHAPTER 2—SAFETY PRECAUTIONS

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

⚠ DANGER

HAZARD OF ELECTRIC SHOCK, BURN, OR EXPLOSION

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

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

CHAPTER 3—OPERATION

This chapter explains how to set up the circuit monitor transient detection module using the display. Some advanced features, such as onboard log configuration, must be set up over the communications link using System Manager Software (SMS). Refer to the SMS instruction bulletin and online help for instructions on setting up advanced features not accessible from the display.

The CM4000T is functionally identical to the CM4000 with the exception that the CM4000T adds the ability to detect impulsive voltage transients that have a duration of 600ns or greater. The only setup required to enable this functionality is configuring and enabling the Impulsive Transient alarm using the display or SMS-3000.

CHAPTER CONTENTS

OPERATING THE DISPLAY

The display shows four lines of information at a time. Notice the arrow on the left of the display screen. This arrow indicates that you can scroll up or down to view more information. For example, on the Main Menu you can view the Resets, Setup, and Diagnostics menu options only if you scroll down to display them. As you scroll down a menu, the arrow points to the first menu item as you press the arrow buttons. When the last three menu items are displayed, the arrow moves to the bottom as illustrated in Figure 3–1.

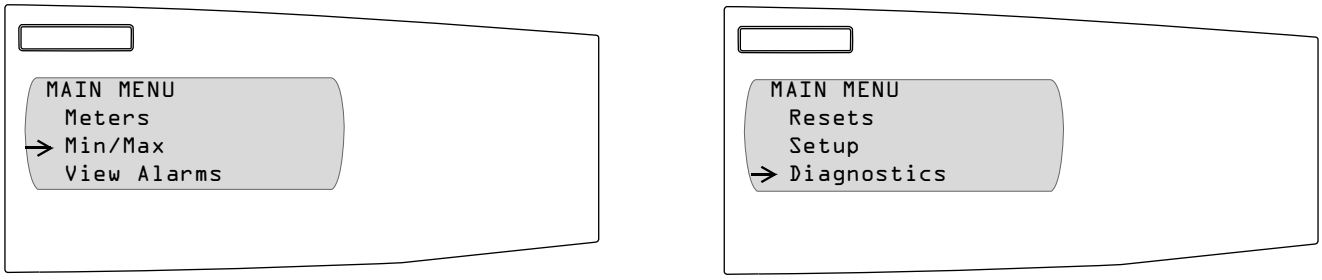


Figure 3–1: Arrow on the display screen

How the Buttons Work

The buttons on the display let you scroll through and select information, move from menu to menu, and adjust the contrast. Figure 3–2 shows the buttons.

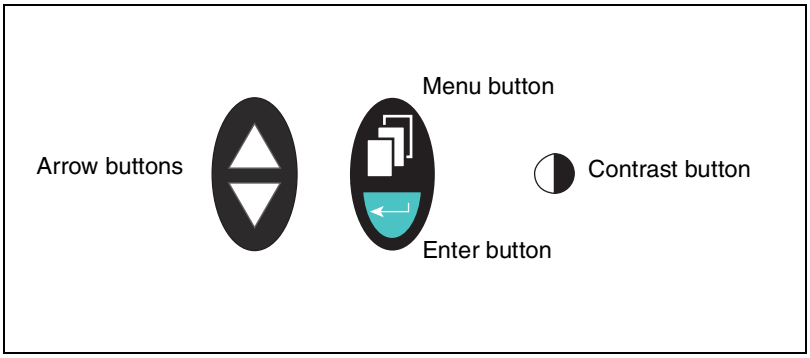


Figure 3–2: Display buttons

The buttons are used in the following way:

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

Display Menu Conventions

This section explains a few conventions that were developed to streamline instructions and for ease of menu navigation. Figure 3–3 shows the parts of a menu.

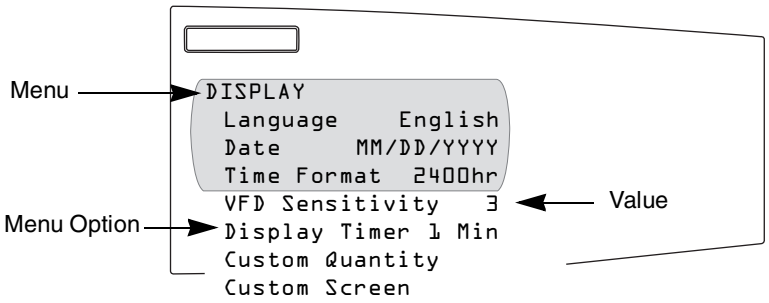


Figure 3–3: Parts of a menu

Selecting a Menu Option

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

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

Changing a Value

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

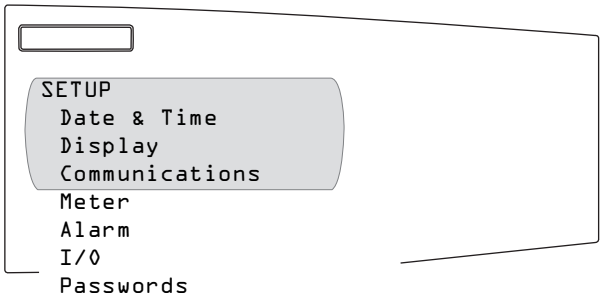
1. Use the arrow buttons to scroll to the parameter you want to change.
2. Press the enter button to activate the value. The value begins to blink.
3. Press the arrow buttons to scroll through the possible values. To select the new value, press the enter button.
4. Press the arrow buttons to move up and down the menu options. You can change one value or all of the values on a menu. To save the changes, press the menu button until the circuit monitor displays:
   “Save changes? No”
   NOTE: Pressing the menu button while a value is blinking will return that value to its most recent setting.
5. Press the arrow to change to “Yes,” then press the enter button to save the changes.

