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1.0 INTRODUCTION

1.1 General

Square D's PowerLogic™ Circuit Monitor(CM) is a multi-function instrumentation, data acquisition and control device capable of replacing conventional metering, control and data acquisition equipment. Its ability to communicate metering information via an RS-485 (RS-422 compatible) communication channel to a SY/MAX® Processor, or like master, allows it to replace discrete meters such as:

- Ammeter(s), Voltmeter(s) and instrument transfer switches
- Watt meters
- Var meters
- kVA meters
- Power Factor meters
- Frequency meters
- Thermal Demand Ammeters
- Watthour meters with Demand Attachment
- Varhour meters

In addition, transducers and other analog to digital conversion equipment can be replaced by the Circuit Monitor. The Circuit Monitor's control capabilities eliminate the need for discrete control relays and timers. Furthermore, the Circuit Monitor offers a whole new range of circuit information, such as comprehensive profiles of current and voltage waveforms, not previously available using discrete devices. (For a complete description of the Circuit Monitor's functional capabilities, refer to section 2.0).

The Circuit Monitor's versatility makes it ideal for a variety of applications including:

- Integration into Square D's full line of power equipment products
- Equipment and process control for the monitoring of circuit parameters
- Retrofit into existing facilities and processes

The PowerLogic Circuit Monitor can be applied virtually anywhere standard current and voltage transformers can be used.

1.2 Standard Features and Options

The Circuit Monitor offers a variety of standard and optional features. These are listed in Table 1.0.

The Circuit Monitor is available in two functional versions. Circuit Monitor model CM-100 offers extensive circuit instrumentation . A second model, CM-200, offers instrumentation and includes the Waveform Capture feature, which offers the ability to capture and analyze 256 data points from a circuit's current and voltage waveforms.

The Circuit Monitor's functional versions are listed below.

CM-100 - Instrumentation
CM-200 - Instrumentation, and Waveform Capture

1.3 Manual Use

This manual provides all of the information necessary to apply and operate the Circuit Monitor in a system. It describes the function and use of the Circuit Monitor, details installation, discusses the theory of operation, outlines communications and register allocation, and covers device maintenance and troubleshooting. The manual is suitable to familiarize a potential user with the device and contains enough information for use by an application engineer who is planning a system.

Section 2.0 offers a functional description of the Circuit Monitor, as well as a complete list of measured and calculated values. Section 3.0 describes the Circuit Monitor's external connections and includes a list of device specifications. Mounting and wiring are covered in Section 4.0 which includes dimension and wiring diagrams. Operation and startup are covered in Section 5.0. Section 6.0 discusses Circuit Monitor communication and offers a complete list of internal register allocations. Theory of operation is covered in Section 7.0, and maintenance and troubleshooting in 8.0

Circuit Monitor Features
• UL Listed (UL 508) • Full 3-Element Instrumentation • True RMS Sensing • Accepts Standard CT and PT inputs (5A and 120V ac) • Industry Standard RS-485/RS-422 Communication • Microprocessor-based Control • Historical Data • Non-Volatile Memory • SY/MAX Compatibility • Waveform Capture (optional) • Energy Management Alarms • On-board Clock/Calendar • User Configurable • Standard Component Encompassing Many Voltage Classes (120 - 32,767 VAC)

Table 1.0 - Circuit Monitor Features

2.0 FUNCTIONAL DESCRIPTION

2.1 Instrumentation

The PowerLogic™ Circuit Monitor's metering capabilities include the calculation and reporting of a number of values such as current, voltage, and frequency. For many of these values, historical data is stored in non-volatile memory, allowing the Circuit Monitor to report peak, minimum, and maximum values upon request. The reported values may be grouped into three classifications. They are:

1) Instantaneous Readings
2) Demand Readings
3) Accumulated Readings

Table 2.2 lists the reported values and the range of each.

In addition to the values listed in Table 2.2, the Circuit Monitor will report, on command, a complete set of all sampled points on a given phase's current or voltage waveform. Section 2.2 discusses the optional Waveform Capture feature.

2.1.1 Instantaneous Readings

The Circuit Monitor reports 20 instantaneous circuit values including current, voltage, power factor, real power, reactive power, apparent power, frequency, and temperature. The values recorded and their associated ranges are listed in Table 2.2. For each instantaneous value, a running minimum and maximum are stored in non-volatile memory. These values are discussed below.

Minimums and Maximums

All running min/max values, with the exception of power factor, represent actual arithmetic minimums and maximums. For example, the Minimum Phase A-B Voltage is simply the lowest value in the range 0 to 32,767V 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 (1.00), 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 2-1 shows

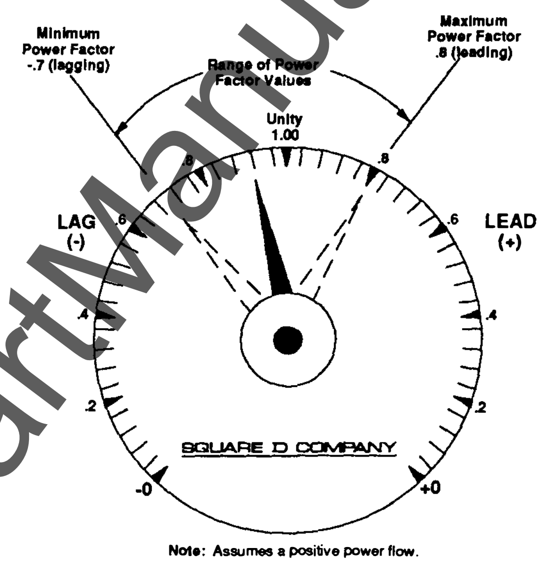


Figure 2-1 - Power Factor meter example.

Reset Command	Affected Value(s)
Reset Min/Max (*)	All minimum and maximum values stored for instantaneous readings (total of 40 values)
Reset Peak Demand, Currents (*)	Peak Demand, Current, Phase A Peak Demand, Current, Phase B Peak Demand, Current, Phase C
Reset Peak Demand, Real Power (*)	Peak Demand, Real Power
Reset Accumulated Energy (*)	Energy, Accumulated Reactive Energy, Accumulated
Reset Historical Data for: Energy Mgmt Alarm Level 1 Energy Mgmt Alarm Level 2 Energy Mgmt Alarm Level 3	 Level 1 Time/Date, Max Level Reached Level 2 Time/Date, Max Level Reached Level 3 Time/Date, Max Level Reached

* Time and date of last reset also stored upon reset execution.
(Note: Values are reset by setting specific bits in register 237. See Section 6.10 for a description of CM registers).

Table 2.1 - Summary of Reset Commands

Reported Value		Range / Units	CM Register
INSTANTANEOUS READINGS (☛):			
Frequency		23.00 to 65.00 Hz	1
Temperature		-100.00 to +100.00 C	2
Current, Phase A rms	(❑)	0 to 9999 A or 0 to 999.9 A	3
Current, Phase B rms	(❑)	0 to 9999 A or 0 to 999.9 A	4
Current, Phase C rms	(❑)	0 to 9999 A or 0 to 999.9 A	5
Current, 3-Phase Average rms	(❑)	0 to 9999 A or 0 to 999.9 A	6
Current, Apparent rms	(❑)	0 to 9999 A or 0 to 999.9 A	7
Voltage, Phase A-B rms		0 to 32,767 V	8
Voltage, Phase B-C rms		0 to 32,767 V	9
Voltage, Phase C-A rms		0 to 32,767 V	10
Voltage, Phase A-N rms	(✿)	0 to 32,767 V	11
Voltage, Phase B-N rms	(✿)	0 to 32,767 V	12
Voltage, Phase C-N rms	(✿)	0 to 32,767 V	13
Power Factor, 3-Phase Total		-0 to 1.00 to 0 ✤	14
Power Factor, Phase A	(▲)	-0 to 1.00 to 0 ✤	15
Power Factor, Phase B	(▲)	-0 to 1.00 to 0 ✤	16
Power Factor, Phase C	(▲)	-0 to 1.00 to 0 ✤	17
Real Power, 3-Phase Total		0 to +/- 32,767 kW	18
Reactive Power, 3-Phase Total		0 to +/- 32,767 kVAr	19
Apparent Power, 3-Phase Total		0 to 32,767 kVA	20
DEMAND READINGS:			
Average Demand, Current, Ph. A	(❑)	0 to 9999 A or 0 to 999.9 A	32
Average Demand, Current Ph. B	(❑)	0 to 9999 A or 0 to 999.9 A	33
Average Demand, Current Ph. C	(❑)	0 to 9999 A or 0 to 999.9 A	34
Average Demand, Real Power		0 to +/- 32,767 kW	35
Predicted Demand, Real Power		0 to +/- 32,767 kW	36
Peak Demand, Real Power		0 to +/- 32,767 kW (✓)	37
Peak Demand, Current, Ph. A	(❑)	0 to 9999 A or 0 to 999.9 A (✓)	84
Peak Demand, Current, Ph. B	(❑)	0 to 9999 A or 0 to 999.9 A (✓)	85
Peak Demand, Current, Ph. C	(❑)	0 to 9999 A or 0 to 999.9 A (✓)	86
ENERGY READINGS:			
Energy, Accumulated		0 to +/- 9999999999999999 WHr	24-27
Reactive Energy, Accumulated		0 to +/- 9999999999999999 QHr	28-31

NOTES:
- (☛) For each instantaneous reading, running minimums and maximums are also stored.
- (❑) The user determines whether all current values will be reported in amps or whether all current values will be reported in tenths of amps. This choice is made by setting the appropriate bits in register 200. See the description of register 200 in section 6.10.
- (✿) For 3-Phase/3-Wire connections, these values are reported at 32,767.
- (▲) For 3-Phase/3-Wire connections, these values are reported equal to 3-Phase Total PF.
- (✤) High order bit indicates leading / lagging. (See Appendix B)
- (✓) Time and Date of peak are stored for all Peak Demand values.

Table 2.2 - Circuit Monitor Instrumentation

the min/max values in a typical environment, assuming a positive power flow. Refer to the power quadrants diagram in Figure 2-2 for an explanation of the relationship between power factor and power flow.

In the example shown in Figure 2-1, 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 in Figure 2-1 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).

All historical minimum and maximum values may be reset by the user, that is, set equal to the present readings, via the communications link. (Refer to Table 2.1 for a complete listing of the Reset commands). The date and time of the last reset operation are stored upon execution of the reset command.

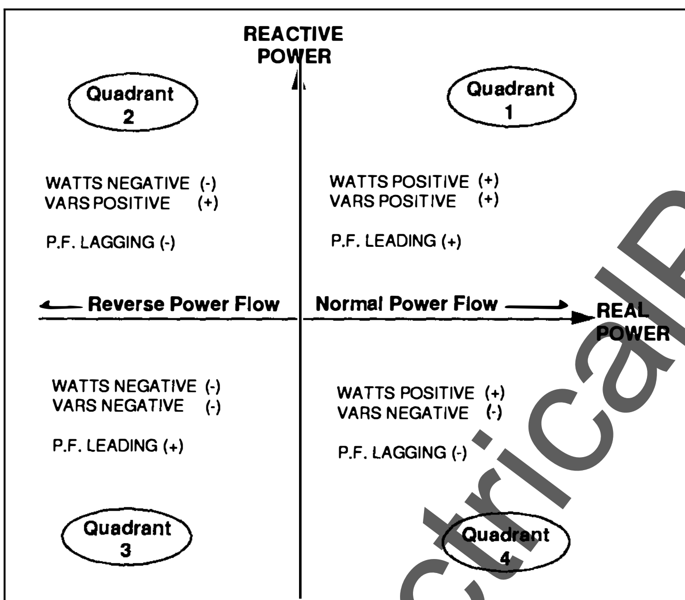


Figure 2-2 - Power Quadrants Diagram

2.1.2 Demand Readings

In addition to instantaneous readings, the Circuit Monitor calculates demand values which include: Average Demand Current, Peak Demand Current, Average Demand Real Power, Predicted Demand Real Power, and Peak Demand Real Power (See Table 2.2). Average Demand Current is calculated for each phase using a sliding window method over a fixed 15 minute interval with a subinterval period of 15 seconds. A running maximum of the Average Demand Current, called Peak Demand Current, is maintained per-phase, along with the date and time the new maximum was recorded. The Circuit Monitor also calculates Average and Predicted Demand for real power using a sliding window method over a user-defined interval (1 - 60 minutes) with a subinterval period of 15 seconds. Again, a running maximum (Peak Demand Real Power) of the real power average demand function is maintained, along with the date and time the new maximum was recorded.

Peak Demand Current values represent true arithmetic maximums of the Average Demand readings for each phase. This means that the Peak Demand Current for Phase A is simply the largest Average Demand in the range 0 to 9999A or (0 to 999.9A) that has occurred since the Peak Demand values were last reset.

Unlike Peak Demand Current, Peak Demand Real Power is not a true arithmetic maximum, but is based on the absolute value of real power. In addition, the sign (+/-) is reported to indicate the direction of power flow associated with the new demand reading. The Peak Demand Real Power is determined by the following logical operation:

If $|D_{avg}| \geq |D_{peak,\ old}|$ Then $D_{peak,\ new} = D_{avg}$

Where D_{avg} = Average Demand Real Power
$D_{peak,new}$ = The new Peak Demand Real Power
$D_{peak,\ old}$ = The old Peak Demand Real Power

So, for example, if the old Peak Demand Real Power value ($D_{peak,\ old}$) is 1,000 kW and the Average Demand reading (D_{avg}) exceeds this (but in the negative direction) to -1,001 kW, then the new Peak Demand Real Power reading ($D_{peak,new}$) will become -1,001 kW. (NOTE: $|D_{avg}|$ must be greater than or equal to $|D_{peak,\ old}|$ for a new time/date to be recorded).

Peak Demand Currents and/or Peak Demand Real Power may be reset (set equal to present readings) via the communications link (See Table 2.1). The date and time of the last reset operation are stored in non-volatile memory.

2.1.3 Accumulated Energy Readings

The Circuit Monitor calculates and stores in non-volatile memory accumulated values for energy and reactive energy, in watthours and varhours, respectively. The user may reset the accumulated energy values (set them equal to all zeroes) via the communications link (See Table 2.1). The date and time of the last reset operation are also stored in non-volatile memory.

2.2 Waveform Capture

Circuit Monitor models CM-200 and CM-210 will, on command, capture and report up to 256 data points describing a given phase's current or voltage waveform. The data points correspond to between 2 and 4 cycles depending on the frequency of the phase.

Captured data may be imported to a personal computer allowing the waveform to be viewed. In addition, waveform data may be imported into commercially available waveform analysis packages which offer spectral analysis and more.

The captured raw data points from each phase's current and voltage waveforms are packed 2 points per register in Circuit Monitor registers (see Section 6.10.1) and, when read, are returned as packed binary values. The unscaled values must then be converted to their equivalent measured currents and voltages. Appendix A describes the scaling process.

2.3 Energy Management Alarms

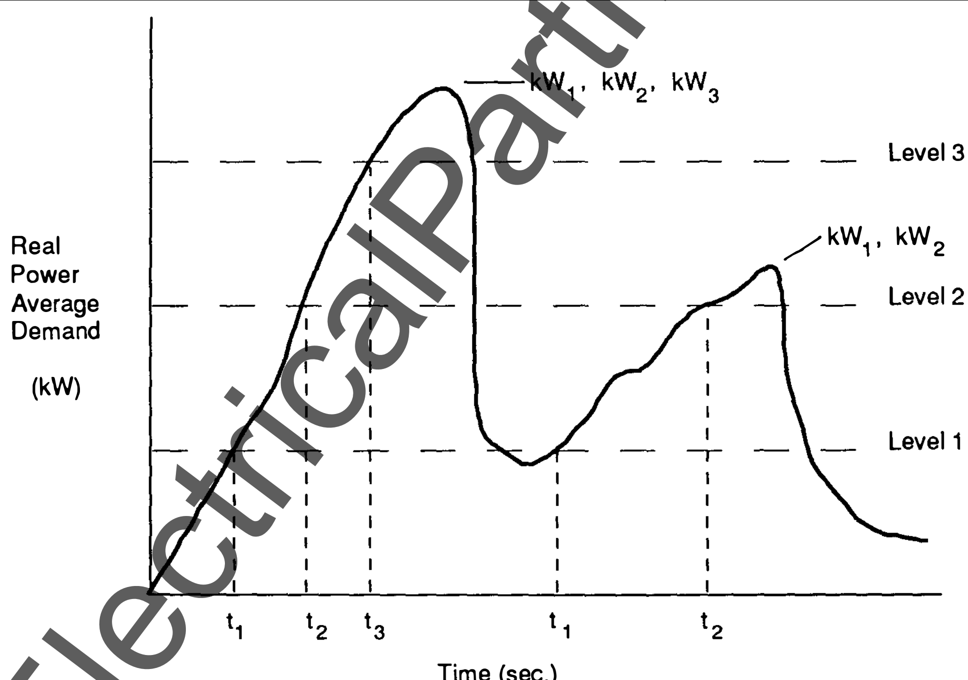
The Circuit Monitor includes three independent Energy Management Alarm levels for comparison with computed Real Power Average Demand values. The alarm levels are user-defined parameters, set via the communications link, ranging from 0 to 32,767 kW.

When the Real Power Average Demand (regardless of direction of power flow, that is, without regard to sign) exceeds an alarm setpoint, the Circuit Monitor indicates that a setpoint level has been exceeded, records the date and time of the event, and records the maximum level of average demand power eventually reached. (The maximum level reached is stored as a signed quantity indicating direction of power flow). For example, if alarm setpoint level 1 is 10,000 kW and the Real Power Average Demand reaches -10,001 kW (the "-" sign indicates reverse power flow), then the alarm set point has been exceeded, and the values discussed above are recorded.

Any time that an alarm set point is changed, the corresponding historical information for that set point should be cleared. Figure 2-3 offers a graphical illustration of the Energy Management Alarms feature and the historical data stored.

2.4 Communications

Circuit Monitor communications are made possible via an RS-485 (RS-422A compatible) communication link, which permits asynchronous, multipoint communications to a host device, such as a SY/MAX processor, or similar controlling unit. (For more on Circuit Monitor communications, refer to section 6.0).



Values Stored by the Circuit Monitor:

Time/Date

t_1, t_2, t_3 = Time/Date which Alarm Levels 1, 2, and 3 are exceeded, respectively.

Maximum Level Reached

kW_1, kW_2, kW_3 = Maximum kW level reached during the *Most Recent* alarm for Levels 1, 2, and 3, respectively.

Figure 2-3 - Illustration of Energy Managment Alarms

3.0 HARDWARE DESCRIPTION

3.1 External Hardware

The Circuit Monitor enclosure consists of three separate pieces of 16 gauge steel: a rear cover, a front cover, and an optional trim ring. The unit is self-cooled by convection and, therefore, has no ventilation openings (See Figure 3-2). The Circuit Monitor is typically attached to an electrical panel with the use of an optional trim ring which is secured through eight holes on the edge of the unit. (See Section 4.0 for complete instructions on Circuit Monitor installation). The Circuit Monitor has a total of 17 external connections which provide for the following:

- •Inputs from Current Transformers (6 lines)
- •Inputs from Potential Transformers (3 lines, neutral)
- •Control Power (2 lines)
- •External Communications (2 lines In, 2 lines Out, shield)

The connections are made to terminal blocks mounted on the back of the Circuit Monitor (See figure 3-1). Table 3.0 lists the location and purpose of each terminal connection.

Also located on the rear of the Circuit Monitor is the Device Address Door (See Figure 3-1). This door allows access to two ten-position rotary switches which determine the communications address of the Circuit Monitor. (For information on setting the address switches, refer to section 5.1).