CREATING AN IMPULSIVE TRANSIENT ALARM

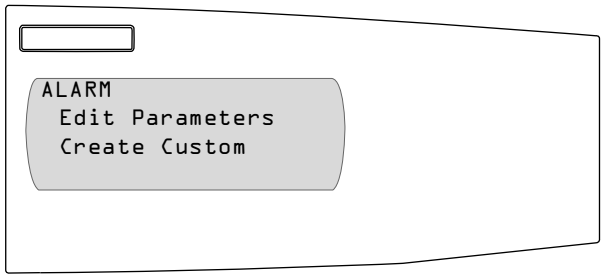
Using the display, perform the steps below to configure the impulsive transient alarm:

NOTE: There is a default transient alarm that enables detection on all phases. If the label and phases are acceptable, you can skip this section and go directly to "Setting Up and Editing Transient Alarms" on page 14.

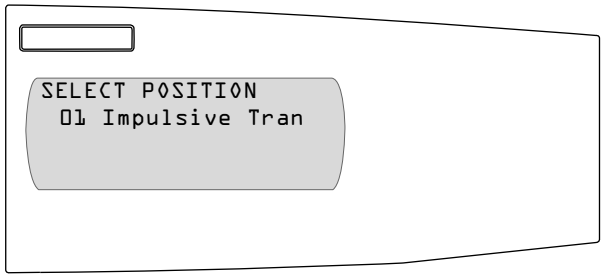
1. From the Main Menu, select Setup.
   The password prompt displays.
2. Select your password. The default password is 0.
   The Setup menu displays.



3. Select Alarm.
   The Alarm menu displays.



4. Select Create Custom.
   The Select Position menu displays.



5. Select the position of the new transient alarm.
   The Alarm Parameters menu displays. Table 3–1 describes the options on this menu.

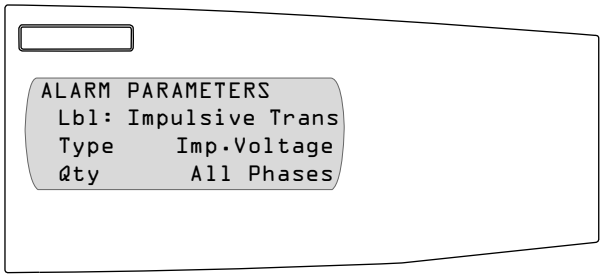


Table 3–1: Options for Creating a Transient Alarm

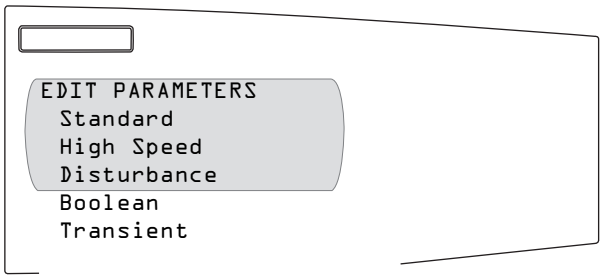
Option	Available Values	Selection Description	Default
Lbl	Alphanumeric Up to 15 characters	Label — name of the alarm. Press the down arrow button to scroll through the alphabet. The lower case letters are presented first, then uppercase, then numbers and symbols. Press the enter button to select a letter and move to the next character field. To move to the next option, press the menu button.	Impulsive Trans
Type	The alarm type is configured by default and cannot be changed.		Imp. Voltage
Qty	All Phases Ph. A Ph. B Ph. A&B Ph. C Ph. A&C Ph. B&C	For transient alarms, this is the value to be evaluated. While selected, press the arrow buttons to scroll through quantity options. Pressing the enter button while an option is displayed will activate that option's list of values. Use the arrow buttons to scroll through the list of options. Select an option by pressing the enter button. *NOTE: For 3-wire systems, selecting Phase A will configure the transient alarm to monitor V_{A-B}. If you select Phases A&B, the transient alarm will monitor V_{A-B} and V_{B-C}.*	All Phases

6. Press the menu button until "Save Changes? No" flashes on the display. Select Yes with the arrow button, then press the enter button to save the changes. Now you are ready to set up and edit the newly created transient alarm.

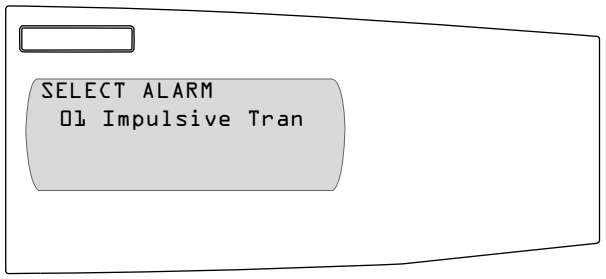
Setting Up and Editing Transient Alarms

Follow the instructions below to set up and edit a transient alarm:

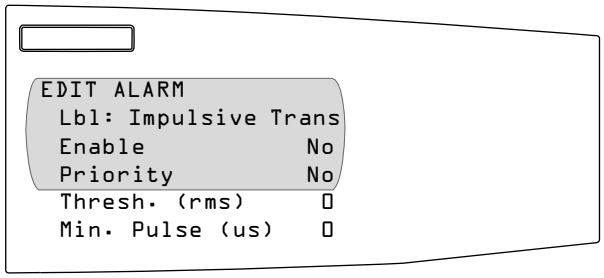
1. From the Main Menu, select Setup > Alarm > Edit Parameters.
   The Edit Parameters menu displays.



2. Select Transient.
   The Select Alarm menu displays.



3. Select the transient alarm.
   The Edit Alarm menu displays. Table 3–2 on page 16 describes the options on this menu.

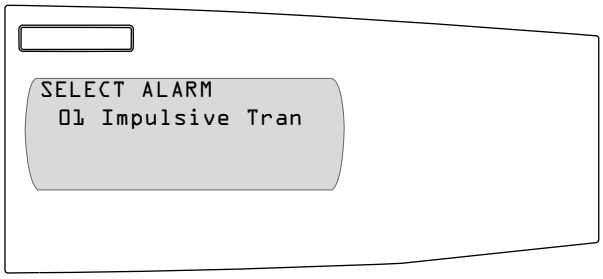


4. Use the arrow buttons to scroll to the menu option you want to change, then edit the following alarm options: Lbl., Priority, Thresh. (rms), and Min. Pulse (µs). See Table 3–2 on page 16 for a description of the alarm options.

   NOTE: Do not *enable the alarm during this step. The alarm must be enabled* after *all changes have been saved.*

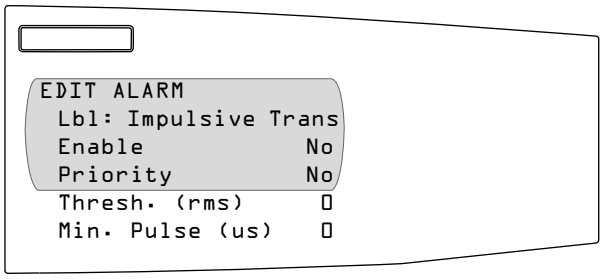
5. When you are finished with all changes, press the menu button until “Save Changes? No” flashes on the display. Select Yes with the arrow button, then press the enter button to save the changes.
6. From the Main Menu, select Setup > Alarm > Edit Parameters > Transients.

   The Select Alarm menu displays.



7. Select the transient alarm.

   The Edit Alarm menu displays. Table 3–2 on page 16 describes the options on this menu.



8. Verify that the Priority, Thresh. (rms), and Min. Pulse (µs) alarm options are set to the values you entered earlier.
9. Use the arrow buttons to scroll to the Enable option, then select Yes to enable the alarm. Verify that Yes is selected before proceeding.
10. Press the menu button until “Save Changes? No” flashes on the display. Select Yes with the arrow button, then press the enter button to save the changes.

NOTE: The Impulsive Transient alarm will be automatically disabled if invalid setpoints (threshold and minimum pulse width) are entered. If you are unable to enable the alarm, check your system configuration (system type, connection, VT ratio) and your alarm setpoints to ensure that the transient circuit monitor operates as intended. Refer to Table 3–3 on page 16 for minimum and maximum setpoint information.

Table 3–2: Options for Editing a Transient Alarm

Option	Available Values	Selection Description	Default
Lbl	Alphanumeric	Label — name of the alarm. Press the down arrow button to scroll through the alphabet. The lower case letters are presented first, then uppercase, then numbers and symbols. Press the enter button to select a letter and move to the next character field. To move to the next option, press the menu button.	Name of the alarm
Enable	Yes No	Select *Y* to make the alarm available for use by the circuit monitor. On preconfigured alarms, the alarm may already be enabled. Select *N* to make the alarm function unavailable to the circuit monitor.	N (not enabled)
Priority	None High Med Low	*Low* is the lowest priority alarm. *High* is the highest priority alarm and also places the active alarm in the list of high priority alarms. To view this list from the Main Menu, select Alarms > High Priority Alarms.	None
Thresh. (rms)	185 – 23,173	The transient alarm threshold or pickup value is set in rms and bounded by system configuration. The minimum value for the transient alarm threshold (pickup) is dependent on the system type and connection (see Table 3–3).	3430 V (rms) 4850 V (peak)
Min. Pulse (µs)	0 – 50 µs	To ensure accurate detection, this value can range from 0 to 50 µs. A transient pulse width must meet the minimum pulse width requirement to trigger the alarm and capture waveforms.	0

Table 3–3: Minimum and Maximum Setpoints for System Wiring Types

System Wiring	System Connection	Minimum Threshold (Setpoint), RMS	Maximum Threshold (Setpoint), RMS
4-wire Wye	Direct connect (L-N)	185	3430
3-wire Delta	Direct connect (L-L)	325	6860
4-wire Wye	VTs	Primary ratio x 185 Example: 480:288 = 2.4 2.4 x 185 = 444 minimum setpoint	Primary ratio x 3430 Example: 480:288 = 2.4 2.4 x 3430 = 8232 maximum setpoint
3-wire Delta	VTs	Primary ratio x 325 Example: 480:288 = 2.4 2.4 x 325 = 780 minimum setpoint	Primary ratio x 6860 Example: 480:288 = 2.4 2.4 x 6860 = 16,464 maximum setpoint

CHAPTER 4—ALARMS

This chapter explains the transient alarm capabilities of the CM4000T. Other alarm groups are detailed in the **POWERLOGIC Circuit Monitor Series 4000 Reference Manual**.