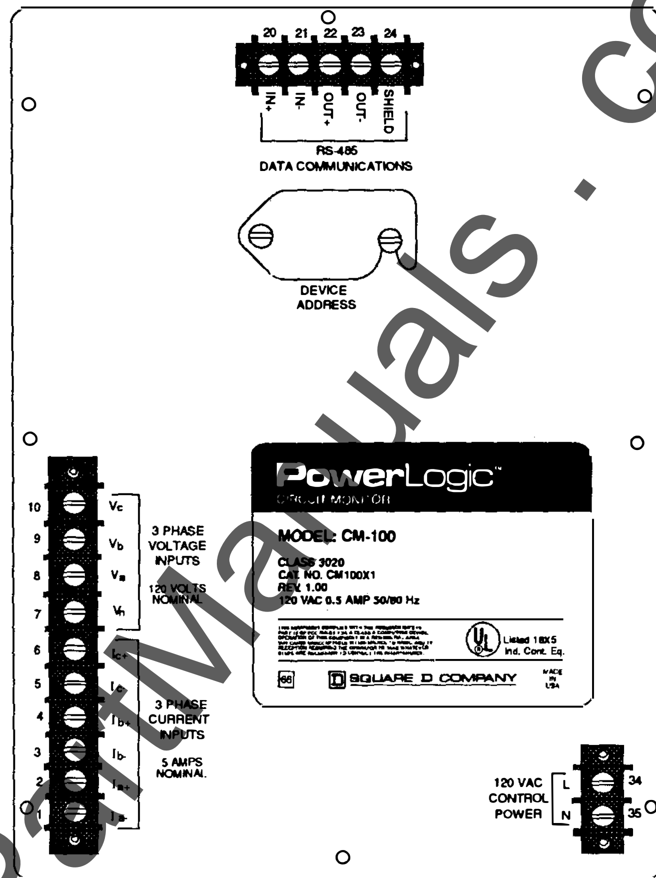


Figure 3-1 - Back of Circuit Monitor

Terminal No.(s)	Symbol(s)	Purpose
1-6	(Ia-,Ia+,Ib-,Ib+,Ic-,Ic+)	Inputs from Current Transformers
7	Vn	Potential Transformer Neutral
8-10	(Va,Vb, Vc)	Inputs from potential transformers
20-21	(IN+, IN-)	RS-485 Input for External Communication
22-23	(OUT+, OUT-)	RS-485 Output for External Communication
24	SHIELD	Communications Shield
34-35	(L, N)	120 VAC Control Power Input Terminals

Table 3.0 - Description of Circuit Monitor Terminal Connections

3.2 Specifications

Metering Specifications

Current Inputs (Each Channel)
- Current Range .... 0 - 7.0 A AC
- Nominal Current .... 5A AC

Voltage Inputs (Each Channel)
- Voltage Range .... 0 - 180V AC
- Nominal Voltage (typical) .... 120V AC

Frequency Range .... 23 to 65 Hz
Harmonic Measurement ....Through 31st

Accuracy (In percent of full scale)
- Current measurements........................... +/- 1.0%
- Voltage measurements.......................... +/- 1.0%
- Power .... +/- 2.0%
- Power Factor .... +/- 4.0%
- Energy ....+/- 2.0%
- Frequency .... +/- 0.5%
- Temperature ....+/- 2° C
- Time of Day Clock (At 25°C)...+/- 1 sec in 24 hrs

Data Update Time...................................... 0.817s (4-wire)
(For Instantaneous Readings) 1.000s (3-wire)

Metering Input Electrical Specifications

Current Inputs
- Overcurrent Withstand Rating 15A Continuous
  50A for 10 sec in 1 hr
  500A for 1 sec in 1 hr
- Burden .... Less than 0.15VA
- Isolation .... 1500V, 1 MIN

Voltage Inputs
- Overvoltage Withstand Rating 180V AC Continuous
- Input Impedance .... 1 MegOhm, minimum

Control Power Input

Voltage
- Nominal ....120 VAC
- Operating Range ....102-132 VAC
- Burden .... 20 VA
- Frequency Range ....45.0 to 65.0 Hz
- Isolation ....1500V, 1 min

Ride-Through on Power Loss ... .244 sec at 120 VAC

Environmental Specifications
- Operating Temperature ....-25 to +70 degrees C
- Storage Temperature ....-40 to +85 degrees C
- Humidity Rating .... 5 - 95% Relative Humidity (non-condensing)

Physical Specifications
- Weight (approx.) .... 7 lbs.
- Dimensions ....8.73"W x 11.65"H x 2.17"D (approx., without trim ring)
- Overall Dimensions ......8.91"W x 11.91"H x 2.17"D (with trim ring)

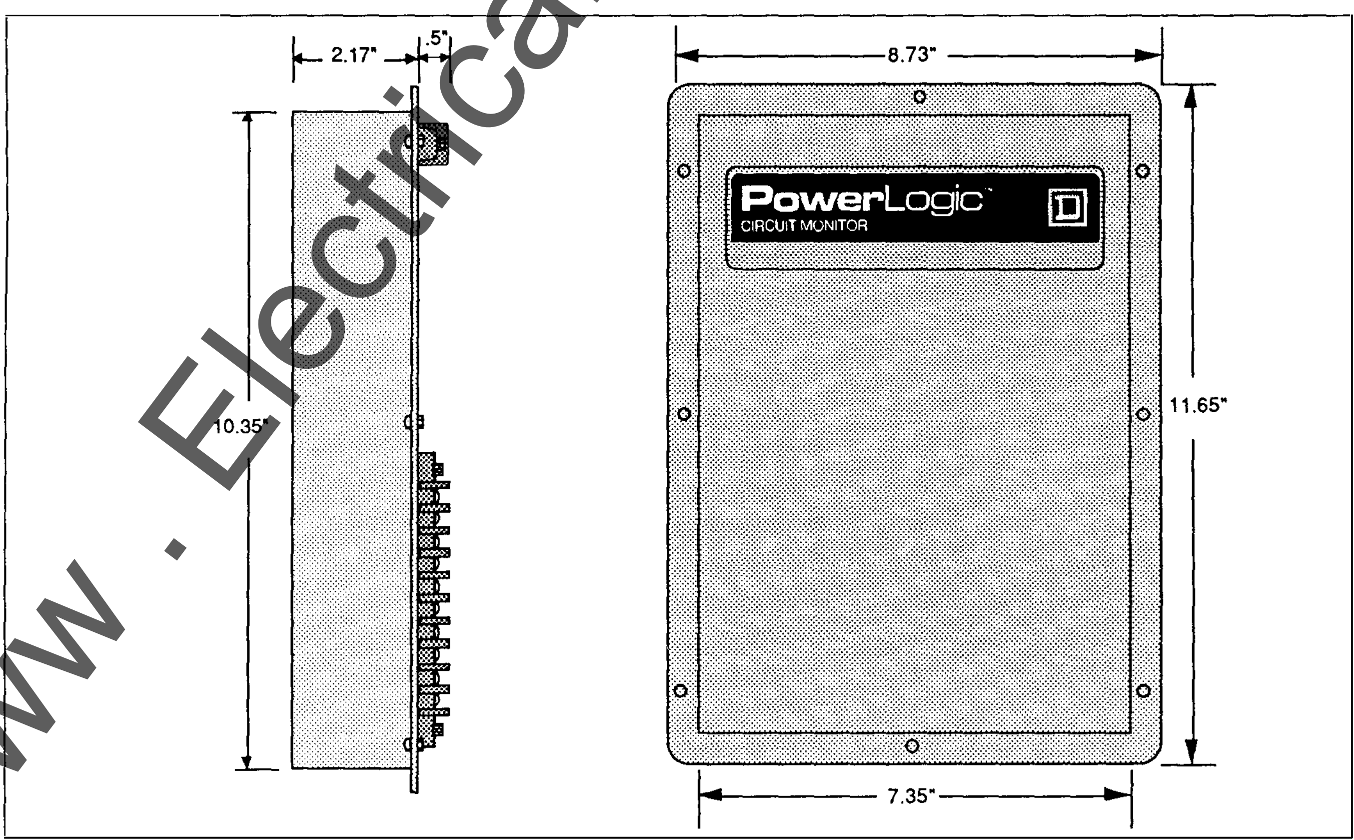


Figure 3-2 - Circuit Monitor with dimensions

4.0 INSTALLATION

4.1 Introduction

This section covers the installation of the Circuit Monitor including:

- Mounting
- Wiring
- Grounding

Included are the drawings and wiring diagrams needed for proper installation.

4.2 Mounting

The Circuit Monitor is normally mounted as a semiflush device that projects through a panel or breaker cell door. Low profile rear terminal blocks are used to prevent interference with devices behind the panel or door. Table 4.0 lists typical mounting locations anticipated for the Circuit Monitor when applied in various power equipment designs.

In situations where space is limited or multiple Circuit Monitors are required in an enclosure, the unit may be mounted using another method.

4.2.1 Panel Preparation

Panel or cell door preparation includes the drilling of eight mounting holes and the removal of a 7.41" x 10.41" cutout. Refer to Figure 4-1 for exact dimensions. (NOTE: Before preparing the cutout, refer to Figure 3-2 and verify that the required clearances exist).

4.2.2 Installing the Circuit Monitor

The Circuit Monitor is secured to the electrical panel with the use of eight machine screws or an optional trim ring. First, insert the Circuit Monitor through the cutout from the rear of the panel or breaker cell door. Guide the machine screws or the trim ring's mounting studs through the holes which have been drilled in the panel, then through the mounting holes on the Circuit Monitor's edges. Secure the unit using eight Hex nuts which are provided with the unit. Figure 4-2 illustrates Circuit Monitor installation.

⚠WARNING

CT and PT inputs may contain potentially hazardous currents and voltages.

4.3 Wiring

Figures 4-3, 4-4, and 4-5 offer typical wiring plans for one or more Circuit Monitors in a 3-phase/3-wire system, a 3-phase/4-wire system, and a 3-phase/4-wire system with mixed loads (3-wire and 4-wire loads). Circuit Monitor 1 in each figure illustrates the wiring for a single unit. The second Circuit Monitor in each figure illustrates the method for wiring multiple Circuit Monitors in a system. Multiple Circuit Monitors are paralleled allowing CMs to share one set of 3-phase PTs. (NOTE: This wiring method requires that PT secondaries are grounded in only one location). Unlike the PTs, each Circuit Monitor requires a separate set of CTs, wired as shown by the first Circuit Monitor in Figures 4-3, 4-4, and 4-5. The following list summarizes important wiring considerations.

- Multiple Circuit Monitors may be connected in parallel to a single set of PTs
- Each Circuit Monitor requires its own set of CTs
- PT secondaries are grounded in only one location

4.4 Grounding

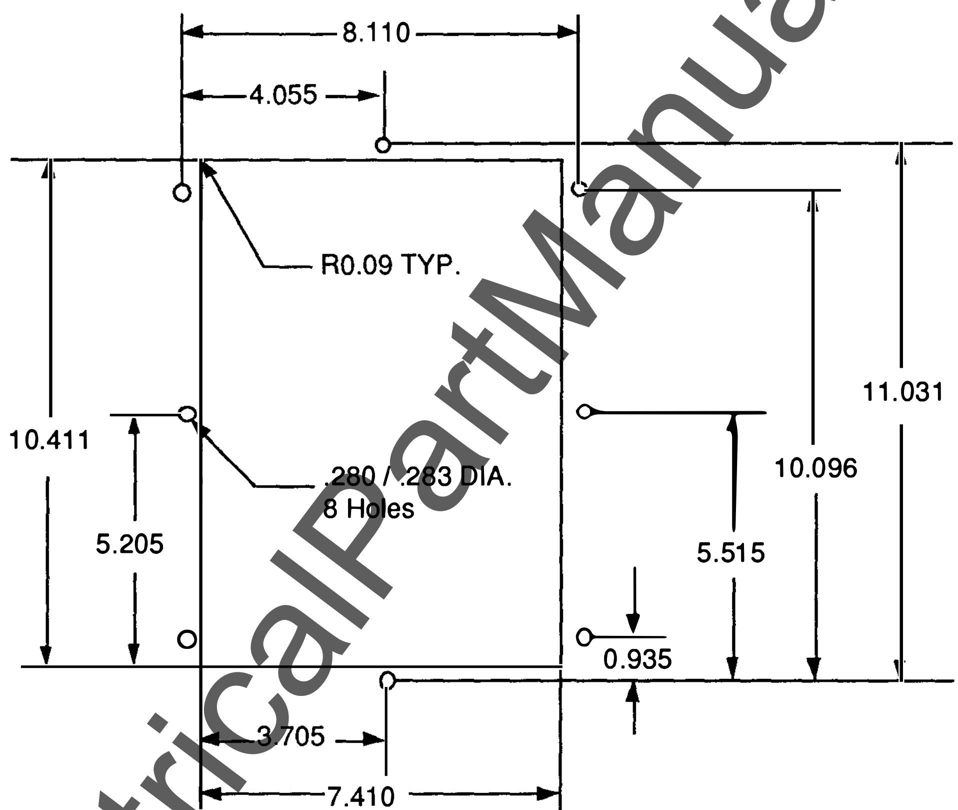
Grounding of the Circuit Monitor case is normally accomplished through the connection of its hardware to a grounded metal enclosure. If additional grounding is deemed necessary, a separate equipment ground wire may be connected to one of the Circuit Monitor's mounting studs.

⚠CAUTION

Dielectric testing of the Circuit Monitor may damage the unit. DO NOT HI-POT.

Equipment Type	Mounting Location
QED Switchboards, Model 5 MCCs	Main Meter Location or Aux. Section
Power Zone III Switchgear	Front of Breaker Cell Door
HVL and Visi/Vac Switchgear	9-inch Front Panel or Instrument Door
Metal-Clad and Substation CBs	Standard Relaying Locations
Isoflex Medium Voltage MCCs	Standard Relaying Locations

Table 4.0 - Typical Circuit Monitor Mounting Locations



Dimensional tolerances of -0" to +.05" unless otherwise noted.

Figure 4-1 - Panel Preparation

Item	Qty	Description	Part Number
1	1	Trim Ring	CMX-101
2	1	Circuit Monitor Assembly	
3	8	Nut, 12-24 HEX, Nylon Lock (Supplied with trim ring kit)	

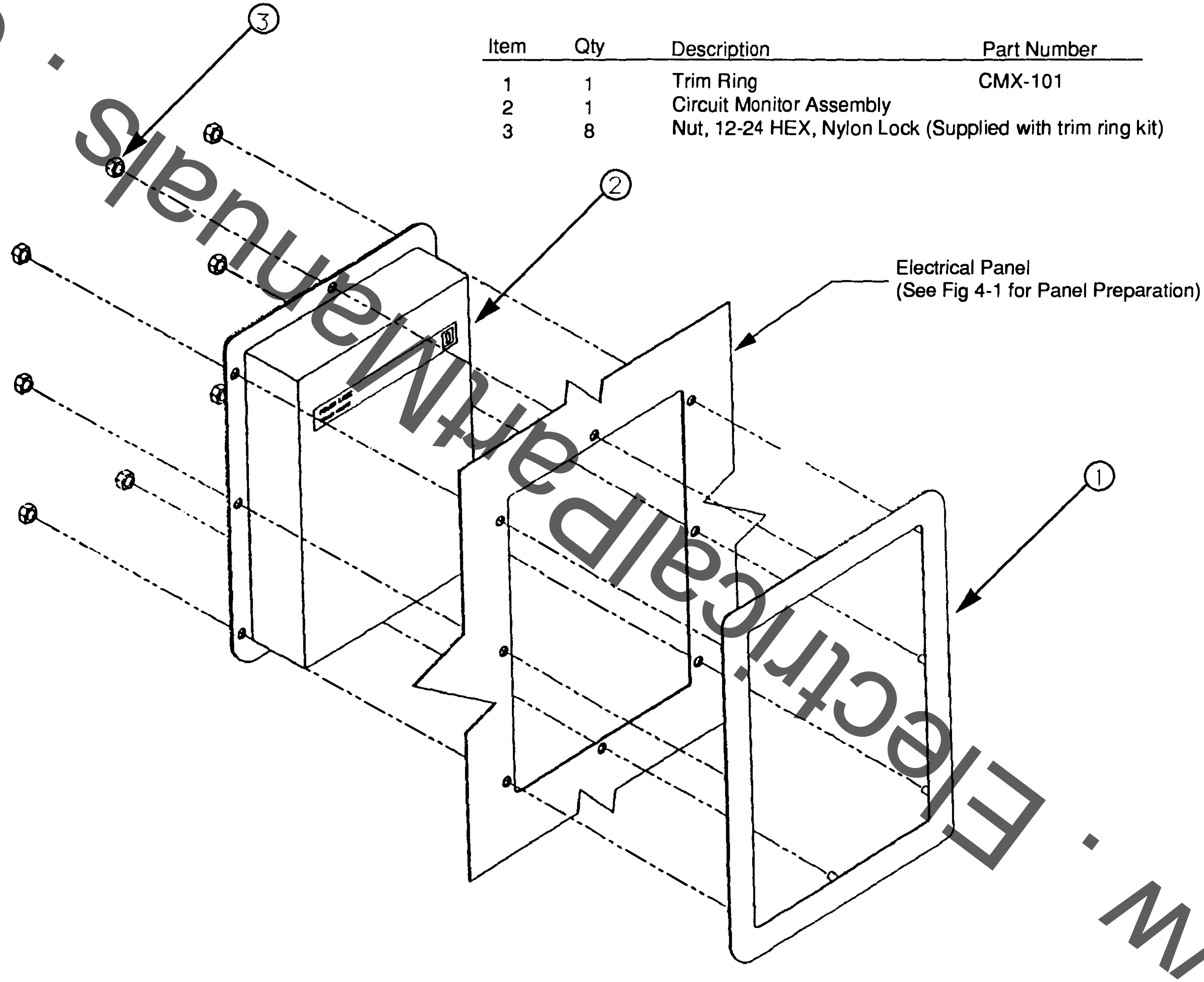


Figure 4-2 - Circuit Monitor Installation

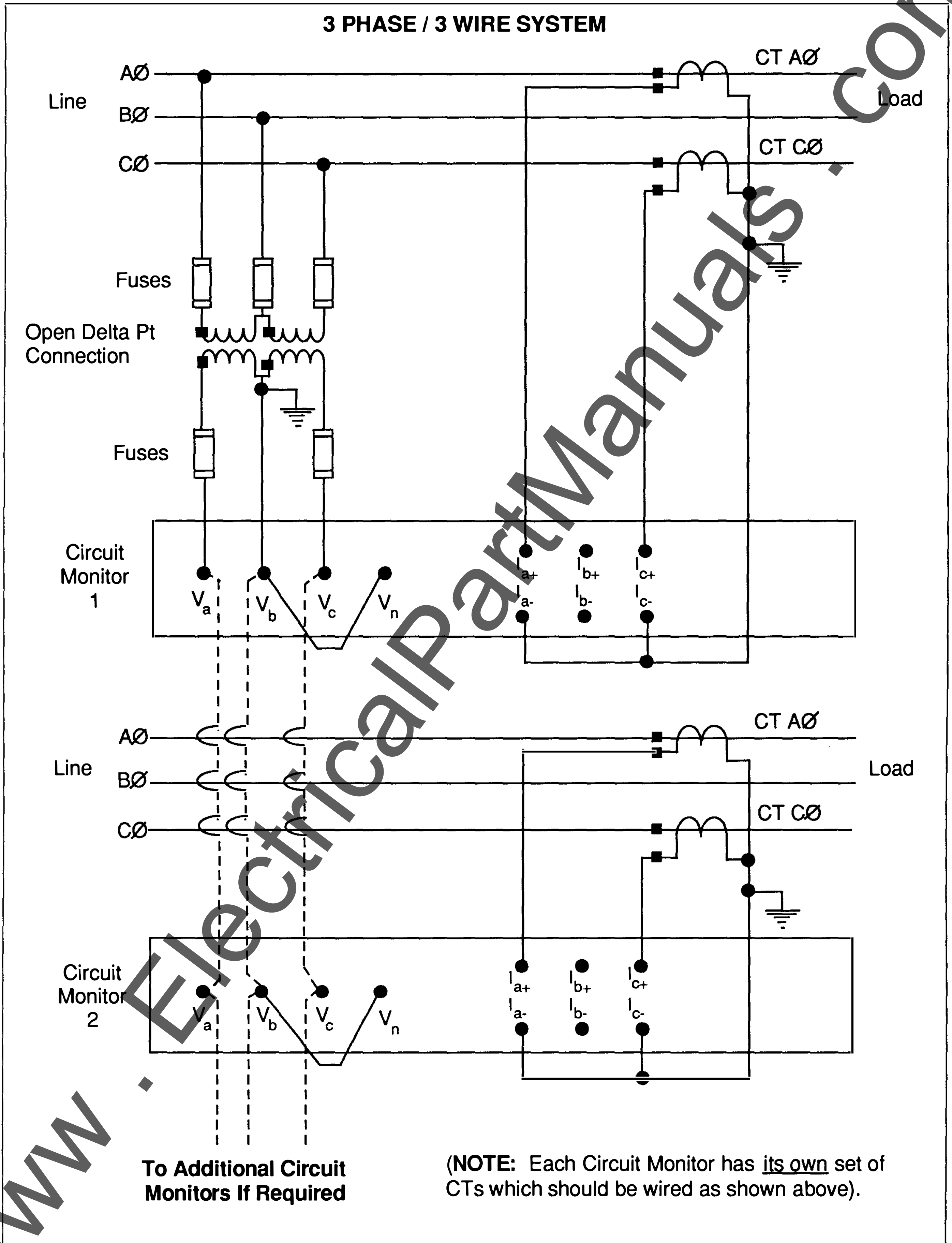


Figure 4-3 - Circuit Monitor Wiring Diagram for 3 phase/ 3 wire system.