CHAPTER CONTENTS

ABOUT ALARMS

The circuit monitor can detect over 100 alarm conditions, including over or under conditions, digital input changes, phase unbalance conditions, and more. It also maintains a counter for each alarm to keep track of the total number of occurrences. A complete list of default alarm configurations are described in Table 6-3 on page 94 of the **POWERLOGIC Circuit Monitor Series 4000 Reference Manual**. The reference manual also provides a detailed description of the different alarm types that the circuit monitor provides. These alarm groups include Standard, High-Speed, Disturbance, Digital, and Boolean.

Impulsive Transient Alarms

The CM4000T provides an additional alarm group for detecting impulsive transients on the voltage inputs. The Impulsive Transient alarm operates differently than the other alarms, yet it provides extensive information about impulsive transients in a system. The Impulsive Transient alarm does not prevent the use of any other alarms. All alarm groups will function concurrently and can trigger concurrent data records.

Detection and capture of high-speed transients are in the nanosecond to microsecond range with a total capture duration of up to 2 milliseconds. There is only one alarm to configure to detect impulsive and oscillatory transients on the three-phase voltage channels in the CM4000T circuit monitor. The transient alarm is in Alarm Position 185 (registers 13980 – 13999). Each transient that is detected forces an entry in the alarm log and forces a transient and disturbance waveform capture if waveform capture is enabled (refer to **Chapter 7—Logging** and **Chapter 8—Waveform and Event Capture** in the **POWERLOGIC Circuit Monitor Series 4000 Reference Manual** for more information about alarm logs and disturbance captures). The table below is an addendum toTable 6-4 in the circuit monitor reference manual to include the transient alarm.

Table 4–1: Transient Alarm Type Description

Type	Description	Operation
185	Impulsive Transient - Voltage	The impulsive transient voltage alarm will occur whenever the peak voltage is above the pickup setpoint and remains above the pickup setpoint for the specified duration.

CONFIGURATION

To configure a transient alarm, you must select the voltage inputs to monitor. The impulsive transient alarm allows you to enter a custom label, enable or disable the alarm, select the alarm's priority, enter the voltage pickup threshold, and input the minimum pulse width. See **Chapter 3—Operation**, "Creating an Impulsive Transient Alarm" on page 12 for more information.

The CM4000T automatically selects the voltage transient monitoring method based on the type of system it is connected to, so there is no need to configure the system type. For example, if the CM4000T is connected to a 4-wire Wye system, the detection method changes to single-ended (L-N) with a maximum voltage range of 5 kV peak (3536 V rms). If the CM4000T is connected to a 3-wire delta system, the detection method changes to differential (L-L) with a maximum voltage range of 10 kV peak (7072 V rms).

RECORDING AND ANALYZING DATA

After each occurrence of an impulsive transient, data is entered into the circuit monitor's alarm log using SMS as long as the alarm priority is set to Low, Medium, or High. The alarm log contains the following information:

- Alarm position
- Unique alarm ID
- Entry type
- Peak Magnitude
- Start time and date
- Correlation sequence number
- File association
- Waveform capture association
- Average magnitude
- Transient duration
- Rise-time

For more information on logging impulsive transient data, see **Chapter 5—Logging** on page 21. For more information on alarm logging features in SMS, refer to the SMS online help.

CHAPTER 5—LOGGING

CHAPTER CONTENTS

ALARM LOG

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

NOTE: All data capture methods that are available in the CM4000 are also available in the CM4000T. Also, a transient alarm has a pickup entry with a duration, but it does not have a dropout entry.

Alarm Log Storage

The circuit monitor stores alarm log data in non-volatile memory. You define the size of the alarm log (the maximum number of events). When determining the maximum number of events, consider the circuit monitor's total storage capacity. For more information on alarm logs and storage, see **Chapter 7—Logging** in the **POWERLOGIC Circuit Monitor Series 4000 Reference Manual**.

IMPULSIVE TRANSIENT LOGGING

Each time an impulsive transient occurs, the transient alarm forces an entry in the CM4000T alarm log, a transient and disturbance waveform capture is generated when waveform capture is enabled, and register-based data in non-volatile memory is recorded. The register-based data in the alarm log consists of the following:

- Date/Time
- Unique ID
- Peak voltage magnitude
- Duration of the peak in tenths of a microseconds
- Rise-time in tenths of a microseconds
- Average voltage

The data can be viewed by selecting View Alarms > Active Alarms List, then selecting the transient alarm. **Chapter 3—Operation** in the **POWERLOGIC Circuit Monitor Series 4000 Reference Manual** explains how to view the alarm log data using the display.

Transient Analysis Information

Register-based transient analysis information is also generated each time an impulsive transient occurs. This data consists of the number of transients for each phase, the date and time of the last register-based transient alarm log reset, number of alarms in the register-based transient alarm log, stress on circuit indication for each phase in volt-seconds, magnitude, and duration. The following list contains the transient analysis information (see also **Appendix A—Abbreviated Register Listing** on page 29):

- Number of transients on Phase A
- Number of transients on Phase B
- Number of transients on Phase C
- Number of transients on all phases
- Date/time of the last register-based alarm log reset
- Number of alarms in the register-based transient alarm log
- Stress on the circuit indication for Phase A (volt-seconds)
- Stress on the circuit indication for Phase B (volt-seconds)
- Stress on the circuit indication for Phase C (volt-seconds)
- Transient categorization — Magnitude 1 and Duration 1
- Transient categorization — Magnitude 1 and Duration 2
- Transient categorization — Magnitude 1 and Duration 3
- Transient categorization — Magnitude 2 and Duration 1
- Transient categorization — Magnitude 2 and Duration 2
- Transient categorization — Magnitude 2 and Duration 3
- Transient categorization — Magnitude 3 and Duration 1
- Transient categorization — Magnitude 3 and Duration 2
- Transient categorization — Magnitude 3 and Duration 3

NOTE: Data log entries and adaptive waveform captures cannot be triggered by an impulsive transient event because transients occur too rapidly for these data capture tools to be effective. However, high-speed alarms and sag/swell alarms can still be configured to trigger if the transient event duration is within the detection criteria for the alarm.