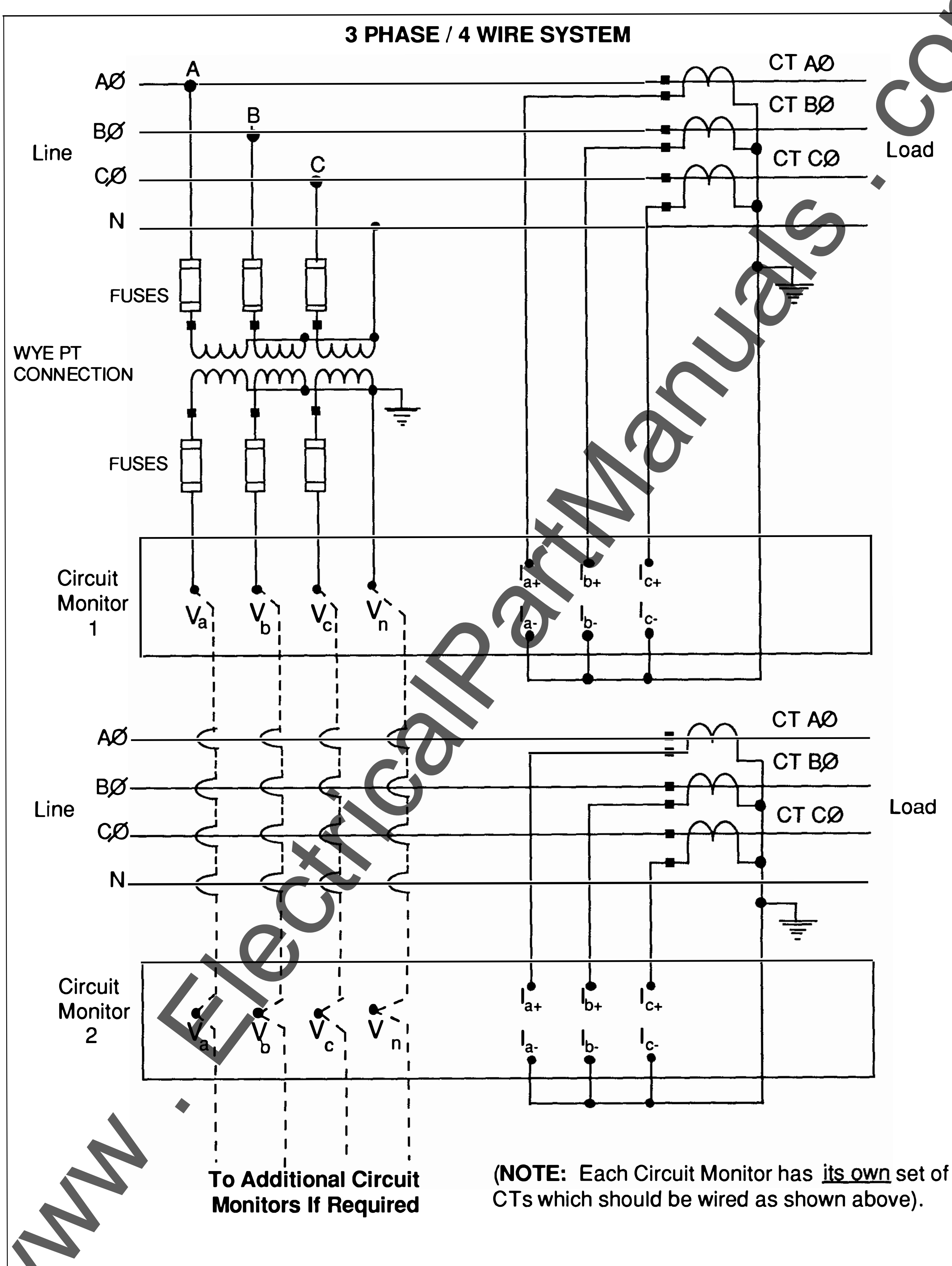


Figure 4-4 - Circuit Monitor Wiring Diagram for 3 phase/4 wire system.

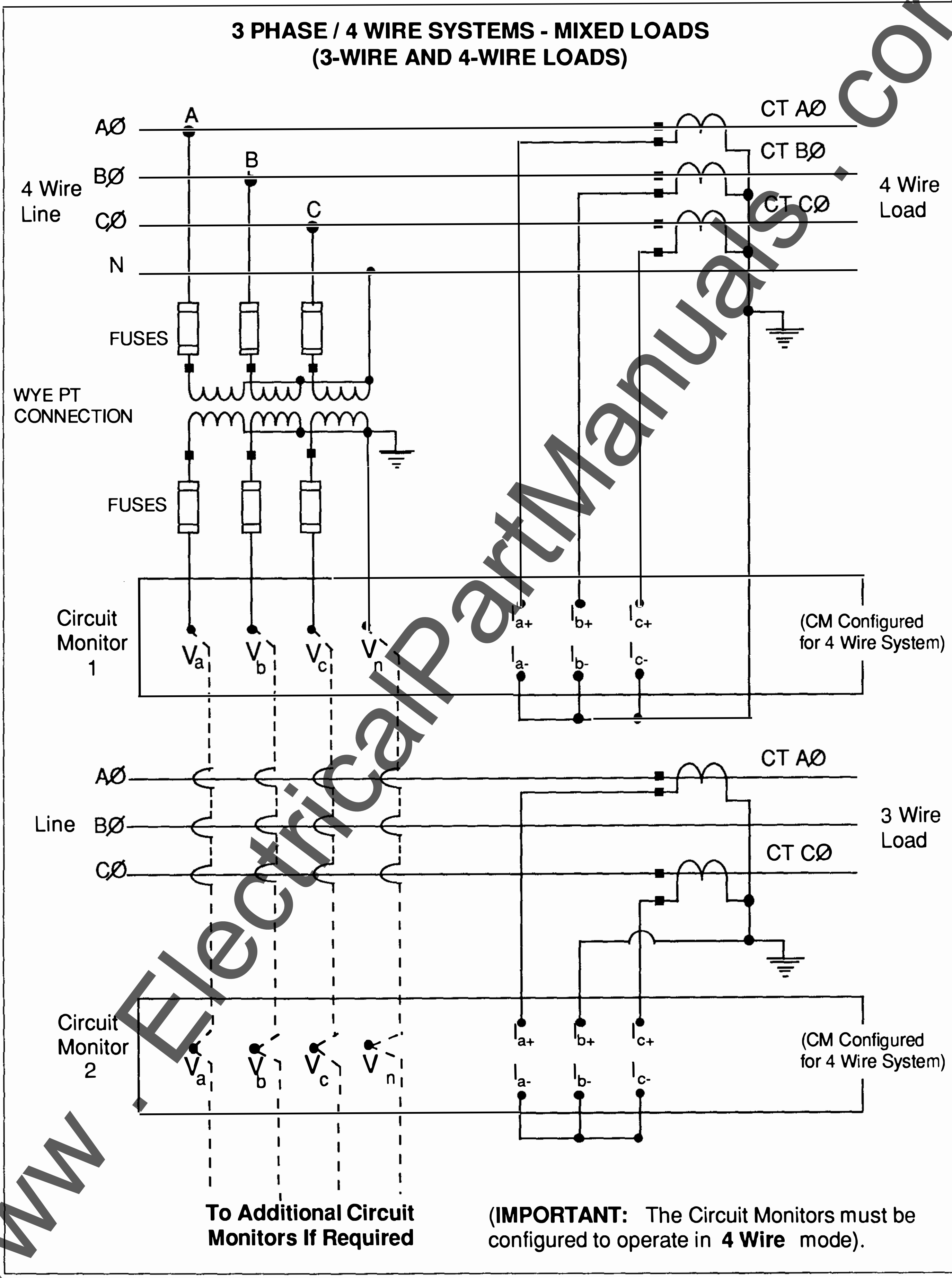


Figure 4-5 - Circuit Monitor Wiring Diagram for 3 phase/4 wire systems with mixed loads.

5.0 OPERATION

This section discusses the operation of the Circuit Monitor. It covers setting the unit's address, setting the baud rate, user-defined parameters, startup, and operation upon power-up and loss of power.

5.1 Setting the Address Switches

Each Circuit Monitor in a system must have a unique address assigned to it. (In this context, the term system means one or more Circuit Monitors "daisy chained" to a processor or similar controlling device). Once assigned, a Circuit Monitor's address is used in a manner similar to one's home address; for example, for the host to exchange information with the Circuit Monitor whose address is 12, it sends the information over the communication lines, accompanied by the address of the target Circuit Monitor (number 12). In this way, information can be routed to specific units in a system.

A Circuit Monitor's address is determined by two ten-position rotary switches located behind a door on the rear of the unit (see Figure 5-1). The switches are accessed by loosening the screws which secure the device address door, and sliding the right end of the door toward the top of the Circuit Monitor. The switches allow a total of 100 settings (0 to 99). The Circuit Monitor only recognizes 39 of those settings, 33 of which are reserved for addressing the unit. (Refer to Table 5.0 for a summary of Circuit Monitor switch settings).

Circuit Monitors can be used in either a multipoint or point-to-point configuration. In either case, CM to host communications are virtually the same. A difference arises in the setting of the address switches. The following paragraphs illustrate the difference.

In a system with multiple CMs in a multipoint configuration, the last CM in the daisy chain, i.e. the CM which is located farthest from the processor, should have the address 01. This is necessary to ensure maximum reliability with standard SY/MAX® protocol. SY/MAX devices periodically send out an *inquire* signal to ensure that the communications link has not failed due to poor connections, device failure, etc... The inquire signal is sent to the device addressed as 01. Failure of CM 01 to respond will result in a communication error. Assigning address 01 to the last CM in a chain, allows the connections preceding CM 01 to be checked since the signal must traverse the entire chain to reach the final unit. Subsequent units may then have any address in the range (2..32), excluding the addresses of previously installed units.

In a system utilizing a single CM in a point-to-point configuration, the address switches on the rear of the unit must be set to 00. This informs the CM's internal logic that communications are point-to-point. The communication lines are then biased for proper operation in the point-to-point mode. **Important:** *Though the address switches are physically set to 00, the logical address of the Circuit Monitor will remain 01. Therefore, all communications to the unit should be sent to Circuit Monitor 01, not CM 00.*

Circuit Monitors are shipped with a default address of 01. To change the address of a Circuit Monitor complete the following steps:

1) Turn the control power to the unit off.
2) Set the address switches to a unique number in the range 1..32. (Set switches to 00 for a single CM system).
3) Return control power to the unit.

Switch Setting	Function
0	Switch Setting for a single CM using point-to-point communications. (Logical device address will be 01).
1-32	Determines the Device Address
33-93	Reserved
94-98	Used to Set the Unit's Baud Rate
99	Reserved

Table 5.0 - Summary of Circuit Monitor Address Switch Settings

The Circuit Monitor must be powered down when the address switches are changed. Once changed, the Circuit Monitor will respond to the new address upon return of control power. The Circuit Monitor will retain its address upon loss of control power if the address switches are not changed during the period of power loss.

5.2 Setting the Baud Rate

The Circuit Monitor is capable of communicating at the following baud rates:

- 19.2 K baud
- 9600 baud
- 4800 baud
- 2400 baud
- 1200 baud

Each Circuit Monitor is shipped with a default setting of 9600 baud, which may be reset as required. The baud rate is set with the use of the device address switches located on the rear of the unit (See Figure 5-1).

To change the baud rate, turn off the control power to the unit, set the device address switch to either 94, 95, 96, 97, or 98, and return control power to the unit. Table 5.1 shows the proper switch settings required for each baud rate.

Address Switch Setting	Baud Rate
94	1200
95	2400
96	4800
97	9600 (default)
98	19.2 K

Table 5.1 - Baud Rate Switch Settings

After the baud rate has been changed, the Circuit Monitor's address must be reset. Section 5.1 details the setting of the Circuit Monitor address. The list that follows summarizes the steps required to change a Circuit Monitor's baud rate. Steps 1-3 change the unit's baud rate. Steps 5-7 reset the device address.

1) Turn off control power to the unit.
2) Set the device address switch to the proper baud rate setting (see Table 5.1).
3) Return control power to the unit.
4) Wait 5 seconds.
5) Turn off control power to the unit.
6) Reset the Circuit Monitor's address (see Section 5.1).
7) Return control power to the unit. The Circuit Monitor will communicate at the selected rate.

The Circuit Monitor will retain its baud setting upon control power loss.

5.3 User Defined Parameters

The Circuit Monitor has 13 user-defined parameters which can be set via the communications link. Each value has a factory default which becomes active upon initial power up. The parameters and the default value of each are listed in Table 5.2.

Upon initial power-up, the user must configure the CM to operate in the desired environment. This is done by transmitting the proper user-defined parameters to their respective storage registers via the communications link. (Section 6.10 offers a complete list of Circuit Monitor Register Assignments). The parameters are stored in non-volatile memory upon loss of power and remain unchanged until new values are transmitted by the user.

Important: After transmitting a new value for System Connection (Reg 200), Current Reporting Precision (Reg 200), CT Ratio (Reg 201), or PT Ratio (Reg 202) to the Circuit Monitor, the user must force a software restart by writing 16 (decimal) to register 237. Failure to force a restart after transmitting a new value to register 200, 201, or 202 will result in incorrect metering values.

5.4 Operation on Complete Loss of Power

When a power-loss occurs, the Circuit Monitor stores all accumulated and historical values in non-volatile memory. The date and time of the power-loss are also stored, and a power-loss status bit is set to indicate that this condition has occurred.

5.5 Operation on Power-Up

On initial power-up (or restoration of power), the Circuit Monitor starts with its calendar set to 01-01-1900 and its clock set at 00:00:00. The correct date and time must then be

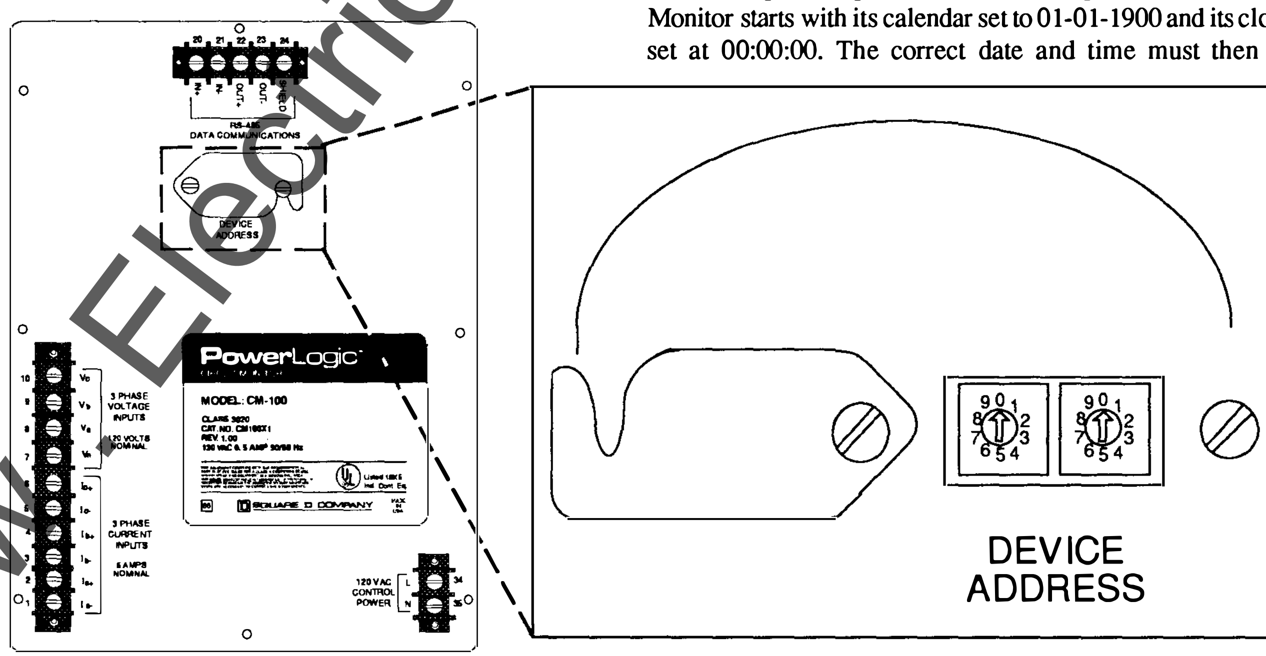


Figure 5-1 - Device Address Switches

transmitted to the unit via the communications channel. Upon receipt of new clock/calendar data, the Circuit Monitor will reset the power-loss status bit and update the calendar and clock to the corrected date and time.

5.6 Startup

When properly installed, the Circuit Monitor will operate upon initial application of power. Until changed, the unit will utilize default values for baud rate, address, and user-defined parameters. To ensure proper operation in a specific environment, the following tasks must have been completed.

- Correct unit wiring and external connections. (See Section 4.0).
- Unit set to operate at proper baud rate. (See Section 5.2).
- Device address switches set to a unique address. (See Section 5.1).
- Proper user-defined parameters transmitted to the unit via the communications link. (Sect 5.3).

Parameter	Allowed Values	Default Value	Register
System Connection (⇨) (▲)	3 = 3-Phase, 3-Wire 4 = 3-Phase, 4-Wire	4	200
Current Reporting Precision (✳) (▲)	0 = amps 1 = tenths of amps	0	200
CT Rating (x:5) (▲)	5 to 9999	5	201
PT Rating (xxxxx:120) (▲)	120 to 32,767	120	202
Accumulated Energy	0 = Absolute Accumulation 1 = Signed Accumulation	0	215
Demand Interval	5 to 60 minutes	15	216
Circuit Monitor Label(✥)	ASCII (4 char. max)	TEST	218-219
Circuit Nameplate Data (✿)	ASCII (16 char. max)	CIRCUIT MONITOR	220-227
Date/Time - CM Format (✓)	MM/DD/YY HH:MM:SS	01/01/00 00:00:00	228-230
Date/Time -Sy/Max Format (✓)	MM/DD/YY HH:MM:SS	01/01/00 00:00:00	784-789
Energy Mgt Alarms: Set Point Level 1 Set Point Level 2 Set Point Level 3	 0 to 32,767 kW 0 to 32,767 kW 0 to 32,767 kW	 32,767 32,767 32,767	 240-241 242-243 244-245
Utility Registers (❑)	-32,767 to +32,767	None	246-255

NOTES:
(⇨) This parameter used to select 3-wire or 4-wire algorithm (2-wattmeter or 3-wattmeter calculation method) used in instrumentation calculations.
(✳) This parameter used to determine whether current related values will be reported in amps or tenths of amps. Table 2.2 shows the affected values.
(✥) This field is a label associated with this Circuit Monitor
(✿) These characters are typically associated with the monitored circuit. For example, if the CM monitors the circuit to the welder on production line 3, the nameplate may be "Welder Line 3".
(✓) 200-Year calendar, beginning year 1900 (00 = 1900)
(✖) This field is used to guard against unintentional operation of the output contacts.
(▲) After transmitting a new value for System Connection, Current Reporting Precision, CT Ratio or PT Ratio, the user must force a software restart by writing 16 (decimal) to register 237.
(❑) These are read/write registers which may be used as required. They will contain meaningless values until they have been written to.

Table 5.2 - User Defined Parameters

6.0 COMMUNICATIONS

6.1 Communications Standard

The Circuit Monitor supports a protocol which is compatible with standard SY/MAX® products. Circuit Monitor communications are made possible via an RS-485 electrical interface which offers RS-422 compatibility and allows multipoint communications from a single controlling source.

The RS-422 standard provides for point-to-point communications. This means that a SY/MAX processor, for example, can communicate *directly* to a single device such as a Network Interface Module (NIM). The NIM must then regenerate the signal and send it to the next device. This process is repeated from point-to-point until the target device has been reached.

In contrast, the RS-485 standard allows asynchronous, multipoint communication to a maximum of 16 Circuit Monitors per input channel. For example, 16 Circuit Monitors may be daisy chained to a single SY/MAX processor's input channel. This allows the processor to send a message to a specific unit without the need for each Circuit Monitor to interpret and regenerate the signal. This method of communication is accomplished with the use of routing. Section 6.5 offers a description of the use of routing in Circuit Monitor communications.

6.2 Baud Rates

The Circuit Monitor is capable of communication at five baud rates, offering a high degree of flexibility. The following baud rates are supported by the Circuit Monitor:

- 19.2 K baud
- 9600 baud
- 4800 baud
- 2400 baud
- 1200 baud

The baud rate may be set externally using the device address switches located on the rear of the Circuit Monitor. Section 5.2 details the steps required to change the unit's baud rate.

6.3 Communication Wiring

The Circuit Monitor requires a communication cable containing two shielded twisted pairs (Belden 8723 or equivalent). Communications wires are daisy-chained from one Circuit Monitor to the next, IN+ being wired to IN+, OUT- to OUT-, and shield to shield. Figure 6-0 offers a drawing illustrating daisy-chained CMs. The connection to a processor, NIM, or remote workstation is made using a 9-pin male (DB-9) connector. Figure 6-1 illustrates the required cable pinouts.

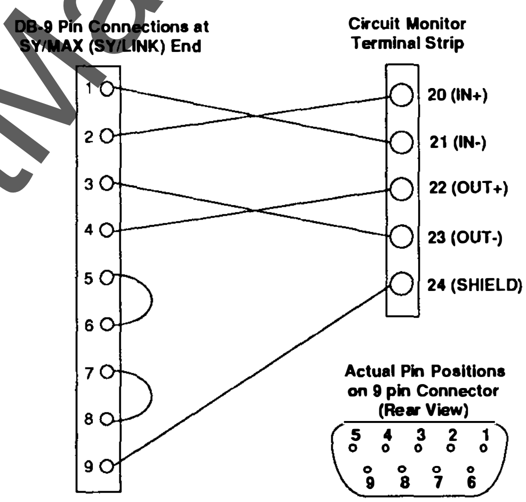
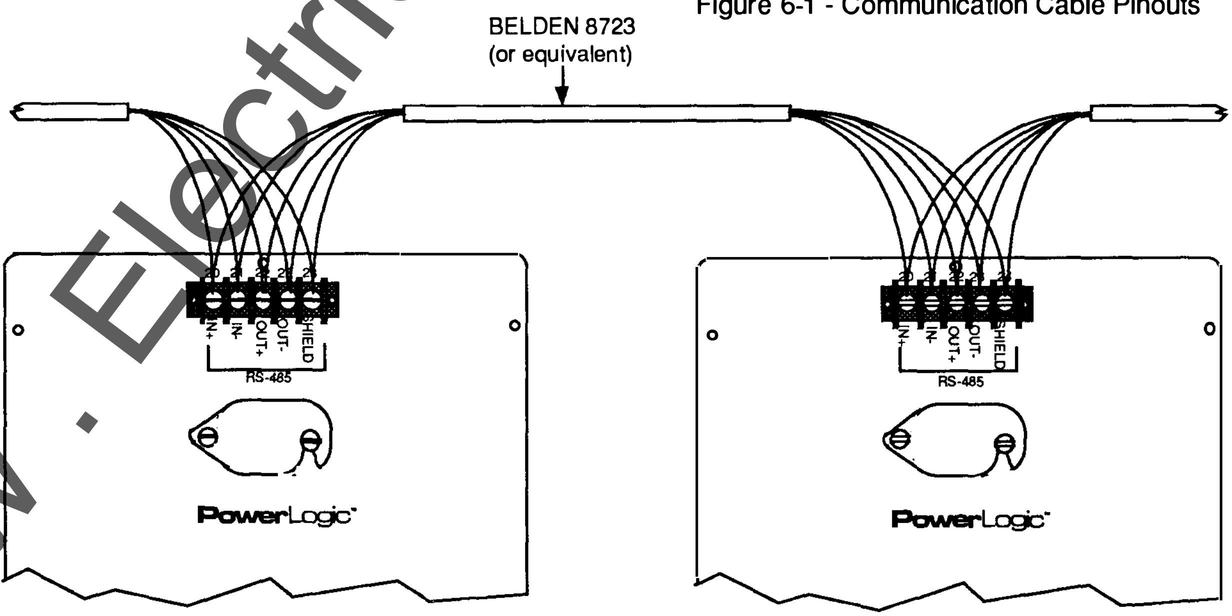


Figure 6-1 - Communication Cable Pinouts



IMPORTANT: The communications shield is terminated at <u>each</u> Circuit Monitor.

Figure 6-0 - Circuit Monitor Communication Wiring

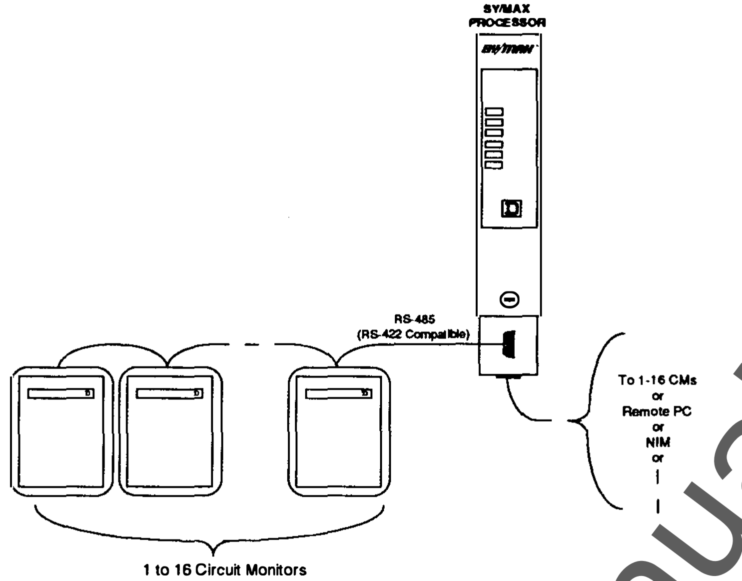


Figure 6-2 - CM Connection to a Communication Port of a SY/MAX Processor

Note: When CMs are connected to the RS-422 port of a SY/LINK card, the port should be configured to operate in Net-to-Net mode. (See the SY/LINK card's instruction bulletin for instructions on configuring the port).

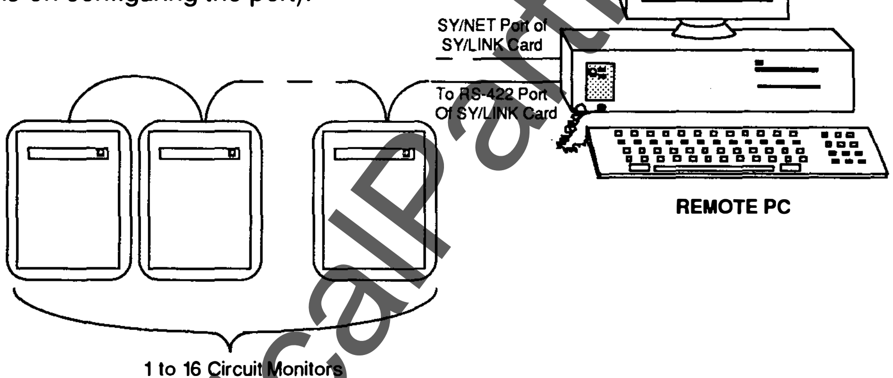


Figure 6-3 - CM Connection to Remote PC Via RS-422 Port of SY/LINK Card

Note: When CMs are connected to the communication port of a NIM, the NIM's port should be configured to operate in Net-to-Net mode. (See the NIM instruction bulletin for instructions on configuring the port).

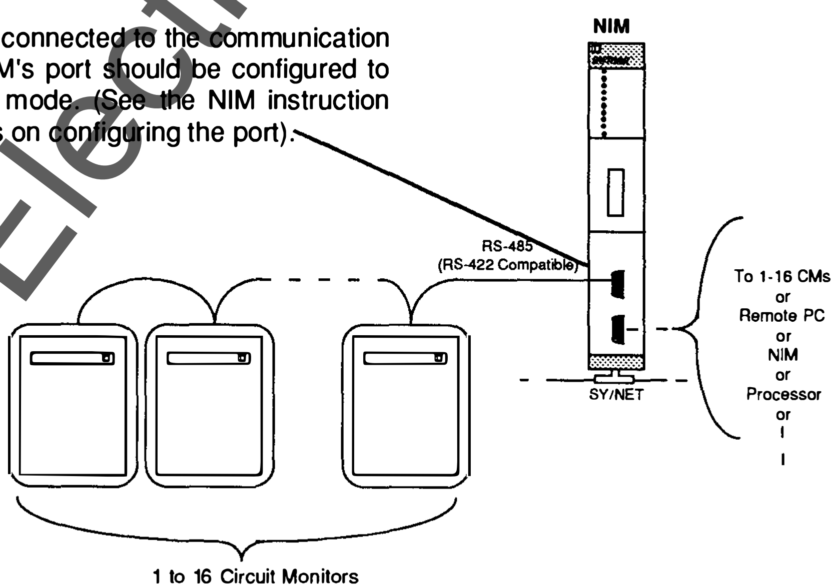


Figure 6-4 - CM Connection to Communication Port of Network Interface Module (NIM)

6.3.1 Termination and Bias of Communication Lines

To ensure accurate communications, steps must be taken to properly terminate and bias the Circuit Monitor communication lines. The following paragraphs detail the necessary steps.

Termination of the communication lines is achieved with the use of the PowerLogic RS-485 Multipoint Communications Terminator (Catalog No. MCT-485). The terminator has four spade connectors which are connected to the IN+, IN-, OUT+, and OUT- communication terminals on the rear of the Circuit Monitor. (See figure 6-6).

IMPORTANT: *Only the **last** CM in a communications link must be terminated.* For example, if a link contains only a single Circuit Monitor, that CM must have a terminator. If multiple CMs are daisy chained together, only the *last* CM in the link should be terminated. Figure 6-6 illustrates the proper placement of the terminator.

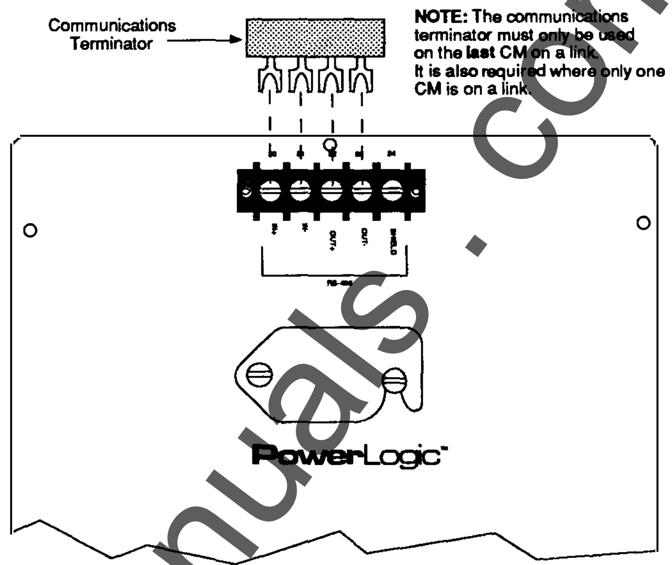


Figure 6-6 - Multipoint Communications Terminator

The communication lines are biased with the use of the PowerLogic RS-485 Multipoint Communications Adapter (Catalog No. MCA-485). The 9-pin, male to female adapter is attached to the host device to which multiple CMs are daisy chained. Possible connection points include: the RS-422 port of a SY/LINK® Card, the communications port of a Network Interface Module, and the communications port of a Model 400 processor. Figure 6-5 illustrates the adapter connected to a communications port of a Model 400 processor.

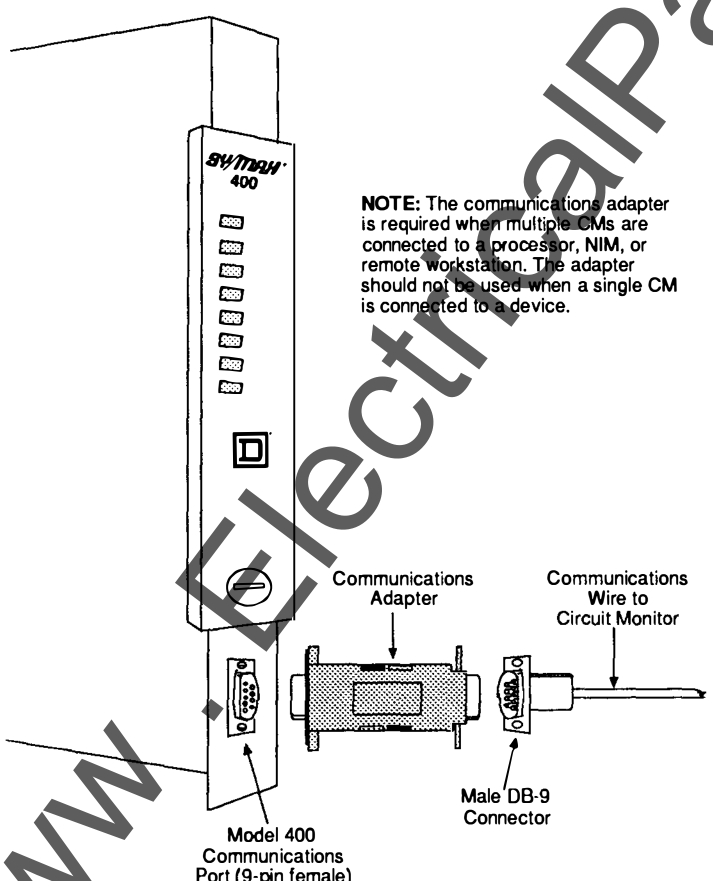


Figure 6-5 - Multipoint Communications Adapter

IMPORTANT: Unlike the Communications Terminator, the Communications Adapter need <u>not</u> be used when only one Circuit Monitor is on a link. When a single CM is used, its address switches must be set to 00 which causes the lines to be properly biased. (See Section 5.1). The Communications Adapter must only be used when *multiple* CMs are daisy chained on a communications link.

6.4 Communication Options

The Circuit Monitor offers three communication options by which data may be obtained. They are:

1) Connection to the communications port of a SY/MAX Processor (See Figure 6-2).
2) Connection to a remote personal computer via the RS-422 port of a SY/LINK Card (See Figure 6-3).
3) Connection to the communications port of a SY/MAX Network Interface Module (See Figure 6-4).

As illustrated in figures 6-2 through 6-4, up to 16 Circuit monitors may be connected to a single communications port. Therefore, a NIM, which has two ports, may have up to 32 CMs connected to it, as may a processor. The SY/LINK Card, which has only one RS-422 port, is limited to 16.

6.5 Communicating to Multiple Circuit Monitors

The Circuit Monitor's RS-485 electrical interface allows multipoint communications with SY/MAX equipment designed for point-to-point communications. For example, a SY/MAX processor may have 16 Circuit Monitors connected to a communication port and may communicate directly to any of the 16 units. This is accomplished by designating the address of the target unit in a route statement. (NOTE: This section assumes a basic understanding of SY/MAX routing techniques. It does not attempt to teach routing, but simply to illustrate the use of routing in communicating to a Circuit Monitor that is daisy chained to multiple Circuit Monitors. For a discussion of SY/MAX routing techniques, refer to the bulletins listed below).

Description	Bulletin
SY/MAX Class 8010 Type SFI-510, 533, 534 SY/LINK Network Interface Boards	30598-27701
SY/MAX Class 8010 Type SPR-300, 310 Deluxe CRT Programmers	30598-167-01

The Instruction bulletin for the SY/MAX processor to be used will also be helpful.

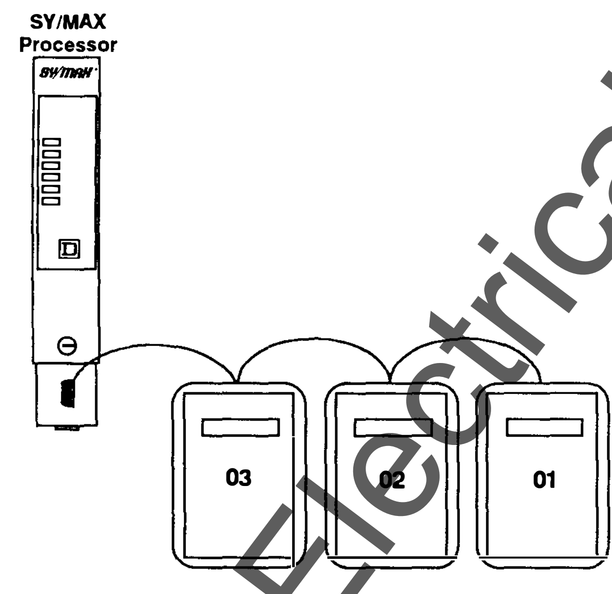


Figure 6-7 - Multiple Circuit Monitors

Each Circuit Monitor in a system must have a unique address in the range (1..32). (NOTE: The address switches on a single CM must be 00. Refer to section 5.1 for an explanation and for instructions on setting the CM's address). Figure 6-7 shows a processor connected to three Circuit Monitors addressed as 03, 02, and 01. (NOTE: The last Circuit Monitor in a daisy chain should have the address 01. Refer to section 5.1 for an explanation.)

To send a message from the processor to the Circuit Monitor whose address is 01, a user experienced with SY/MAX point-to-point routing techniques might assume a route of 03, 02, 01, but in truth the route statement would simply be:

Route	Route
000	01
	(To CM whose address is 01)

Note: SY/MAX routing guidelines specify that a communications rung must have at least two route statements. In order to conform to this standard, a "placeholder" route must be included when communicating directly to a CM from a processor. A route value of 000 is typically used, as shown in the preceding and following examples.

To send a message from the processor to the Circuit Monitor whose address is 02, the route would simply be:

Route	Route
000	02
	(To CM whose address is 02)

When sending a message to a Circuit Monitor which is daisy chained to multiple Circuit Monitors , the originating device need only send the address of the ***target*** *Circuit Monitor.*

6.6 Communication Over a Network

When sending a message to a Circuit Monitor over a network, standard point-to-point routing techniques are used to reach the device to which the target CM is daisy chained. In the example shown in figure 6-8, communications from the processor are sent through a NIM to the CM whose address is 01. In this example, the route statement would be:

Route	Route	Route
020	120	01
(To port 0 of NIM 20)	(Out port 1 of NIM 20)	(To CM 01)

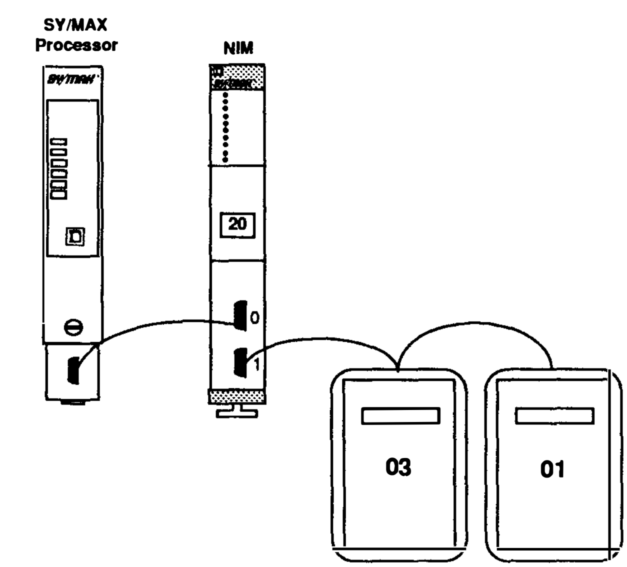


Figure 6-8 - Circuit Monitors on a Network

6.7 Communication Rules

In addition to proper installation, there are some general rules to follow to ensure efficient communication between the Circuit Monitor and the host device. These rules are listed below:

General Rules:

1. When laying out a CM network, only CMs should be connected to a communication channel. Network interface modules are required if other devices are part of the system.

2. The host device may communicate to *only one* CM at a time. This means that only one communication rung from the SY/MAX processor to a CM may be activated at a time. This rung should maintain continuity until the communication is completed.

3. Only READ and WRITE commands will be recognized by the CM if the CM is connected to a processor or NIM. If a personal computer is used as a host device, the user will need to determine what commands he will use to read from and write to the CM.

4. The CM will only *respond* to communications from the host. The CM can not *initiate* any communications.

5. To ensure the fastest response time, CMs should utilize the lowest available addresses.

6. When multiple CMs are connected to a single communication channel, there must be one (and only one) CM whose device address switches are set to 01. This should be the last CM on the link. (See section 5.1).

7. When a single CM is connected to a communication channel, its device address switches must be set to 00. The unit's logical address will still be 01. (See section 5.1).

6.8 General SY/MAX® Programming Information for Circuit Monitor Control

Communications to the CM can be accomplished via a ladder program stored in a SY/MAX processor. A typical program may include the following functions:

- Initialization of User-defined parameters
- Establishment of Communications
- Control Commands

Sample ladder code illustrating these functions is shown in section 6.8.4.

6.8.1 Initialization of User-defined Parameters

To ensure that the CM will return proper values for a specific system, the user must transmit the correct user-defined parameter values to the unit. These values are sent via WRITE instructions. Once the user-defined parameters have been written to the CM, they will remain unchanged until new value are written. The following section illustrates the use of the WRITE statement in transmitting values to the CM.

6.8.2 Establishing Communications (READ and WRITE Instructions)

Communications rungs are available to transfer storage register values from the processor to a CM (using WRITE instructions) and from a CM to the processor (using READ instructions). Processor communication instructions allow hosts to communicate directly with a CM or communicate with multiple CMs.

Communication operations are displayed as horizontal boxes preceded by at least one input condition. See Figure 6-9 for an example. These operations are transitional, meaning that the input condition must experience an open to closed transition before the message is sent.

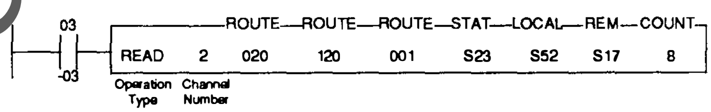


Figure 6-9 - Example READ Instruction.

The first entry in the box is the operation type and the channel number. The channel number specifies the particular serial port on the processor which is being used for transmission. (Deluxe Model 300, Model 500, and Model 400 processors have two serial ports labeled Channel 1 and Channel 2. All Model 700 processors have four serial ports labeled Channels 1-4). The next entry in the box is the routing information which is used to establish a communication path between the processor (containing the communications rung) and the intended CM on the network. Also included in each type of communications operation is a message status register which is used to monitor the progress of the message and the response from the receiving device.

For the following examples, the word "local" refers to the processor that contains the communications rung in the ladder program.

ROUTING

A series of 3 digit numbers is entered under the header ROUTE in READ and WRITE boxes, to establish the communication route between the local processor and the intended remote CM.

Typically, only two 3 digit numbers are used to determine the route. The first 3 digit number represents the source (connection point of the NIM to the network) and the last 3 digit number represents the destination (connection point of the remote CM to the NIM).

As shown in Figure 6-9, a route number consists of three digits — the first indicates which of two ports on the NIM (Network Interface Module) the processor or remote CM is connected to, and the last two digits indicate the number of the NIM set by the thumb wheel switches on the NIM module. The first digit can be (1) or (0) (two ports on a NIM) and the last two digits can range from 00-99 (100 possible devices in one network). For the processor to communicate with a remote CM in this example, the routing statements 020, 120 and 001 would have to be contained in the communication rung (in the order shown) of the local processor.

Refer to sections 6.5 and 6.6 for specific CM routing examples.

READ OPERATION

An example of a READ operation is shown in Figure 6-9. READ operations transfer data from a CM to the local processor.