To utilize all of the transient analysis features of the CM4000T you should configure the transient categorization magnitude and duration setpoints. The CM4000T provides nine accumulators that evaluate each catpured transient and assigns it to a category based on magnitude and duration. For example, a 480 V Wye system might have a Transient Alarm Threshold (pick-up) setpoint of 600 V rms (848 V peak). Transient captures for L-N connected systems is 5 kV (peak). Therefore, all captured transient magnitudes will be between 848 V peak and 5 kV peak. The Magnitude #1 (register 9226) and Magnitude #3 (register 9227) parameters for the Transient Categories might be configured as 1471 V peak ((5 kV – 848) * 15% + 848) which would include transients in the lower 15% in magnitude. Magnitude #3 might be configured as 2509 V peak ((5 kV – 848) * 40% * 848) which includes transients in the upper 60% in magnitude. Magnitude #2 is implied as those transients > 15% of the range to < 40% of the range.

Much like Magnitude #1 and Magnitude #3, values for Duration #1 (register 9228) and Duration #3 (register 9229) must be configured. We recommend that Duration #1 is set to 32 µs and Duration #3 is set to 130 µs. This implies that all transients with duration ≤ 32 µs will be considered Duration #1 and transients with duration ≥ 130 µs will be Duration #3. Duration #2 is implied as those transients with a duration > 32 µs, but < 130 µs. See **Appendix A—Abbreviated Register Listing** on page 29 for register numbers and descriptions.

WRITING TRANSIENT REGISTER VALUES

The following is a list of the steps necessary to enter the transient register values. For more information on reading and writing registers, refer to “Reading and Writing Registers” on page 44 in **Chapter 3—Operation** of the **POWERLOGIC Circuit Monitor Series 4000 Reference Manual**.

1. Write 9020 to register 8000 to enter Setup mode
2. Write the desired value into the following registers:
   - 9226 for Magnitude #1
   - 9227 for Magnitude #3
   - 9228 for Duration #1
   - 9229 for Duration #3
3. Write 1 to register 8001.
4. Write 9021 to register 8000 to exit Setup and save changes.

CHAPTER 6—WAVEFORM AND EVENT CAPTURES

This chapter explains the waveform captures generated by an impulsive transient event. For more information on the types of waveform captures and how they are recorded, refer to **Chapter 8—Waveform and Event Captures** in the **POWERLOGIC Circuit Monitor Series 4000 Reference Manual**.

CHAPTER CONTENTS

TRANSIENT WAVEFORM CAPTURES

Using waveform captures you can view each detected transient. Each time an impulsive transient event is detected, the CM4000T records two waveform captures when waveform capture is enabled. The first waveform capture is a transient waveform capture that records the signal on each of the three voltage inputs at a rate of 83,333 samples per cycle. The transient waveform capture will display voltage transients up to 5 kV peak magnitude for a 4-wire configuration and up to 10 kV for a L-L, 3-wire configuration when direct connected.

The second waveform capture is a disturbance waveform capture that is configurable using the display or SMS. SMS will indicate all transient captures that are contained withing each disturbance waveform capture. The disturbance waveform capture can range from seven channels at a rate of 512 samples per cycle for 28 cycles to seven channels at a rate of 16 samples per cycle for 915 cycles (see Table 6–1). It is recommended that the disturbance waveform capture in a CM4000T be configured for 512 samples per cycle, which is one data point every 32 µs. This maximizes the available data for analysis of the transient event.

Table 6–1: Disturbance Waveform Capture Maximum Duration for the Number of Samples Per Cycle

Samples per Cycle	Max Duration
16	915 cycles
32	457 cycles
64	228 cycles
128	114 cycles
256	57 cycles
512	28 cycles

Table 6–2: Transient Waveform Capture Maximum Duration for the Number of Samples Per Cycle

Samples per Cycle	Max Duration
83,333	2 millisecond (1/8 of a cycle)

TRANSIENT WAVEFORM CAPTURE EXAMPLE

The following figure is an example of a transient waveform capture. Below the figure is an explanation of the waveform capture.