CHANNEL NUMBER — This entry specifies which serial port on the processor being programmed is to be used for the transmission. (i.e. Deluxe Model 300, Model 400, and Model 500 have two serial ports labeled Channel 1 and Channel 2. Model 700 processors have 4 serial ports labeled Channels 1-4).

ROUTE — This entry is used to establish a communication path between the processor being programmed and the intended CM.

STAT — This entry is the address of the communication status register. This register is used to monitor the progress of the communication and the expected response.

LOCAL — This entry is the address of the register in the processor which will store the data that is read from the remote CM. There will be multiple local registers if a COUNT other than 1 is specified.

REMOTE — This entry is the address of the register in the CM whose data will be read by the local processor. There will be multiple remote registers if a COUNT other than 1 is specified.

COUNT — This entry specifies the number of consecutive registers, starting with the local and remote registers that will be involved in the READ operation.

Circuit Operation (Refer to Figure 6-9):

When input 03-03 of the local processor makes the transition from open to closed, the contents of storage registers S17 through S24 (the count of 8 storage registers starting with S17) in the remote drive controller are copied into storage registers S52 through S59 in the local processor. Channel 2 is used for the transmission, and local storage register S23 contains the message status information. In this example, the local processor is connected to port zero of the NIM numbered 20 (Route 020) and the CM is connected to port one of the NIM module numbered 20 (Route 020, CM #001).

Programming Considerations

1. The horizontal READ box must be preceded by at least one contact.
2. Each time the input condition controlling the READ box makes the transition from open to close, the transmission is initiated.
3. READ operations cannot be programmed in parallel within the same rung.
4. Contacts cannot be programmed in parallel with a READ operation.
5. The possible number of positions in each line of the contact matrix controlling a READ operation is reduced by the number of statements used inside the READ box. In Figure 6-9, the maximum size the contact matrix could be is 4 x 7 (28 contacts).
6. Only one channel number can be used in a READ operation.
7. Use the status register to indicate the completion of the transmission. (Refer to section 6.5 of CRT Programmers Manual, Bulletin: 30598-174-01). Do not use this register elsewhere in the control program.
8. Only the data portion (first 16 bits) of the registers are transferred to the local device when a read operation is performed.
9. When a READ rung is displayed (using the DISPLAY mode) the data shown below the register address in the REM column does not reflect the data in the remote CM (it is the data of the register having that address in the local processor).
10. When communicating to a CM that is directly connected to the processor (either alone or in a daisy chain), the only CM address that is required in the route statement is the address of the target CM.
11. Routes greater than 223 can only be programmed using a Deluxe CRT with software revision 2.4 or later.

12. Routes greater than 223 should not be programmed in Model 300 processor which have the following series designations or earlier.

Class 8020 Type SCP	Series
311	E
312	E
313	D
321	D
322	D
323	C
332	D
333	D
344	C

13. The maximum COUNT number is 128, independent of the processor containing the communications rung.

14. For the proper application of READ instructions, refer to instruction bulletin 30598-257-01.

WRITE OPERATION

An example of a WRITE operation is shown in Figure 6-10. A WRITE operation copies storage register data residing in the local processor to the specified CM register.

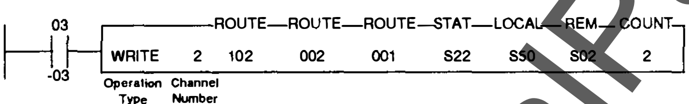


Figure 6-10 - Example WRITE Instruction.

CHANNEL NUMBER — This entry specifies which serial port on the processor being programmed is to be used for the transmission. (i.e. Deluxe Model 300, Model 400, and Model 500 have two serial ports labeled Channel 1 and Channel 2. Model 700 processors have 4 serial ports labeled Channels 1-4).

ROUTE — This entry is used to establish a communication path between the processor being programmed and the intended CM.

STAT — This entry is the address of the communication status register. This register is used to monitor the progress of the communication and the expected response.

LOCAL — This entry is the address of the register in the processor whose data is sent to the specified CM register. There will be multiple local registers if a COUNT other than 1 is specified.

REMOTE — This entry is the address of the register in the CM which will store the data sent from the processor. There will be multiple remote registers if a COUNT other than 1 is specified.

COUNT — This entry specifies the number of consecutive registers, starting with the local and remote registers that will be involved in the WRITE operation.

Circuit Operation (Refer to Figure 6-10):

When input 03-03 of the local processor in Figure 6-10 makes the transition from open to closed, the contents of storage registers 0050 through 0051 (the count of two storage registers starting with 0050) in the local processor are copied to registers 0002 and 0003 in the CM. Channel 2 is used for the transmission, and local storage register 0022 contains the message status information. In this example, the local processor is connected to port one of the NIM numbered 02 (ROUTE 102) and the remote CM is connected to port zero of the NIM module numbered 01 (ROUTE 001, CM #001).

Programming Considerations

1. The horizontal WRITE box must be precede by at least one contact.
2. Each time the input condition controlling the WRITE box makes the transition from open to close, the transmission is initiated.
3. WRITE operations cannot be programmed in parallel within the same rung.
4. Contacts cannot be programmed in parallel with a WRITE operation.
5. The possible number of positions in each line of the contact matrix controlling a WRITE operation is reduced by the number of statements used inside the WRITE box. In Figure 6-10, the maximum size the contact matrix could be is 4 x 7 (28 contacts).
6. Only one channel number can be used in a WRITE operation.
7. Use the status register to indicate the completion of the transmission. (Refer to section 6.5 of CRT Programmers Manual, Bulletin: 30598-174-01). Do not use this register elsewhere in the control program.
8. Only the data portion (first 16 bits) of the registers are transferred to the local device when a READ operation is performed.
9. When a WRITE rung is displayed (using the DISPLAY mode) the data shown below the register address in the REM column does not reflect the data

in the remote CM (it is the data of the register having that address in the local processor).

10. When communicating to a CM that is directly connected to the processor (either alone or in a daisy chain), the only CM address that is required in the route statement is the address of the target CM.

11. Routes greater than 223 can only be programmed using a Deluxe CRT with software revision 2.4 or later.

12. Routes greater than 223 should not be programmed in Model 300 processor which have the following series designations or earlier.

Class 8020 Type SCP	Series
311	E
312	E
313	D
321	D
322	D
323	C
332	D
333	D
344	C

13. The maximum COUNT number is 128, independent of the processor containing the communications rung.

14. For the proper application of WRITE instructions, refer to instruction bulletin 30598-257-01.

MESSAGE STATUS REGISTER

Each communications rung must contain a unique storage register. This storage register, called the message status register, is used to monitor the progress of the message and the expected response. Once a status register is assigned to a communication rung, that register must not be used in the program again. Bits #22 and #17 of the message status register provide information about the sending of the message and bits 1-16 provide information about the response coming back from the intended CM. Bits #1 through #24 of the message register are cleared when the input condition controlling a communication box is open.

Sending a Message

When the input to a communication box is closed, bit #22 of the status register will be set immediately upon that rung being scanned. If the channel selected by the communication rung is busy, the message will not be sent until the channel is free. When the channel is free bit #17 of the status register is set and the message is sent. After bits#22 and# 17 are set, the processor can then process the next communication rung with bit #22 set (input condition closed) and bit #17 reset.

Responding to a Message

If a valid response to a READ, or WRITE is received, bit #16 will be set while bits #1 through #14 stay cleared. If an invalid response is received, bit# 16 will stay cleared and an error code number will be loaded into bits #1 through #14. Bit #15, when set, indicates that the CM is running. The error code number in bits #1 through #14 will always be odd, therefore only bit #1 need be checked to determine if an error has occurred. The error codes used by the status register can be found in the error code appendix under the heading "Processor Errors" in instruction bulletin 30598-174-01.

6.8.3 Control Commands

Control Commands are executed by using LET and IF instructions and by setting specific bits in the CM command register (Reg 237). To perform LET and IF instructions with registers in the CM, you must first READ the value of the intended register into the processor. Once the value is in a processor register, the user may change its contents or copy its contents to another register. If the register's contents are changed, the new value in the register may then be transferred back to the CM via a WRITE statement.

Note: The only commands that may be performed directly on CM registers are the READ and WRITE commands.

LET Instruction

LET instructions are used to copy data from a storage register into another storage register or to enter a specific value into a CM register.

The LET instruction is programmed in a horizontal box with the word LET as the first entry in the box (See Figure 6-11). The first entry after the word LET must be a storage register in the processor followed by an equal (=) sign. The register following the equal sign will contain the data to be copied to the register preceding the equal sign. If there is a number following the equal sign, this value will be copied to the register preceding the equal sign.

```
——| LET S(NUMBER) = (NUMBER OR STORAGE REGISTER) |——
INSTRUCTION        STORAGE REGISTER, DATA OR MATH RESULT
```

Figure 6-11 - Example LET Instruction.

General Programming Rules:

1. The LET box must occupy positions 10 and 11 in the programming matrix. Nothing can be programmed after a LET box.

2. Up to 8 contacts in series and 7 parallel branches may precede a LET box (8 x 7 matrix).

3. Nothing can be programmed in parallel with a LET box.

4. The only allowable entry after the equal (=) sign is a storage register address or a 5-digit number (0 to 32767). The value of this 5-digit will be defined by the allowed values for the control register into which it is copied.

5. IF boxes may precede the LET box providing the 10 x 7 matrix is not exceeded (See Rule 2).

6. A LET box does not have to be preceded by a contact.

LET Instruction Used as a Preset

If a number is programmed to the right of the equal sign, the LET instruction will perform a preset operation.

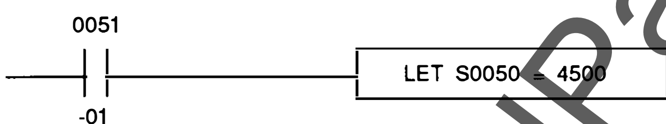


Figure 6-12 - LET Instruction Used as a Preset

Circuit Operation:

In Figure 6-12 when contact 51-01 is closed, the value 4500 will be placed in SY/MAX storage register 0050. If contact 51-01 is open, the preset will not be performed. The LET instruction in Figure 6-12 will be performed on every scan of the ladder program, provided that contact 51-01 remains closed. If the user wishes the preset to be performed only once, he may use a transitional LET instruction (see Section 5 in Bulletin 30598-174-01).

LET Instruction Used as a Data Transfer

If a storage register address is programmed to the right of the equal sign, the LET instruction will perform a data transfer operation.

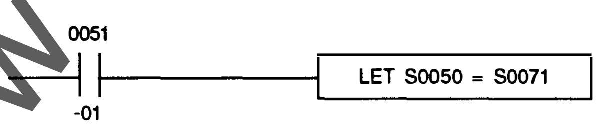


Figure 6-13 - LET instruction Used as a Data Transfer

Circuit Operation:

In Figure 6-13, when contact 51-01 is closed, the value in SY/MAX register 0071 will be transferred into SY/MAX register 0050. The transfer of data in Figure 6-13 will occur every time the processor makes a scan of the ladder program, provided that contact 51-01 is closed. If the user wished the data transfer to occur only once, he may use a transitional LET instruction (see Section 5 of Bulletin 30598-174-01).

IF Instruction

If statements are used to compare the number in a storage register to:

1. A number in another storage register.
2. A number as a result of a math function.
3. A constant.

The IF instruction is programmed in a horizontal box with the word IF as the first entry in the box. The next entry after the word IF must be a storage register (compare to register) followed by a compare symbol. The data in this storage register will be compared to the result of the right side of the compare symbol (See Figure 6-14).

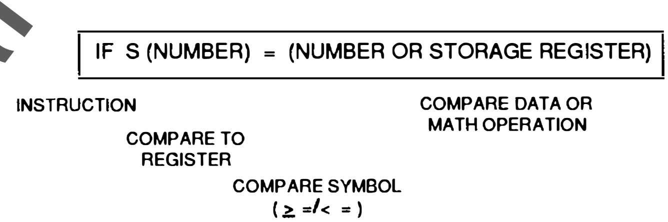


Figure 6-14 - IF Instruction

General Programming Rules

1. The IF box may occupy any position in the programming matrix except the coil position (position #11).

2. Multiple IF boxes can be programmed in series and/or parallel providing the 10 x 7 contact matrix is not exceeded.

3. Contacts may be programmed in series or parallel with an IF box.

4. The comparison symbols can be any of the following:
   a. (=) equal to
   b. (≠) not equal to
   c. (≥) greater than or equal to
   d. (<) less than

5. The only allowable entry after the comparison symbol is a storage register address or a 5-digit number (0 to 32767).

Comparison of a Storage Register Value to a Constant Value

When a number is programmed to the right of the comparison symbol, the storage register value will be compared to that number (See Figure 6-15).

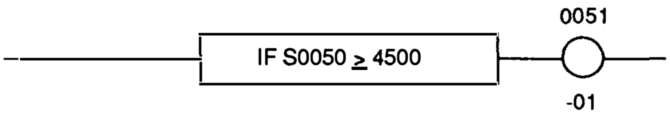


Figure 6-15 - Comparison of Register to Constant

Circuit Operation:

When the value of SY/MAX storage register 0050 is greater than or equal to 4500, coil 51-01 will be energized. When the comparison is not true (register 0050 < 4500) coil 51-01 will not be energized.

Comparison of Two Storage Register Values

When a SY/MAX storage register address is programmed to the right of the comparison symbol, it will be compared to the SY/MAX storage register address programmed to the left of the comparison symbol (See Figure 6-16).

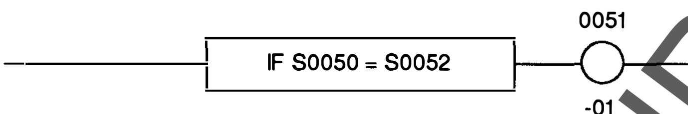


Figure 6-16 - Comparison of Two Storage Registers

Circuit Operation:

When the value in SY/MAX storage register 0052 is equal to the value in SY/MAX storage register 0050, coil 51-01 will be energized. If the value in register 0052 is not equal to the value in register 0050, coil 51-01 will not be energized.

When used for comparison purposes, addition, subtraction, multiplication, and division can be programmed using the IF instruction.

For additional information on the LET and IF instructions refer to Section 5 of the CRT Programmer Instruction Bulletin

6.8.4 Sample Ladder Code

The following 3 pages contain sample ladder code illustrating methods for transmitting data to and acquiring data from the Circuit Monitor. **The rungs do not represent a complete ladder program for Circuit Monitor operation**, but are simply examples of the use of ladder instructions. The rungs don not incorporate error recovery, and other important ladder techniques. Refer to the appropriate SY/MAX® instruction bulletins for details on ladder programming.

Note: The ladder code that follows has been written for use with a Model 400 SY/MAX® processor. Some of the techniques used may not work with other SY/MAX processors.

Rungs 001-003 initialize four user-defined parameters: System Connection, Current Reporting Precision, CT and PT Ratios. Rung 0001 stores the decimal values 0003, 2000, 120 and 0016 in SY/MAX registers 200, 201, 202 and 203 respectively. Rung 0002 then writes the values stored in SY/MAX registers 200, 201, and 202 to CM registers 200, 201, and 202, respectively. Doing so sets the System Connection to a 3 wire system, Current Reporting Precision to Amps, CT ratio to 2000:5, and PT ratio to 120:120. (See the description of registers 200, 201, and 202 in Section 6.10).

Any time that a new value has been transmitted to CM registers 200, 201, or 202, the user must force a software restart of the CM. (See Section 5.3 for an explanation). **Rung 0003** accomplishes this by writing a decimal value of 16 (the value stored in SY/MAX register 202) to CM register 237. Since a decimal 16 is equivalent to a binary value of 0000 0000 0001 0000, this rung effectively sets bit 5 of CM register 237 forcing a software restart.

Since it is not desirable to re-initialize CM registers 200, 201 and 202 on each scan of the ladder code, we must insure that rungs 0001-0003 are only executed once. **Rung 0004** accomplishes this by setting a control bit after the CM has been initialized.

When used in CM communications, SY/MAX communication rungs should be controlled by a timer or counter. **Rung 0005** shows a timer which triggers a coil for one scan once every minute. Rungs 0006, 0012, and 0013 utilize this timer.

Rung 0006 reads the status of the CM clock once per minute.

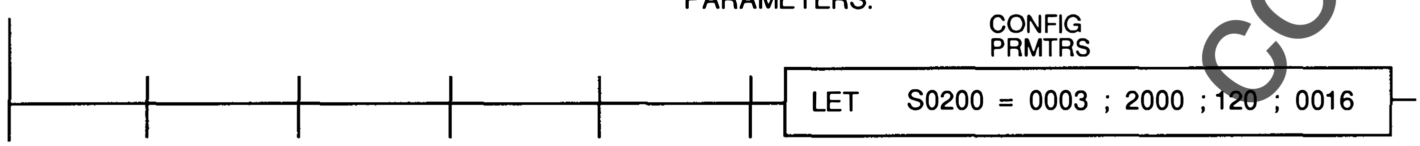
Rung 0007 checks to see if the CM clock is reset or has not been initialized. If the value in SY/MAX register 30 is equal to 1900 (indicating an incorrect year and therefore an incorrect date/time), a coil is activated to begin the process of updating the CM clock.

Rungs 0008-0009 transfer the date/time in the Model 400 processor to registers 784-789 in the Circuit Monitor. Rung 0008 transfers the seconds, minutes, and hour, while rung 0009 transfers the day, month, and year.

Rungs 0010-0011 illustrate the use of the READ instruction in acquiring CM data. Both rungs are controlled by a 1 minute trigger (see rung 0005). Rung 0012 reads the System Frequency and rung 0013 reads the Accumulated Energy.

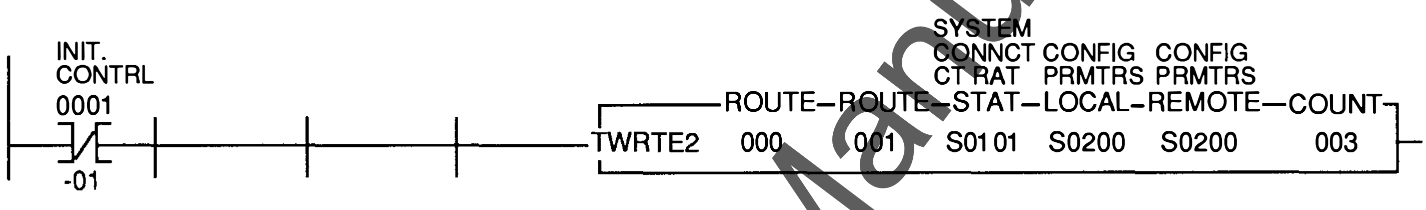
RUNG 0001

INITIALIZE CIRCUIT MONITOR CONFIGURATION PARAMETERS.



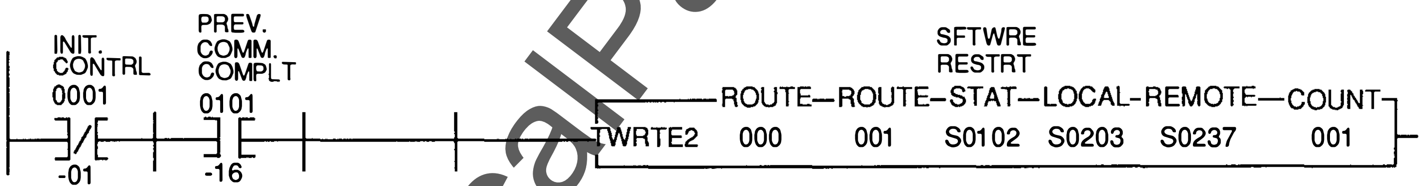
RUNG 0002

THIS RUNG SETS THE SYSTEM CONNECTION TO A 3 PH., 3-WIRE SYSTEM, AN AMPS REPORTING PRECISION IN WHOLE UNITS, AND A CT RATIO OF 2000/5.



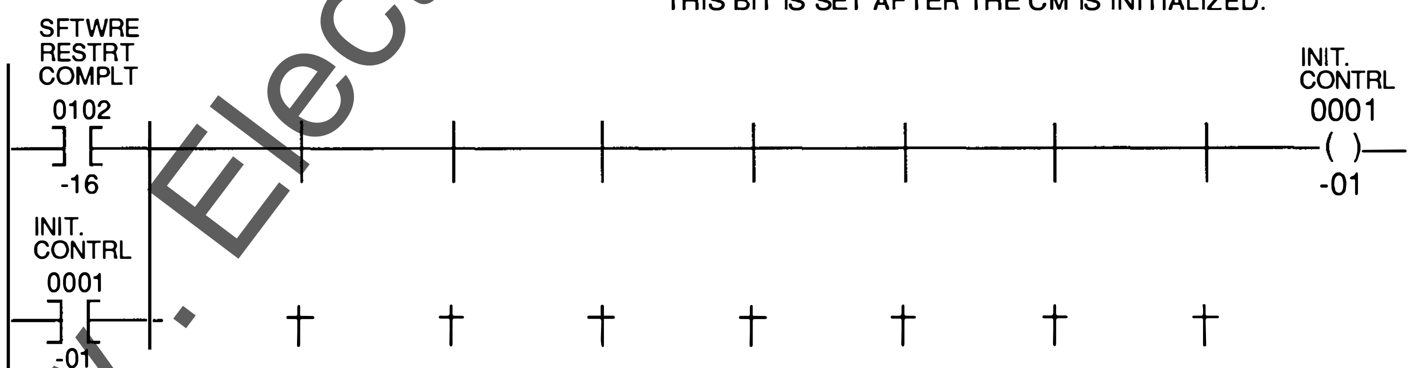
RUNG 0003

EXECUTES A SOFTWARE RESTART OF THE CIRCUIT MON.