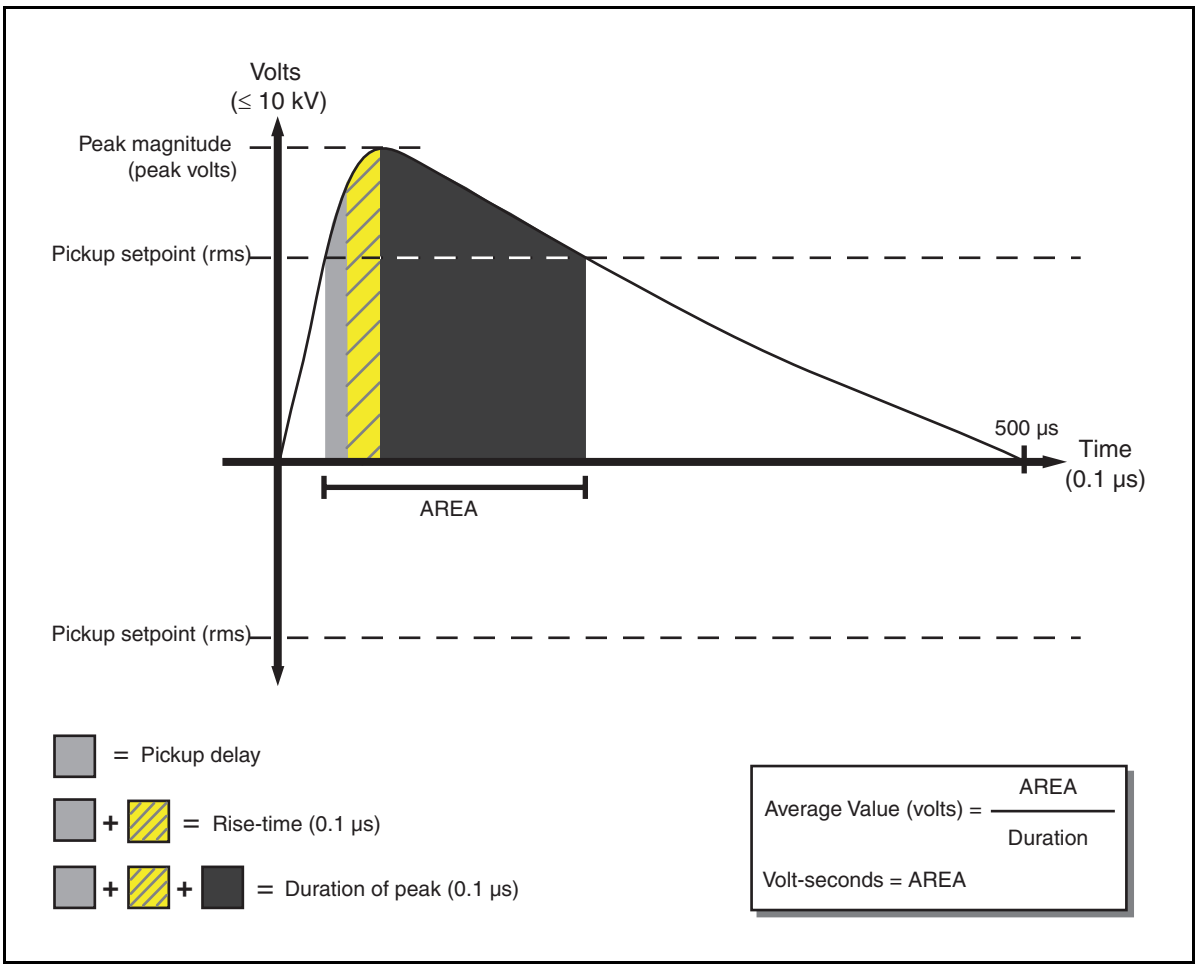


Figure 6–1:Impulsive Transient

The CM4000T provides analysis data for each transient captured. The meter reports a pickup date/time, rise-time, duration of the peak, peak magnitude, and average voltage of the transient. The CM400T also provides an accumulated value per phase captured to indicate the severity of the transients in volt-seconds. For example, Figure 6–1 illustrates an impulsive transient. The average voltage of the impulsive transient is calculated by taking the AREA, which includes the product of the voltage and duration within the transient curve bound by the threshold (pickup and drop-out) setpoints, and dividing it by the duration of the peak.

APPENDIX A—ABBREVIATED REGISTER LISTING

This appendix contains informatin about the registers of the circuit monitor for transients. Other register information and explanations on how registers are stored can be found in **Appendix A—Abbreviated Register Listing** of the CM4000 reference manual.

Table A–1: Register-based Transient Alarm Log

Register Number	Description	Scale Factor	Units	Register Range
Register-based Transient Alarm Log				
9000–9009	Transient Event #1	—	See Template	See Template
9010–9019	Transient Event #2	—	See Template	See Template
9020–9029	Transient Event #3	—	See Template	See Template
9030–9039	Transient Event #4	—	See Template	See Template
9040–9049	Transient Event #5	—	See Template	See Template
9050–9059	Transient Event #6	—	See Template	See Template
9060–9069	Transient Event #7	—	See Template	See Template
9070–9079	Transient Event #8	—	See Template	See Template
9080–9089	Transient Event #9	—	See Template	See Template
9090–9099	Transient Event #10	—	See Template	See Template
9100–9109	Transient Event #11	—	See Template	See Template
9110–9119	Transient Event #12	—	See Template	See Template
9120–9129	Transient Event #13	—	See Template	See Template
9130–9139	Transient Event #14	—	See Template	See Template
9140–9149	Transient Event #15	—	See Template	See Template
9150–9159	Transient Event #16	—	See Template	See Template
9160–9169	Transient Event #17	—	See Template	See Template
9170–9179	Transient Event #18	—	See Template	See Template
9180–9189	Transient Event #19	—	See Template	See Template
9190–9199	Transient Event #20	—	See Template	See Template

Table A–1: Register-based Transient Alarm Log

Register Number	Description	Scale Factor	Units	Register Range
Register-based Transient Alarm Log Template				
Base + 0 to Base + 3	Date/Time Base + 0 Bits 15–08 = Month Bits 07–00 = Day Base + 1 Bits 15–08 = Year + 1900 Bits 07–00 = Hour Base + 2 Bits 15–08 = Minute Bits 07–00 = Seconds Base + 3 Bits 15–00 = Milliseconds For more information, see “How Date and Time Are Stored in the Register” in **Appendix A—Abbreviated Register Listing** of the **POWERLOGIC Circuit Monitor Series 4000 Reference Manual**.	—	—	—
Base + 4 to Base + 5	Unique ID Base + 4: 1 = Va 2 = Vb 3 = Va and Vb 4 = Vc 5 = Vc and Va 6 = Vc and Vb 7 = All Phases Base + 5: Bits 15–08 = Alarm type always 0x6F Bits 07–00 = Level (0–9) always 0x00	—	—	Base + 4 = 1–7 Base + 5 = 0x6F (alarm type) and 0x00 (level)
Base + 6	Peak Magnitude	H	Volts (peak) x Scale	-32,726 to 32,767
Base + 7	Duration in microseconds	—	0.1 (µs)	0 to 20,000
Base + 8	Rise time	—	0.1 (µs)	0 to 20,000
Base + 9	Average value (volts)	H	Volts (peak) x Scale	0 to 32,767

Table A–2: Abbreviated Register List

Register Number	Description	Scale Factor	Units	Register Range
Transient Log Template				
9200	Transient Counter 1 Counter for transients as having: Level 1 Magnitude Level 1 Duration	—	—	1 to 32,767
9201	Transient Counter 2 Counter for transients as having: Level 1 Magnitude Level 2 Duration	—	—	1 to 32,767
9202	Transient Counter 3 Counter for transients as having: Level 1 Magnitude Level 3 Duration	—	—	1 to 32,767
9203	Transient Counter 4 Counter for transients as having: Level 2 Magnitude Level 1 Duration	—	—	1 to 32,767
9204	Transient Counter 5 Counter for transients as having: Level 2 Magnitude Level 2 Duration	—	—	1 to 32,767
9205	Transient Counter 6 Counter for transients as having: Level 2 Magnitude Level 3 Duration	—	—	1 to 32,767
9206	Transient Counter 7 Counter for transients as having: Level 3 Magnitude Level 1 Duration	—	—	1 to 32,767
9207	Transient Counter 8 Counter for transients as having: Level 3 Magnitude Level 2 Duration	—	—	1 to 32,767
9208	Transient Counter 9 Counter for transients as having: Level 3 Magnitude Level 3 Duration	—	—	1 to 32,767
9209	Phase A Transient Counter Number of transients reported for phase A	—	—	1 to 32,767
9210	Phase B Transient Counter Number of transients reported for phase B	—	—	1 to 32,767

Table A–2: Abbreviated Register List

Register Number	Description	Scale Factor	Units	Register Range
9211	Phase C Transient Counter Number of transients reported for phase C	—	—	1 to 32,767
9212	Total Transient Counter Number of transients reported for phases A, B, and C	—	—	1 to 32,767
9214	Phase A Transient volt-seconds Accumulator Accumulation of all volt-seconds from transients on phase A	—	Volts Seconds	$10^{\pm 38}$ (IEEE floating point number)
9216	Phase B Transient volt-seconds Accumulator Accumulation of all volt-seconds from transients on phase B	—	Volts Seconds	$10^{\pm 38}$ (IEEE floating point number)
9218	Phase C Transient volt-seconds Accumulator Accumulation of all volt-seconds from transients on phase C	—	Volts Seconds	$10^{\pm 38}$ (IEEE floating point number)
9226	Sorting Magnitude Level 1 All transients of magnitude less than this level are considered Level 1	H	Volts (peak) x Scale	1 to 32,767
9227	Sorting Magnitude Level 3 All transients of magnitude greater than or equal to this level are considered Level 3	H	Volts (peak) x Scale	1 to 32,767
9228	Sorting Duration Level 1 (Micro Seconds) All transients of duration less than this level are considered Level 1	—	0.1 (µS)	1 to 32,767
9229	Sorting Duration Level 3 (Micro Seconds) All transients of duration greater than or equal to this level are considered Level 3	—	0.1 (µS)	1 to 32,767
9230	Count of Records in Log Number of records present in the transient log	—	—	1 to 32,767
9231 to 9234	D/T Last Transient Event Log Reset	—	See the template section ”Register-based Transient Alarm Log Template” in Table A–1 on page 29.	See the template section ”Register-based Transient Alarm Log Template” in Table A–1 on page 29.