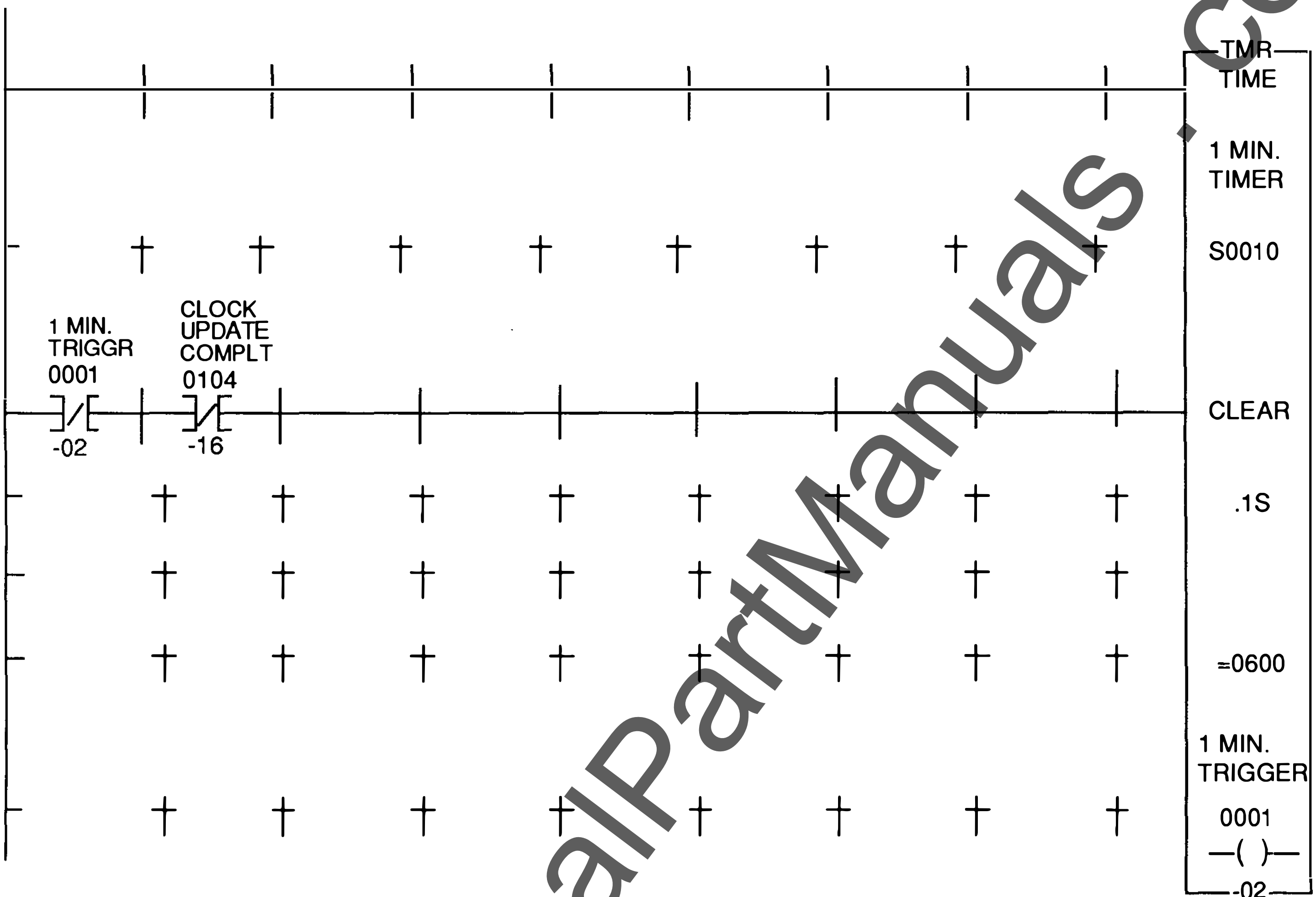
RUNG 0004

THIS BIT IS SET AFTER THE CM IS INITIALIZED.



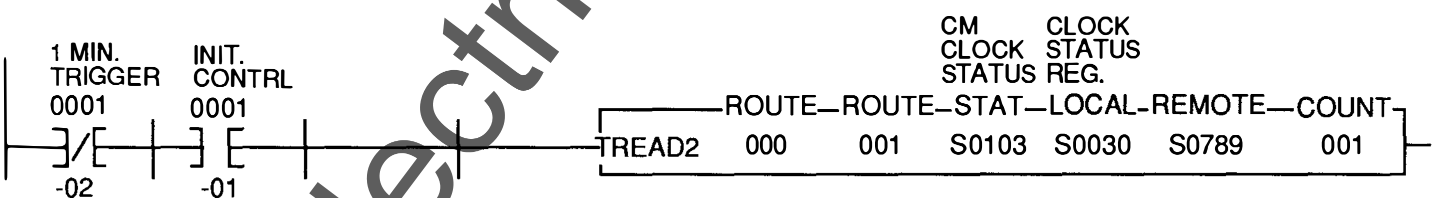
RUNG 0005

THIS COIL IS TRIGGERED FOR ONE SCAN
ONCE EVERY MINUTE.



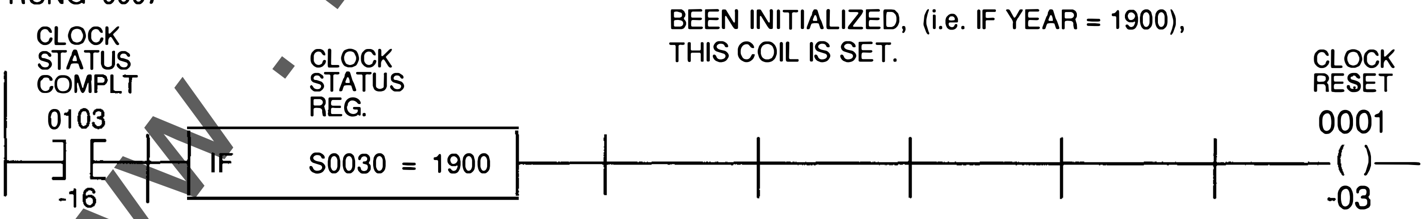
RUNG 0006

THIS RUNG READS THE STATUS OF THE CM CLOCK.



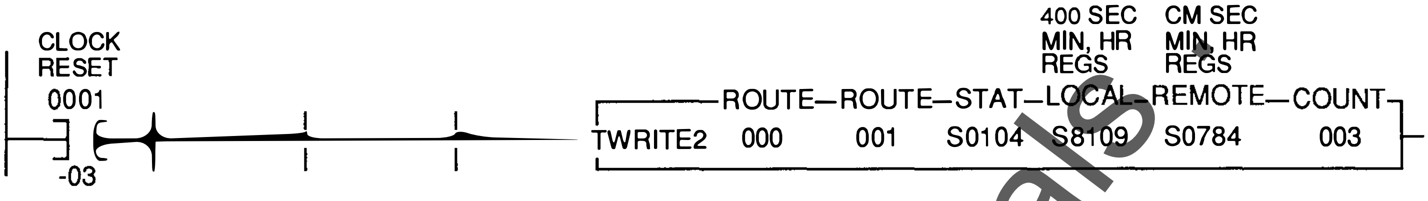
RUNG 0007

IF THE CM CLOCK IS RESET OR HAS NOT
BEEN INITIALIZED, (i.e. IF YEAR = 1900),
THIS COIL IS SET.



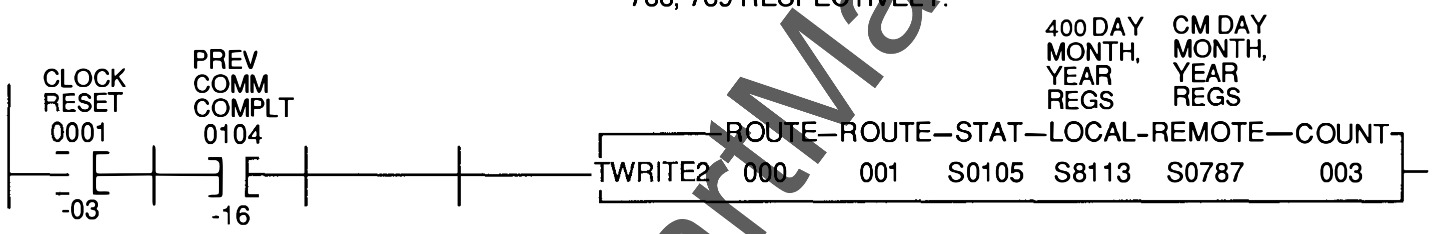
RUNG 0008

TRANSFER MODEL 400 SEC (S8109), MIN (S8110), HOUR (S8111) TO CIRCUIT MONITOR REGISTERS 784, 785, 786 RESPECTIVELY.



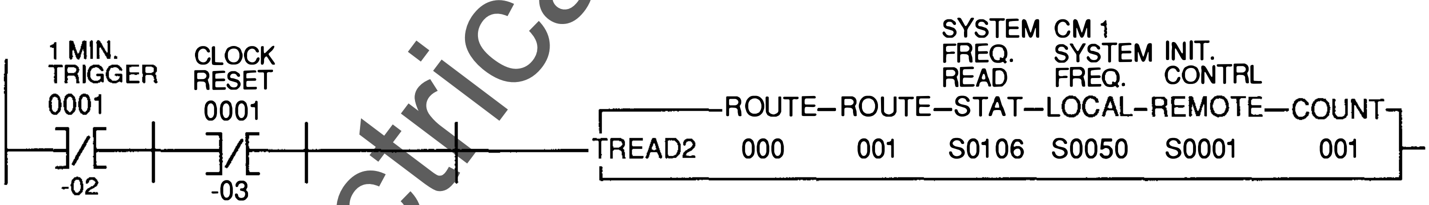
RUNG 0009

TRANSFER MODEL 400 DAY (S8113), MONTH (S8114), YEAR (S8115) TO CIRCUIT MONITOR REGISTERS 787, 788, 789 RESPECTIVELY.



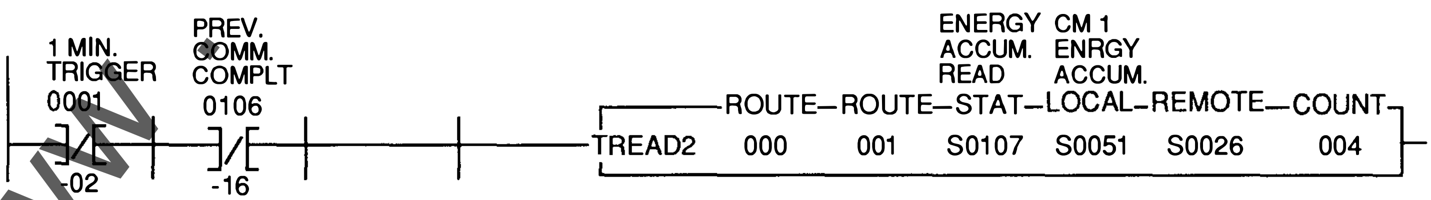
RUNG 0010

READ FREQUENCY FROM CM



RUNG 0011

READ ACCUMULATED ENERGY FROM CM



6.9 General SY/LINK® Information for Circuit Monitor Control

6.9.1 Introduction

As noted in section 6.4, the Circuit Monitor may communicate directly to a personal computer via the RS-422 port of a SY/LINK board. The SY/LINK board is a network interface board which mounts in a long expansion slot of an IBM personal computer or compatible. The board gives the computer direct access to the SY/NET® Local Area Network for communication with programmable controllers and other devices. In addition, the SY/LINK board offers an RS-422 port which allows RS-422 devices, including the Circuit Monitor, to access the network.

Exchange of information between the computer and CM's is accomplished through application programs written for the desired tasks. The SY/LINK system will operate with virtually any computer language that will run on a personal computer (BASIC, Compiled BASIC, FORTRAN, C, Assembler, etc.). This flexibility allows the user to design custom software in the language that is most familiar to him.

To achieve communication, the user program must address the following functions:

1. Initializing SY/LINK board parameters.
2. READ operations (for applications that gather information)
3. WRITE operations (for applications that send information)
4. Error handling

The remainder of Section 6.9 will touch upon each of these functions. **NOTE:** The following sections should by no means be considered a complete guide to SY/LINK communications. For complete instructions on the function and use of the SY/LINK card, refer to SY/MAX® instruction bulletin 30598-277-01.

6.9.2 Configuring the SY/LINK® Board for Circuit Monitor Communication

To allow the SY/LINK board to communicate on the network, the user (and the program) must properly configure the board. To configure the SY/LINK board, selections must be made for such items as computer memory address range, network address number, network baud rate, network size, RS-422 operating mode, and RS-422 port baud rate. Of greatest importance for Circuit Monitor communications is the proper configuration of the RS-422 port. Configuration of the RS-422 port is discussed below.

RS-422 Port Operating Mode - The RS-422 port can be configured to operate in four modes. They are SY/MAX mode, NET-TO-NET mode, Peripheral mode, and terminal mode. When communicating directly to Circuit Monitors, the port should be set to operate in NET-TO-NET mode.

Parity - The RS-422 port must be set to *Even* parity.

Word Size - Word size should be set to 8 bit.

Baud Rate - The SY/LINK card can operate at baud rates ranging from 110 to 19,200 baud. The Circuit Monitor offers five baud rates ranging from 1200 to 19,200 baud. The Circuit Monitor may be set to operate at any of the five supported baud rates. The RS-422 port of the SY/LINK Card must be set to operate at **the same** baud rate as the Circuit Monitor(s) to which it is communicating.

The SY/LINK board offers additional configuration options including network size, network baud, and more. For a complete description of SY/LINK initialization and configuration, refer to Sections 6.0 and 7.0 of the SY/LINK instruction bulletin, 30598-277-01.

6.9.3 READ Operations

READ operations allow the user program to obtain values from Circuit Monitor storage registers and storage registers located in other devices on the network or on the SY/LINK board.

To perform a READ operation, the user program loads values into certain memory locations. These values tell the SY/LINK board what registers to read and where to find them. When ready, the user program sets a send flag and the SY/LINK board performs the desired operation. If the READ is successful, the SY/LINK board will store the requested data in the reply data buffer and reset the send flag to zero. The user program can then examine the data. If the READ is unsuccessful, the SY/LINK board will place an error code in the error flag location and reset the send flag without storing data in the reply data buffer.

The Circuit Monitor supports three kinds of READ operations: Non-priority READ, Priority READ, and Random Access READ. For the majority of applications, the user program should use Non-priority READs. A Non-priority READ can be preempted by a Priority READ (or WRITE) operation that requires the network at the same time. The Non-priority READ can be preempted a maximum of 32 times before it is allowed on the network.

NOTE: Random Access READ operations can obtain data from a group of registers whose addresses are not continuous. (Standard Non-priority and Priority READs access continuous blocks of registers). The Random Access READ is classified as a Non-priority operation; it can be preempted by a Priority READ. The Random Access READ is approximately twice as slow as the Priority and Non-priority READs.

For a complete description of the READ commands and their use, refer to Section 7.0 of bulletin 30598-277-01.

6.9.4 WRITE Operations

WRITE operations allow the user program to send data values to Circuit Monitor storage registers, storage registers in other devices on the network or on the SY/LINK board.

To perform a WRITE operation, the user program loads values into certain memory locations. These values tell the SY/LINK board which registers to write to, where to find them, and what data to put in them. When ready, the user program sets a send flag and the SY/LINK board performs the desired WRITE operation. If the WRITE is successful, the SY/LINK board will reset the send flag to zero. If the WRITE is unsuccessful, the SY/LINK board will place an error code in the error flag location and reset the send flag.

The Circuit Monitor understands and responds to two kinds of WRITE operations: Non-priority WRITE, and Priority WRITE. For the majority of applications, the user program should use Non-priority WRITEs. A Non-priority WRITE can be preempted by a Priority WRITE (or READ) operation that requires the network at the same time. The Non-priority WRITE can be preempted a maximum of 32 times before it is allowed on the network.

NOTE: Priority WRITEs should be employed in the user program only when there is a critical need to send data as quickly as possible. Over-use of Priority WRITEs can interfere with other network communications.

For a complete description of the WRITE commands and their use, refer to Section 7.0 of bulletin 30598-277-01.

6.9.5 Error Handling

During a READ or WRITE operation, the user program can monitor the Error Flag Location for non-zero values. A non-zero value placed here during a communication indicates that the communication was unsuccessful due to an error condition.

The user program can be designed to respond to the error in a manner corresponding to the nature of the error. For example, if the error code is 017 (Remote Device Inactive), the user could display or print a message informing the operator that the remote device is powered down or not connected.

Section 7.5 of the SY/LINK instruction bulletin (30598-277-01) offers more on error handling. A list of command/reply error codes and their meanings is given in Appendix C of the bulletin.

6.10 Circuit Monitor Register Assignments

Each Circuit Monitor (CM) has an identical set of SY/MAX compatible registers. Depending on the version of CM being dealt with, certain registers may simply be reserved and unused. This is indicated where appropriate. Reserved registers may be read but the values returned will simply be undefined or garbage. This allows the user to read large blocks of consecutive registers (up to 128) which contain reserved fields.

The CM has two types of registers:

a) Read Only registers
b) Write/Read registers

The read only registers will contain the values calculated based on the raw data sampled by the CM. The write/read registers will contain user-defined parameters that are down loaded or changed from the host. All registers contain decimal values in the range -32,767 to +32,767 unless otherwise noted. Appendix B discusses unusual register formats. (NOTE: If the host attempts to read from a non-existent register a "0" data value will be returned. However, if the host attempts to write to a non-existent register an error will be returned). Both types of registers have register numbers associated with them. Table 6.0 lists these register numbers:

Register Range	Type of register
1-143	Read only, standard definition
144-199	Read only, reserved for future use
200-241	Write/read, standard user defined parameters
242-299	Write/read, reserved for future use
700-783	Read only, Model 400 compatible date/time registers
784-795	Write/read, Model 400 compatible date/time registers
2000-2127	Read Only, Voltage Phase A, Waveform Data Samples
2128-2255	Read Only, Voltage Phase B, Waveform Data Samples
2256-2383	Read Only, Voltage Phase C, Waveform Data Samples
2384-2511	Read Only, Current Phase A, Waveform Data Samples
2512-2639	Read Only, Current Phase B, Waveform Data Samples
2640-2767	Read Only, Current Phase C, Waveform Data Samples
2768	Read Only, Intersample Interval of Waveform Samples
8172-8192	Registers required to maintain SY/MAX compatibility

Table 6.0 - Register Descriptions with Associated Numeric Range

The standard registers come defined from the factory. Shown below are the standard definition of read only registers and their ranges that can be requested by a host and returned by a CM:

Local Reg #	Register Name	Register Description
1	Frequency	**Type**: Read only **Size**: 1 Register **Units**: Hertz in 100ths **Range**: 2300 - 6500 (23.00 - 65.00) **Function**: Frequency of circuit being monitored, as measured from measured voltage of phase A. If the frequency is not within the specified range, this register will return a 0 when read. **Restored at power-up / reset:** No

Local Reg #	Register Name	Register Description
2	Temperature	**Type:** Read only **Size**: 1 Register **Units:**Degrees Celsius (Centigrade) in 100ths **Range**: -10000 to +10000 (-100.00 to +100.00) **Function:** Temperature inside CM enclosure **Restored at power-up / reset:** Yes
3	Current, Phase A	**Type**: Read only **Size**: 1 Register **Units**: Amps or tenths of Amps **Range**: 0 to 9999 (User-definable, See Reg 200) **Function**: Measured RMS Phase A Current **Restored at power-up / reset:** No
4	Current, Phase B	**Type:** Read only **Size**: 1 Register **Units:** Amps or tenths of Amps **Range**: 0 to 9999 (User-definable, See Reg 200) **Function**: Measured RMS Phase B Current **Restored at power-up / reset:** No
5	Current, Phase C	**Type**: Read only **Size:** 1 Register **Units**: Amps or tenths of Amps **Range**: 0 to 9999 (User-definable, See Reg 200) **Function:** Measured RMS Phase C Current **Restored at power-up / reset:** No
6	Current, 3 Phase Average	**Type**: Read only **Size**: 1 Register **Units**: Amps or tenths of Amps **Range**: 0 to 9999 (User-definable, See Reg 200) **Function:** Simple Arithmetic mean of the rms current flowing in the 3 phases. ((Ia +Ib + Ic)/3) Ia, Ib, Ic are contained in registers 3-5 **Restored at power-up / reset:** No
7	Current, Apparent rms	**Type:** Read only **Size**: 1 Register **Units**: Amps or tenths of Amps **Range**: 0 to 9999 (User-definable, See Reg 200) **Function**: This value is used to evaluate the impact of harmonics and other forms of distortion on a power circuit by reporting the "apparent" rms current as seen by many peak-detecting protection and instrumentation devices. This value is actually the maximum detected instantaneous peak current from any of the phases during the sample period, divided by the square root of 2 (the rms conversion factor for a true sinusoid). **Restored at power-up / reset:** No
8	Voltage, Phase A to B	**Type:** Read only **Size:** 1 Register **Units:** Volts **Range:** 0 - 32,767 **Function**: RMS Voltage Between Phases A and B. (Measured in 3-wire, derived in 4-wire). **Restored at power-up / reset:** No