Table A–3: CVMT Alarms

Register Number	Description	Scale Factor	Units	Register Range
Alarms – Configuration/Status				
10000 to 10009	P1 Alarm Queue Queue of last ten active priority 1 alarms	—	—	1 to 185
10010	P1 Acknowledge Status Acknowledge status for each of the P1 alarms in the queue	—	Bitmap	0x0000 to 0x03FF
10011 to 10022	Active Alarm Map Each bit corresponds to an Alarm Type: Bit00 = Alarm #01 Bit01 = Alarm #02 ... etc.	—	Bitmap	0x0000 to 0xFFFF
10023	Active Alarm Status Active Alarms: Bit00 = 1 if any priority 1-3 alarm is active Bit01 = 1 if a "High" (1) priority alarm is active Bit02 = 1 if a "Medium" (2) priority alarm is active Bit03 = 1 if a "Low" (3) priority alarm is active Remaining bits not used.	—	Bitmap	0x0000 to 0x000F
10024	Latched Active Alarm Status Latched Active Alarms: (from the last time the register was cleared) Bit00 = 1 if any priority 1-3 alarm is active Bit01 = 1 if a "High" (1) priority alarm is active Bit02 = 1 if a "Medium" (2) priority alarm is active Bit03 = 1 if a "Low" (3) priority alarm is active Remaining bits not used.	—	Bitmap	0x0000 to 0x000F
10025	Total Counter Total alarm counter, including all priorities 1, 2 and 3	—	1.0	0 to 32,767
10026	P3 Counter Low alarm counter, all priority 3s	—	1.0	0 to 32,767
10027	P2 Counter Medium alarm counter, all priority 2s	—	1.0	0 to 32,767
10028	P1 Counter High alarm counter, all priority 1s	—	1.0	0 to 32,767
10029 to 10040	Pickup Mode Selection Selection of absolute or relative pickup test for each of the Alarm Types (if applicable, based on type) 0 = Absolute (default), 1 = Relative Bit00 = Alarm #01 Bit01 = Alarm #02 ... etc.	—	Bitmap	0x0000 to 0xFFFF
Alarms – Counters				
10299	Alarm Type #185 Counter	—	1.0	0 to 32,767

Table A–3: CVMT Alarms

Register Number	Description	Scale Factor	Units	Register Range
Alarms – Setup Blocks				
13980	Unique Identifier Bits 15–08 (reserved) Bits 07–00: 1 = Va 2 = Vb 3 = Va and Vb 4 = Vc 5 = Vc and Va 6 = Vc and Vb 7 = All Phases	—	—	1 to 7
13981	Unique Identifier	—	—	—
13982	Enable/Disable Alarm 0 = Disabled 255 = Enabled	—	—	0 to 255
13983 to 13990	Label 16-character label	—	—	Alphanumeric
13991	Threshold Magnitude	—	V (rms)	0 to 23,169
13992	Minimun Pulse Duration	—	µs	0 to 50

APPENDIX B—SPECIFICATIONS

This appendix contains specifications for the circuit monitor and display.

Table B–1: Specifications

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

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

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

③ If higher precision is required, see “Digital Inputs” on page 71 of the reference manual for more information.

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

Table B–1: Specifications

Voltage Inputs④	
Nominal Full Scale	347 Vac Line to Neutral, 600 Line to Line
Metering Over-range	50%
Input Impedance	Greater than 2 Megohm (L-L), 1 Megohm (L-N)
CONTROL POWER INPUT SPECIFICATIONS	
120/240 Vac Nominal	
Operating Input Range	90–305 Vac
Burden, maximum	50 VA
Frequency Range	45–67 Hz, 350–450 Hz
Isolation	2300 V, 1 minute
Ride-through on Power Loss	0.1 second at 120 Vac
125/250 Vdc Nominal	
Operating Input Range	100–300 Vdc
Burden	30 W maximum
Isolation	3250 Vdc, 1 minute
Ride-through on Power Loss	0.1 second at 120 Vdc
Mains Supply Voltage Fluctuations	not to exceed ±10%
ENVIRONMENTAL SPECIFICATIONS	
Operating Temperature	
Meter and Optional Modules	–25° to +65°C maximum (See information about operating temperature of the circuit monitor in “Mounting” on page 17.)
Remote Display	VFD model is –20 to +70°C LCD model is –20 to +60°C
Storage Temperature	
Meter and Optional Modules	–40 to +85°C
Remote Display	VFD model is –40 to +85°C LCD model is –30 to +80°C
Humidity Rating	5–95% Relative Humidity (non-condensing) at 40°C
Pollution Degree	UL840, IEC 1010-1 (Class 2)
Installation Category	UL508, IEC 1010-1 (Class 2)
Altitude Range	0 to 3,048 m (10,000 ft)
Physical Specifications	
Weight (approximate, without add-on modules)	4.2 lb (1.90 kg)
Dimensions	See “Dimensions” on page 16.
REGULATORY/STANDARDS COMPLIANCE	
Electromagnetic Interference	
Radiated Emissions	FCC Part 15 Class A/CE heavy industrial
Conducted Emissions	FCC Part 15 Class A/CE heavy industrial
Electrostatic Discharge (Air Discharge)	IEC pub 1,000-4-2 level 3
Immunity to Electrical Fast Transient	IEC pub 1,000-4-4 level 3
Immunity to Surge (Impulse Wave)	IEC pub 1,000-4-5 level 4
Dielectric Withstand	UL 508, CSA C22.2-14-M1987, EN 61010
Immunity to Radiated Fields	IEC pub 61000-6-2
Accuracy	ANSI C12.20 and IEC 687 Class 0.2

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

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

③ If higher precision is required, see “Digital Inputs” on page 71 of the reference manual for more information.

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

Table B–1: Specifications

Safety	
USA	UL 508
Canada	CSA C22.2-2-4-M1987
Europe	CE per low voltage directive EN 61010
Listings	cUL and UL Listed 18X5 Ind Cont. Eq.
KYZ SPECIFICATIONS	
Load voltage	240 Vac, 300 Vdc maximum
Load current	96 mA maximum
ON resistance	50 ohms maximum
Leakage current	0.03 μA (typical)
Turn ON/OFF time	3 ms
Input or output isolation	3750 V rms

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

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

③ If higher precision is required, see “Digital Inputs” on page 71 of the reference manual for more information.

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

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