Local Reg #	Register Name	Register Description
9	Voltage, Phase B to C	**Type**: Read only **Size**: 1 Register **Units**: Volts **Range**: 0 - 32,767 **Function**: RMS Voltage Between Phases B and C. (Measured in 3 wire, derived in 4 wire). **Restored at power-up / reset:** No
10	Voltage, Phase C to A	**Type:** Read only **Size:** 1 Register **Units**: Volts **Range:** 0 - 32,767 **Function**: Derived RMS Voltage Between Phases C and A **Restored at power-up / reset:** No
11	Voltage, Phase A to Neutral	**Type**: Read only **Size**: 1 Register **Units**: Volts **Range**: 0 - 32,767 **Function**: Measured RMS Voltage Between Phase A and Neutral In a 3 wire system, this value is not meaningful and when read will be returned as 32,767. **Restored at power-up / reset:** No
12	Voltage, Phase B to Neutral	**Type**: Read only **Size**: 1 Register **Units**: Volts **Range**: 0 - 32,767 **Function**: Measured RMS Voltage Between Phase B and Neutral In a 3 wire system, this value is not meaningful and when read will be returned as 32,767. **Restored at power-up / reset:** No
13	Voltage, Phase C to Neutral	**Type**: Read only **Size:** 1 Register **Units**: Volts **Range**: 0 - 32,767 **Function**: Measured RMS Voltage Between Phase C and Neutral In a 3 wire system, this value is not meaningful and when read will be returned as 32,767. **Restored at power-up / reset:** No
14	Power Factor, 3 Phase Total⁕	**Type:** Read only **Size:** 1 Register **Units:** Percent **Range:** -0 to 100 to +0 (+/- 1.00) P.F. reported in percent; to convert back to a value in the range shown in Table 2.2, divide reported value by 100). The sign +/- indicates leading/lagging. (See Appendix B). Lead/Lag is always supplied, but the user should use per phase indication when available (i.e. when a 4 wire connection is used). **Function:** Total power factor of a 3 phase circuit calculated as the 3 phase total real power (reg 18) divided by the 3 phase total apparent power (reg 20). **Restored at power-up / reset:** No

⁕ Signed Magnitude Notation (See Appendix B)

Local Reg #	Register Name	Register Description
15	Power Factor, Phase A⁕	**Type:** Read only **Size:** 1 Register **Units:** Percent **Range:** +/- 100 (+/- 1.00) P.F. reported in percent; to convert back to a value in the range shown in Table 2.2, divide reported value by 100). The sign indicates leading/lagging (positive indicates leading, negative indicates lagging). **Function**: The ratio of the Phase A real power to the Phase A apparent power. Power Factor is described as "LAG" (current lagging voltage in an inductive circuit) or "LEAD" (current leading voltage in a capacitive circuit). A perfect unity (1.00) indicates a purely resistive circuit. [Note: per phase power factor values are not available in a 3 wire system and, when read, will be reported equal to 3-Phase Total Power Factor]. **Restored at power-up / reset:** No
16	Power Factor, Phase B⁕	**Type:** Read only **Size:** 1 Register **Units:** Percent **Range**: same as reg #15 **Function**: Same as reg #15 only for Phase B **Restored at power-up / reset:** No
17	Power Factor, Phase C⁕	**Type**: Read only **Size**: 1 Register **Units:**Percent **Range**: same as reg #15 **Function:** Same as reg #15 only for Phase C **Restored at power-up / reset:** No
18	Real Power, Three Phase Total (P)	**Type**: Read only **Size**: 1 Register **Units:** Kilowatts **Range:** - 32,767 to +32,767 **Function:** Sum of the real power values for each of the 3 phases **Restored at power-up / reset:** No
19	Reactive Power, Three Phase Total (Q)	**Type**: Read only **Size**: 1 Register **Units:** Kilovoltamperes Reactive (kVAr) **Range**: - 32,767 to +32,767 **Function**: Sum of the reactive power values for each of the 3 phases **Restored at power-up / reset:** No
20	Apparent Power, Three Phase Total (S)	**Type:** Read only **Size:** 1 Register **Units**: Kilovoltamperes (kVA) **Range:** - 32,767 to +32,767 **Function**: Total volt-amps consumed in a 3 phase circuit. Magnitude of the complex power vector S. It is defined as: $\lvert S \rvert = \sqrt{P^2 + Q^2}$ Where P and Q are register 18 and 19 respectively. **Restored at power-up / reset:** No

⁕ Signed Magnitude Notation (See Appendix B)

Local Reg #	Register Name	Register Description
21-23		Reserved
24-27	Energy Accumulated	**Type:** Read only **Size**: 4 Registers **Units**: Watthours **Range**: 0 to +/- 9999999999999999 **Function**: This is a running accumulation over time, since last reset (by setting bit #5 of reg. 237), of the energy monitored in a given circuit. The total energy consumed is obtained by continuously integrating instantaneous real power with respect to time. Energy may be accumulated based on the absolute value of real power (regardless of direction of power flow) or based on its signed value (for reverse power flow, value of accumulated energy is reduced). Energy is accumulated as indicated by bit 1 of register 215. EAcc = WHr(Acc -1) + (P x t) if the signed mode of energy calculation is selected, and: EAcc = WHr(Acc -1) + (ABS(P) x t) if the unsigned mode of energy calculation is selected. Where Acc-1 = previous energy reading, P = 3 phase real power, t = time interval between calculations. **Restored at power-up / reset:** Yes
28-31	Reactive Energy, Accumulated	**Type:** Read only **Size:** 3 Registers **Units**: Varhours **Range**: 0 to +/- 9999999999999999 **Function:** This is a running accumulation over time, since last reset, of the reactive energy monitored in a given circuit. Reactive energy is obtained by using the equation above (regs #24-27), substituting varhours for watthours and Q (in vars) for P. This quantity is accumulated without regard to sign. **Restored at power-up / reset:** Yes
32	Average Demand, Current Phase A	**Type**: Read only **Size**: 1 Register **Units**: Amps or tenths of Amps **Range**: 0 to 9999 (User-definable, See Reg 200) **Function**: Average demand current for phase A (reg 3) calculated using a sliding window over a 15 minute demand interval. **Restored at power-up / reset:** No
33	Average Demand, Current Phase B	**Type:** Read only **Size:** 1 Register **Units**: Amps or tenths of Amps **Range**: 0 to 9999 (User-definable, See Reg 200) **Function:** Same as reg #32 except phase B current (reg 4) is used. **Restored at power-up / reset:** No
34	Average Demand, Current Phase C	**Type:** Read Only **Size**: 1 Register **Units:** Amps or tenths of Amps **Range:** 0 to 9999 (User-definable, See Reg 200) **Function:** Same as reg #32 except phase C current (reg 5) is used. **Restored at power-up / reset:** No

Local Reg #	Register Name	Register Description
35	Average Demand, Real Power	**Type:** Read only **Size:** 1 Register **Units:** Kilowatts **Range**: - 32,767 to +32,767 **Function**: This is the average demand real power, calculated using a sliding window method over a user specified (see reg. 216) demand interval. **Restored at power-up / reset:** No
36	Predicted Demand Real Power	**Type:** Read only **Size**: 1 Register **Units:** Kilowatts **Range:** - 32,767 to +32,767 **Function:** This value is intended to provide a more meaningful predictor of real power usage when demand levels are changing. This value is obtained by taking the latest real power average demand, adding this to the most recent real power reading, and dividing by two. In this way, the predicted demand is weighted in favor of more recent data and, therefore, provides a means to anticipate changes in demand. **Restored at power-up / reset:** No
37	Peak Demand, Real Power (Maximum of Average Demand Real Power)	**Type**: Read only **Size**: 1 Register **Units**: Kilowatts **Range:** - 32,767 to +32,767 **Function:** This is maximum of the average demand real power (reg 35). It is not a true arithmetic maximum but is based on the absolute value of the Average Demand Power. (See section 2.1.2). **Restored at power-up / reset:** Yes

Registers 38-57 represent the minimum values for each of the registers discussed above since the last reset or minimum/maximum clear. Each time the present instantaneous value (registers 1 - 20) is updated it is compared to the previous minimum of that register, and if the new value is less than the previous, it becomes the new minimum value. All of the minimum value registers are saved in the event of a control power failure. The minimum value registers are of the same type, size, unit, and range as the corresponding instantaneous values.

Local Reg #	Register Name	Register Description
38	Minimum Frequency	**Type**: Read only **Size**: 1 Register **Units**: Hertz in 100ths **Range**: 2300 - 6500 (23.00 - 65.00) **Function**: Minimum frequency (reg 1) of the circuit being monitored. This register is only updated when the frequency is within the given range. **Restored at power-up / reset:** Yes
39	Minimum Temperature	**Type**: Read only **Size:** 1 Register **Units**:Degrees Celsius (Centigrade) in 100ths **Range:** -10000 to +10000 (-100.00 to +100.00) **Function:** Minimum temperature inside CM enclosure **Restored at power-up / reset:** Yes

Local Reg #	Register Name	Register Description
40	Minimum Current, Phase A	**Type**: Read only **Size**: 1 Register **Units:** Amps or tenths of Amps **Range**: 0 to 9999 (User-definable, See Reg 200) **Function**: Minimum measured RMS Phase A Current (reg 3). **Restored at power-up / reset:** Yes
41	Minimum Current, Phase B	**Type:** Read only **Size**: 1 Register **Units:** Amps or tenths of Amps **Range**: 0 to 9999 (User-definable, See Reg 200) **Function**: Minimum measured RMS Phase B Current (reg 4). **Restored at power-up / reset:** Yes
42	Minimum Current, Phase C	**Type**: Read only **Size:** 1 Register **Units**: Amps or tenths of Amps **Range**: -9999 to +9999 (User-definable, See Reg 200) **Function:** Minimum measured RMS Phase C Current (reg 5). **Restored at power-up / reset:** Yes
43	Minimum Current, 3 Phase Average	**Type**: Read only **Size**: 1 Register **Units**: Amps or tenths of Amps **Range**: -9999 to 9999 (User-definable, See Reg 200) **Function:** Minimum Simple Arithmetic mean of the rms current flowing in the 3 phases (reg 6). ((Ia +Ib + Ic)/3) Ia, Ib, Ic are contained in registers 3-5. **Restored at power-up / reset:** Yes
44	Minimum Current, Apparent rms	**Type:** Read only **Size**: 1 Register **Units**: Amps or tenths of Amps **Range**: 0 to 9999 (User-definable, See Reg 200) **Function**: The minimum of reg 7, the value used to evaluate the impact of harmonics and other forms of distortion on a power circuit by reporting the "apparent" rms current as seen by many peak-detecting protection and instrumentation devices. **Restored at power-up / reset:** Yes
45	Minimum Voltage, Phase A to B	**Type**: Read only **Size**: 1 Register **Units**: Volts **Range:** 0 - 32,767 **Function**: Minimum measured RMS Voltage Between Phases A and B (reg 8). **Restored at power-up / reset:** Yes
46	Minimum Voltage, Phase B to C	**Type**: Read only **Size**: 1 Register **Units**: Volts **Range**: 0 - 32,767 **Function**: Minimum measured RMS Voltage Between Phases B and C (reg 9). **Restored at power-up / reset:** Yes

Local Reg #	Register Name	Register Description
47	Minimum Voltage, Phase C to A	**Type:** Read only **Size:** 1 Register **Units**: Volts **Range:** 0 - 32,767 **Function**: Minimum measured RMS Voltage Between Phases C and A (reg 10). **Restored at power-up / reset:** Yes
48	Minimum Voltage, Phase A to Neutral	**Type**: Read only **Size**: 1 Register **Units**: Volts **Range**: 0 - 32,767 **Function**: Minimum measured rms voltage between Phase A and Neutral (reg 11). In a 3 wire system, this value is not meaningful and when read will be returned as 32,767. **Restored at power-up / reset:** Yes
49	Minimum Voltage, Phase B to Neutral	**Type**: Read only **Size**: 1 Register **Units**: Volts **Range**: 0 - 32,767 **Function**: Minimum measured rms voltage Between Phase B and Neutral (reg 12). In a 3 wire system, this value is not meaningful and when read will be returned as 32,767. **Restored at power-up / reset:** Yes
50	Minimum Voltage, Phase C to Neutral	**Type:** Read only **Size:** 1 Register **Units**: Volts **Range**: 0 - 32,767 **Function**: Minimum measured rms Voltage Between Phase C and Neutral (reg 13). In a 3 wire system, this value is not meaningful and when read will be returned as 32,767. **Restored at power-up / reset:** Yes
51	Minimum Power Factor, 3 Phase Total⁕	**Type:** Read only **Size:** 1 Register **Units:** None **Range:** +/- 100 (+/- 1.00) The sign indicates leading/lagging (positive indicates leading, negative indicates lagging). (See Appendix B). Lead/Lag is always supplied, but the user should use per phase indication when available (i.e. when a 4 wire connection is used). **Function:** Minimum total power factor of a 3 phase circuit calculated as the 3 phase total real power divided by the 3 phase total apparent power (reg 14). **Restored at power-up / reset:** Yes
52	Minimum Power Factor, Phase A ⁕	**Type:** Read only **Size:** 1 Register **Units:** None **Range:** +/- 100 (+/- 1.00) The sign indicates leading/lagging (positive indicates leading, negative indicates lagging).

⁕ Signed Magnitude Notation (See Appendix B)

Local Reg #	Register Name	Register Description
52	(Continued)	**Function**: Minimum of the ratio of the Phase A real power to the Phase A apparent power. Power Factor is described as "LAG" (current lagging voltage in an inductive circuit) or "LEAD" (current leading voltage in a capacitive circuit). A perfect unity (1.00) indicates a purely resistive circuit. [Note: per phase power factor values are not available in a 3 wire system and, when read,will be reported equal to 3-Phase Total Power Factor]. **Restored at power-up / reset:** Yes
53	Minimum Power Factor, Phase B⁕	**Type:** Read only **Size:** 1 Register **Units**: None **Range**: Same as reg #52 **Function**: Same as reg #52 only for Phase B (reg 16). **Restored at power-up / reset:** Yes
54	Minimum Power Factor, Phase C⁕	**Type**: Read only **Size**: 1 Register **Units:** None **Range**: Same as reg #52 **Function:** Same as reg #52 only for Phase C (reg 17) **Restored at power-up / reset:** Yes
55	Minimum Real Power, Three Phase Total (P)	**Type**: Read only **Size**: 1 Register **Units:** Kilowatts **Range:** - 32,767 to +32,767 **Function:** Minimum sum of the real power values for each of the 3 phases (reg 18). **Restored at power-up / reset:** Yes
56	Minimum Reactive Power, Three Phase Total (Q)	**Type**: Read only **Size**: 1 Register **Units:** Kilovoltamperes Reactive (kVAr) **Range**: - 32,767 to +32,767 **Function**: Minimum sum of the reactive power values for each of the 3 phases (reg 19). **Restored at power-up / reset:** Yes
57	Minimum Apparent Power, Three Phase Total (S)	**Type:** Read only **Size:** 1 Register **Units**: Kilovoltamperes **Range:** - 32,767 to +32,767 **Function**: Minimum total volt-amps consumed in a 3 phase circuit (reg 20). Magnitude of the complex power vector S. It is defined as: $\lvert S \rvert = \sqrt{P^2 + Q^2}$ Where P and Q are register 18 and 19 respectively. **Restored at power-up / reset:** Yes
58-60		Reserved

⁕ Signed Magnitude Notation (See Appendix B)

Registers 61-86 represent the maximum values for each of the registers discussed above since the last reset or minimum/maximum clear. Each time the present instantaneous value (registers 1-20, 32-34) is updated it is compared to the previous maximum of that register and if the new value is greater than the previous it becomes the new maximum value. All of the maximum value registers are saved in the event of a control power failure. The maximum value registers are of the same type, size, unit, and range as the corresponding instantaneous values.

Local Reg #	Register Name	Register Description
61	Maximum Frequency	**Type**: Read only **Size**: 1 Register **Units**: Hertz in 100ths **Range**: 2300 - 6500 (23.00 - 65.00) **Function**: Maximum system frequency (reg 1). This register is only updated when the frequency falls within the given range. **Restored at power-up / reset:** Yes
62	Maximum Temperature	**Type**: Read only **Size**: 1 Register **Units:**Degrees Celsius (Centigrade) in 100ths **Range**: -10000 to +10000 (-100.00 to +100.00) **Function:** Maximum temperature inside CM enclosure **Restored at power-up / reset:** Yes
63	Maximum Current, Phase A	**Type**: Read only **Size**: 1 Register **Units**: Amps or tenths of Amps **Range**: 0 to 9999 (User-definable, See Reg 200) **Function**: Maximum measured RMS Phase A Current (reg 3). **Restored at power-up / reset:** Yes
64	Maximum Current, Phase B	**Type:** Read only **Size**: 1 Register **Units:** Amps or tenths of Amps **Range**: 0 to 9999 (User-definable, See Reg 200) **Function**: Maximum measured RMS Phase B Current (reg 4). **Restored at power-up / reset:** Yes
65	Maximum Current, Phase C	**Type**: Read only **Size:** 1 Register **Units**: Amps or tenths of Amps **Range**: 0 to 9999 (User-definable, See Reg 200) **Function:** Maximum measured RMS Phase C Current (reg 5). **Restored at power-up / reset:** Yes
66	Maximum Current, 3 Phase Average	**Type**: Read only **Size**: 1 Register **Units**: Amps or tenths of Amps **Range**: 0 to 9999 (User-definable, See Reg 200) **Function:** Maximum simple arithmetic mean of the rms current flowing in the 3 phases (reg 6). ((Ia +Ib + Ic)/3) Ia, Ib, Ic are contained in registers 3-5. **Restored at power-up / reset:** Yes

Local Reg #	Register Name	Register Description
67	Maximum Current, Apparent rms	**Type:** Read only **Size**: 1 Register **Units**: Amps or tenths of Amps **Range**: 0 to 9999 (User-definable, See Reg 200) **Function**: The maximum of reg 7, the value used to evaluate the impact of harmonics and other forms of distortion on **a** power circuit by reporting the "apparent" rms current as seen by many peak-detecting protection and instru-mentation devices. **Restored at power-up / reset:** Yes
68	Maximum Voltage, Phase A to B	**Type**: Read only **Size**: 1 Register **Units**: Volts **Range:** 0 - 32,767 **Function**: Maximum measured RMS Voltage Between Phases A and B (reg 8) **Restored at power-up / reset:** Yes
69	Maximum Voltage, Phase B to C	**Type**: Read only **Size**: 1 Register **Units**: Volts **Range**: 0 - 32,767 **Function**: Maximum measured RMS Voltage Between Phases B and C (reg 9) **Restored at power-up / reset:** Yes
70	Maximum Voltage, Phase C to A	**Type:** Read only **Size:** 1 Register **Units**: Volts **Range:** 0 - 32,767 **Function**: Maximum measured RMS Voltage Between Phases C and A (reg 10) **Restored at power-up / reset:** Yes
71	Maximum Voltage, Phase A to Neutral	**Type**: Read only **Size**: 1 Register **Units**: Volts **Range**: 0 - 32,767 **Function**: Maximum measured RMS Voltage Between Phase A and Neutral (reg 11). In a 3 wire system, this register is meaningless, and when read, will return 32,767 . **Restored at power-up / reset:** Yes
72	Maximum Voltage, Phase B to Neutral	**Type**: Read only **Size**: 1 Register **Units**: Volts **Range**: 0 - 32,767 **Function**: Maximum measured RMS Voltage Between Phase B and Neutral (reg 12). In a 3 wire system, this register is meaningless, and when read, will return 32,767 . **Restored at power-up / reset:** Yes

Local Reg #	Register Name	Register Description
73	Maximum Voltage, Phase C to Neutral	**Type:** Read only **Size:** 1 Register **Units**: Volts **Range**: 0 - 32,767 **Function**: Maximum measured RMS Voltage Between Phase C and Neutral (reg 13). In a 3 wire system, this register is meaningless, and when read, will return 32,767. **Restored at power-up / reset:** Yes
74	Maximum Power Factor, 3 Phase Total⁕	**Type:** Read only **Size:** 1 Register **Units:** None **Range:** +/- 100 (+/- 1.00) The sign indicates leading/lagging (positive indicates leading, negative indicates lagging). (See Appendix B). Lead/Lag is always supplied, but the user should use per phase indication when available (i.e. when a 4 wire connection is used). **Function:** Maximum total power factor of a 3 phase circuit calculated as the 3 phase total real power divided by the 3 phase total apparent power (reg 14). **Restored at power-up / reset:** Yes
75	Maximum Power Factor, Phase A⁕	**Type:** Read only **Size:** 1 Register **Units:** None **Range:** +/- 100 (+/- 1.00) The sign indicates leading/lagging (positive indicates leading, negative indicates lagging). **Function**: Maximum of the ratio of the Phase A real power to the Phase A apparent power. (reg 15). Power Factor is described as "LAG" (current lagging voltage in an inductive circuit) or "LEAD" (current leading voltage in a capacitive circuit). A perfect unity (1.00) indicates a purely resistive circuit. [Note: per phase power factor values are not available in a 3 wire system and, when read,will be reported equal to 3-Phase Total Power Factor]. **Restored at power-up / reset:** Yes
76	Maximum Power Factor, Phase B ⁕	**Type:** Read only **Size:** 1 Register **Units**: None **Range**: Same as reg #75 **Function**: Same as reg #75 only for Phase B (reg 16). **Restored at power-up / reset:** Yes
77	Maximum Power Factor, Phase C⁕	**Type**: Read only **Size**: 1 Register **Units:** None **Range**: Same as reg #75 **Function:** Same as reg #75 only for Phase C (reg 17). **Restored at power-up / reset:** Yes
78	Maximum Real Power, Three Phase Total (P)	**Type**: Read only **Size**: 1 Register **Units:** Kilowatts **Range:** - 32,767 to +32,767 **Function:** Maximum sum of the real power values for each of the 3 phases (reg 18) **Restored at power-up / reset:** Yes

⁕ Signed Magnitude Notation (See Appendix B)

Local Reg #	Register Name	Register Description
79	Maximum Reactive Power, Three Phase Total (Q)	**Type**: Read only **Size**: 1 Register **Units:** Kilovoltamperes Reactive (kVAr) **Range**: - 32,767 to +32,767 **Function**: Maximum sum of the reactive power values for each of the 3 phases reg 19). **Restored at power-up / reset:** Yes
80	Maximum Apparent Power, Three Phase Total (S)	**Type:** Read only **Size:** 1 Register **Units**: Kilovoltamperes **Range:** - 32,767 to +32,767 **Function**: Maximum of the total volt-amps consumed in a 3 phase circuit (reg 20).Magnitude of the complex power vector S. It is defined as: $\|S\| = \sqrt{P^2 + Q^2}$ Where P and Q are register 18 and 19 respectively. **Restored at power-up / reset:** Yes
81-83		Reserved
84	Peak Demand Current Phase A	**Type**: Read only **Size**: 1 Register **Units**: Amps or tenths of Amps **Range**: 0 to 9999 (User-definable, See Reg 200) **Function**: Maximum average demand current for phase A (reg 32) calculated using a sliding window over a 15 minute demand interval. **Restored at power-up / reset:** Yes
85	Peak Demand Current Phase B	**Type:** Read only **Size:** 1 Register **Units**: Amps or tenths of Amps **Range**: 0 to 9999 (User-definable, See Reg 200) **Function:** Same as reg #84 except phase B current (reg 33) is used. **Restored at power-up / reset:** Yes
86	Peak Demand Current Phase C	**Type:** Read Only **Size**: 1 Register **Units:** Amps or tenths of Amps **Range:** 0 to 9999 (User-definable, See Reg 200) **Function:** Same as reg #84 except phase C current (reg 34) is used. **Restored at power-up / reset:** Yes
87	CM Address Switch Setting	**Type:** Read only **Size:** 1 Register **Range:** 0-99 **Function:** When this register is read, it returns the current address of the CM as shown on the device address switches on the rear of the unit. **Restored at power-up / reset:** Yes

Local Reg #	Register Name	Register Description
88-90	Last Restart Date/time	**Type:** Read only **Size:** 3 Registers **Units**: Month, Day, Yr, Hr, Min, Sec **Range:** Register 88, Month (byte 1) = 1 - 12, Day (byte 2) = 1 - 31, Register 89, Year (byte 3) = 0 - 199, Hour (byte 4) = 0 - 23, Register 90, Minutes (byte 5) = 0 - 59, Seconds (byte 6) = 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 as109). **Function:** The date/time in these registers is the last time the CM was restarted from the host by writing to register 237 with bit 5 = 1. The date and time are taken from the CM internal clock. **Restored at power-up / reset:** Yes
91-93	Date/time of Peak Demand Current,Phase A	**Type**: Read only **Size:** 3 Registers **Units:** Same as regs # 88-90 **Range:** Same as regs # 88-90 **Function:** These registers store the date/time when a new peak demand for current phase A was recorded (reg 84). The date and time are taken from the CM internal clock. **Restored at power-up / reset:** Yes
94-96	Date/time of Peak Demand Current, Phase B	**Type:** Read only **Size:** 3 Registers **Units:** Same as regs # 88-90 **Range:** Same as regs # 88-90 **Function:** These registers store the date/time when a new peak demand for current phase B is recorded (reg 85). The date and time is taken from the CM internal clock. **Restored at power-up / reset:** Yes
97-99	Date/time of Peak Demand Current, Phase C	**Type:** Read only **Size:** 3 Registers **Units:** Same as regs # 88-90 **Range**: Same as regs # 88-90 **Function**: These registers store the date/time when a new peak demand for current phase C was recorded (reg 86). The date and time is taken from the CM internal clock. **Restored at power-up / reset:** Yes
100-102	Date/time of Peak Demand, (Average Real Power)	**Type**: Read only **Size:** 3 Registers **Units**: Same as regs # 88-90 **Range:** Same as regs # 88-90 **Function**: These registers store the date/time when the last peak demand (reg # 37) was recorded. The date and time is taken from the CM internal clock. **Restored at power-up / reset:** Yes
103-105	Date/time of Last Reset of Peak Demand Currents	**Type:** Read only **Size:** 3 Registers **Units:** Same as regs # 88-90 **Range:** Same as regs # 88-90 **Function:** The date/time in these registers record the last time a write to register 237 with bit 3 = 1 occurred. The time is taken from the CM internal clock. **Restored at power-up / reset:** Yes

Local Reg #	Register Name	Register Description
106-108	Date/time of Last Min/Max Clear of Instantaneous Values	**Type:** Read only **Size:** 3 Registers **Units**: Same as regs # 88-90 **Range:** Same as regs # 88-90 **Function**: These registers store the date/time when a write to register 237 with bit 1 = 1 last occurred causing the instantaneous max and min values to be reset to their present values. **Restored at power-up / reset:** Yes
109-111	Date/time of Last Write to Circuit Tracker™ Setpoint Register	**Type:** Read only **Size:** 3 Registers **Units:** Same as regs #88-90 **Range:** Same as regs #88-90 **Function:** This is the date/time when reg 238 was last written to by the host. **Restored at power-up / reset:** Yes
112-114	Date/time When Peak Demand (Average Real Power) Was Last Cleared	**Type**: Read only **Size:** 3 Registers **Units:** Same as regs # 88-90 **Range**: Same as regs # 88-90 **Function:** The date/time in these registers record the last occurrence of a write to reg. 237 with bit 4 = 1, causing the peak demand to be set equal to the current average demand, real power. (Register 35). **Restored at power-up / reset:** Yes
115-117	Date/time When Accumulated Energy Last Cleared	**Type**: Read only **Size**: 3 Registers **Units**: Same as regs # 88-90 **Range:** Same as regs # 88-90 **Function:** These registers store the date/time when the accumulated energy values, both real and reactive, in registers 24-31 are zeroed. This is accomplished by a write to register 237 with bit 2 = 1. The date and time are taken from the CM internal clock. **Restored at power-up / reset:** Yes
118-120	Date/time When The Control Power Failed Last	**Type:** Read only **Size:** 3 Registers **Units**: Same as regs # 88-90 **Range:** Same as regs # 88-90 **Function:** These registers store the date/time when the control power to the CM failed last. The date and time is taken from the CM internal clock. **Restored at power-up / reset:** Yes
121	Level 1 Energy Management Setpoint Last Exceeded Level	**Type**: Read only **Size**: 1 Register **Units**: Kilowatts **Range**: - 32,767 to +32,767 **Function**: This value represents the highest value of real power average demand (reg #35) which exceeded the level 1 energy management setpoint (reg # 239). (See Section 2.3). **Restored at power-up / reset:** Yes

Local Reg #	Register Name	Register Description
122	Level 2 Energy Management Set-point Last Exceeded Level	**Type:** Read only **Size**: 1 Register **Units**: Kilowatts **Range**: - 32,767 to +32,767 **Function:** This value represents the highest value of real power average demand (reg #35) which exceeded the level 2 energy management setpoint (reg #240). (See Section 2.3). **Restored at power-up / reset:** Yes
123	Level 3 Energy Management Set-point Last Exceeded Level	**Type:** Read only **Size**: 1 Register **Units**: Kilowatts **Range**: - 32,767 to +32,767 **Function**: This value represents the highest value of real power average demand (reg #35) which exceeded the level 3 energy management setpoint (reg #241). (See Section 2.3). **Restored at power-up / reset:** Yes
124-126	Date/time When Level 1 Energy Management Set-Point Alarm Period Was Last Entered	**Type:** Read only **Size**: 3 Registers **Units:** Same as regs # 88-90 **Range:** Same as regs # 88-90 **Function:** These registers store the date/time when the level 1 energy management setpoint (regs # 239) was exceeded and entered a level 1 alarm period. This date/time does NOT indicate when the highest exceeded value (regs #121) was recorded. The date and time are taken from the CM internal clock. (See Section 2.3). **Restored at power-up / reset:** Yes
127-129	Date/time When Level 2 Energy Management Set-Point Alarm Period Was Last Entered	**Type:** Read only **Size**: 3 Registers **Units:** Same as regs # 88-90 **Range:** Same as regs # 88-90 **Function**: The date/time in these registers is when the level 2 energy management setpoint (regs # 240) was exceeded and entered a level 2 alarm period. This date/time does NOT indicate when highest exceeded value (regs #122) was recorded. The date and time are taken from the CM internal clock. (See Section 2.3). **Restored at power-up / reset:** Yes
130-132	Date/time When Level 3 Energy Management Set-point Alarm Period Was Last Entered	**Type**: Read only **Size:** 3 Registers **Units**: Same as regs # 88-90 **Range**: Same as regs # 88-90 **Function**: The date/time in these registers is when the level 3 energy management setpoint (regs # 241) was exceeded and entered a level 3 alarm period. This date/time does NOT indicate when highest exceeded value (regs #123) was recorded. The date and time are taken from the CM internal clock. (See Section 2.3). **Restored at power-up / reset:** Yes
133	Number of Messages Sent To This Unit	**Type**: Read only **Size**: 1 Register **Units**: None **Range**: 0 - 32,767 (Rolls over to 0 when max is exceeded) **Function**: This value is a counter that is incremented every time a communications exchange with the host and this CM is executed without errors. **Restored at power-up / reset:** Yes

Local Reg #	Register Name	Register Description
134	Number of Messages Sent To Other Units	**Type:** Read only **Size:** 1 Register **Units**: None **Range:** 0 - 32,767 (Rolls over to 0 when max is exceeded) **Function**: This value is a counter that is incremented every time a communications exchange occurs with another CM and the host. **Restored at power-up / reset:** Yes
135	Number of Messages With Invalid Addresses	**Type**: Read only **Size**: 1 Register **Units**: None **Range**: 0 - 32,767 (Rolls over to 0 when max is exceeded) **Function**: This value is a counter that is incremented every time a message is sent from the host with an invalid CM address or route number. **Restored at power-up / reset:** Yes
136	Number Of Messages With Bad Checksum	**Type:** Read only **Size:** 1 Register **Units**: None **Range**: 0 - 32,767 (Rolls over to 0 when max is exceeded) **Function**: This value is a counter that is incremented every time a message for this CM is received but has a bad checksum. **Restored at power-up / reset:** Yes
137	Number Of Bad Messages Received At This CM	**Type**: Read only **Size:** 1 Register **Units:** None **Range**: 0 - 32,767 (Rolls over to 0 when max is exceeded) **Function**: This value is a counter that is incremented every time a bad message is received at this CM. **Restored at power-up / reset:** Yes
138	Number of Messages Received At This CM With Illegal Opcode	**Type**: Read only **Size:** 1 Register **Units:** None **Range:** 0 - 32,767 (Rolls over to 0 when max is exceeded) **Function**: This value is a counter that is incremented every time **a** message is received for this CM and has an illegal opcode. **Restored at power-up / reset:** Yes
139	Number of Messages Received At This CM With Illegal Registers	**Type**: Read only **Size**: 1 Register **Units**: None **Range**: 0 - 32,767 (Rolls over to 0 when max is exceeded) **Function:** This value is a counter that is incremented every time a message is received for this CM and has illegal Registers. **Restored at power-up / reset:** Yes
140	Number of Messages Received At This CM With Illegal Counts	**Type**: Read only **Size**: 1 Register **Units**: None **Range:** 0 - 32,767 (Rolls over to 0 when max is exceeded) **Function:** This value is a counter that is incremented every time a message is received for this CM and has illegal counts. **Restored at power-up / reset:** Yes

<table>
<tr><th>Local Reg #</th><th>Register Name</th><th>Register Description</th></tr>
<tr><td>141</td><td>Number of Messages Received At This CM With Bad Frames</td><td>Type: Read only Size: 1 Register Units: None
Range: 0 - 32,767 (Rolls over to 0 when max is exceeded)

Function: This value is a counter that is incremented every time a message is received for this CM and has bad frames.

Restored at power-up / reset: Yes</td></tr>
<tr><td>142</td><td>Metering Microprocessor Status</td><td>Type: Read only Size: 1 Register Units: None
Range: Not Applicable

Function: This value is a status register reflecting the state of the meter microprocessor.

Bit Positions

1 1 1 1 1 1 1
6 5 4 3 2 1 0 9 8 7 6 5 4 3 2 1
_ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _
|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|

Bit 1 = If any of the other bits is a 1 this bit will be set to 1.
Bit 2 = If an on board ram error occurred during self test this bit will be set to 1.
Bit 3 = If an off board ram error occurred during self test this bit will be set to 1.
Bit 4 = If an EPROM checksum error occurred during self test this bit will be set to 1.
Bit 5 = If an interrupt error occurred during self test this bit will be set to 1.
Bit 6 = If the phase A current is 0, this bit will be set to 1.
Bit 7 = If the phase B current in a 4 wire system is 0, this bit will be set to 1.
Bit 8 = If the phase C current is 0 this bit will be set to 1.
Bit 9 = If the measured temp in the CM exceeds 70 C, this bit will be set to 1.
Bit 10 = If the phase A voltage is 0, this bit will be set to 1.
Bit 11 = If the phase B voltage is 0, this bit will be set to 1.
Bit 12 = If the phase C voltage in a 4 wire system is 0, this bit will be set to 1.
Bit 13 = Reserved
Bit 14 = Invalid Parameters in reg 200-202. This bit is set to 1 when any of the following invalid parameters occur:
a) The value in reg 200 is not 3 or 4.
b) The value in reg 201 in less than 5.
c) The value in reg 202 is less than 120.
Bit 15 = No Frequency. This bit is set to 1 when any of the following conditions occurs:
a) Overvoltage (Saturation of the A/D Converter)
b) DC Voltage
c) No Voltage
d) Frequency not withing the range 13-65 HZ
Bit 16 = Reserved

Once this register has been read by the host, the register will be cleared so new status information will be current. This register is updated after each sample pass of the raw data.

Restored at power-up / reset: No</td></tr>
</table>

<table>
<tr><th>Local Reg #</th><th>Register Name</th><th>Register Description</th></tr>
<tr><td>143</td><td>Communications Microprocessor Status</td><td>
Type: Read only Size: 1 Register Units: None
Range: Not Applicable

Function: This value is a status register reflecting the state of the communication microprocessor.

Bit Positions

1 1 1 1 1 1 1
6 5 4 3 2 1 0 9 8 7 6 5 4 3 2 1
_ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _
|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|

Bit 1 = If any of the other bits is a 1 this bit will be set to 1
Bit 2 = If an error occurred in the meter microprocessor (reg #142) this bit is set to a 1.
Bit 3 = If a power fail occurred this bit will be set to 1. When the CM date/time is reset, i.e. registers 784-789 or 228-230 are written to, this bit is cleared.
Bit 4 = If an on board ram error occurred during self test this bit will be set to 1.
Bit 5 = If an off board ram error occurred during self test this bit will be set to 1.
Bit 6 = If an error was detected in the non-volatile ram during self test this bit will set to a 1.
Bit 7 = If an EPROM checksum error was detected during self test this bit will be set to 1.
Bit 8 = If an interrupt error was detected during self test this bit will be a 1.
Bit 9 = If excessive communication errors (reg # 135-141) have occurred this bit will be set to a 1.
Bit 10 = Level 1 Energy Management Setpoint Being Exceeded. This bit is set while the Real Power Average Demand value is exceeding the Level 1 Energy Management Setpoint (reg #239). It remains set while the Real Power Average Demand value exceeds the setpoint and is reset to 0 when the Real Power Average Demand falls below the setpoint.
Bit 11 = Level 2 Energy Management Setpoint Being Exceeded. This bit is set while the Real Power Average Demand value is exceeding the Level 2 Energy Management Setpoint (reg #240). It remains set while the Real Power Average Demand value exceeds the setpoint and is reset to 0 when the Real Power Average Demand falls below the setpoint.
Bit 12 = Level 3 Energy Management Setpoint Being Exceeded.This bit is set while the Real Power Average Demand value is exceeding the Level 3 Energy Management Setpoint (reg #241). It remains set while the Real Power Average Demand value exceeds the setpoint and is reset to 0 when the Real Power Average Demand falls below the setpoint.
Bits 13-16 = Reserved

After this register has been read by the host it will be cleared so new status information will be current. This register is updated after each sample pass of the raw data.

Restored at power-up / reset: No
</td></tr>
</table>

The following registers (200 - 241) are write/read registers that can be written to from the host processor over the communications link. (Regs 203-214 cannot be written to in the field). Some of these items are used in the calculations, some are for identification purposes, and some cause commands to be executed. **NOTE**: After writing to a register in the range 200-214, the user must force a software restart by setting bit #5 of register 237 (i.e. writing 16 to it).

Local Reg #	Register Name	Register Description
200	System Connection/ Current Reporting Precision	**Type:** Write/Read **Size:** 1 Register **Units:** None **Range:** 03, 04, 19, 20 **Function**: This register is used to set two independent parameters: System Connection and Current Reporting Precision. System Connection is used to indicate the way in which the CM is connected to the circuit being monitored. Current Reporting Precision indicates whether Current related values will be reported in amps or tenths of amps. Specific decimal values must be written to this register to indicate the desired configuration. The chart that follows indicates the decimal values which should be transmitted to achieve each configuration.

System Connection	Current Precision	Decimal Val
3 wire	amps	03
3 wire	tenths	19
4 wire	amps	04
4 wire	tenths	20

Local Reg #	Register Name	Register Description
		Restored at power-up / reset: Yes
201	CT Rating	**Type**: Write/Read **Size**: 1 Register **Units**: None **Range**: 5 - 9999 **Default**: 5 **Function**: This value represents the primary rating of the current transformers connected to the CM (This assumes 5A secondary CTs). (See section 4.3) **Restored at power-up / reset:** Yes
202	PT Rating	**Type:** Write/Read **Size**: 1 Register **Units**: None **Range**: 120 - 32,767 **Default:** 120 **Function**: This value represents the primary rating of the potential transformers connected to the CM (This assumes 120V secondary PTs). (See section 4.3) **Restored at power-up / reset:** Yes
203	Channel A Voltage Gain	**Type:** Write/Read **Size**: 1 Register **Units**: None **Range**: 0.0000 - 3.0000 in 10,000ths (Nominal = 0.0000) **Function**: This value is used for calibration of the CM and is set at the factory. This register cannot be written to in the field. **Restored at power-up / reset:** Yes

Local Reg #	Register Name	Register Description
204	Channel A Voltage Offset	**Type:** Write/Read **Size:** 1 Register **Units**: None **Range:** -3.0000 to +3.0000 in 10,000ths (Nominal = 1.0000) **Function**: This value is used for calibration of the CM and is set at the factory. This register cannot be written to in the field. **Restored at power-up / reset:** Yes
205	Channel B Voltage Gain	**Type:** Write/Read **Size:** 1 Register **Units**: None **Range**: 0.0000 - 3.0000 in 10,000ths (Nominal = 0.0000) **Function**: Same as reg # 203 except for channel B. **Restored at power-up / reset:** Yes
206	Channel B Voltage Offset	**Type**: Write/Read **Size**: 1 Register **Units**: None **Range**: -3.0000 to +3.0000 in 10,000ths (Nominal = 1.0000) **Function**: Same as reg # 204 except for channel B. **Restored at power-up / reset:** Yes
207	Channel C Voltage Gain	**Type**: Write/Read **Size**: 1 Register **Units**: None **Range:** 0.0000 - 3.0000 in 10,000ths (Nominal = 0.0000) **Function**: Same as reg # 203 except for channel C. **Restored at power-up / reset:** Yes
208	Channel C Voltage Offset	**Type**: Write/Read **Size**: 1 Register **Units**: None **Range**: -3.0000 to +3.0000 in 10,000ths (Nominal = 1.0000) **Function**: Same as reg # 204 except for channel C. **Restored at power-up / reset:** Yes
209	Channel A Current Gain	**Type**: Write/Read **Size**: 1 Register **Units**: None **Range**: 0.0000 - 3.0000 in 10,000ths (Nominal = 0.0000) **Function**: This value is used for calibration of the CM and is set at the factory. This register cannot be written to in the field. **Restored at power-up / reset:** Yes
210	Channel A Current Offset	**Type**: Write/Read **Size**: 1 Register **Units**: None **Range**: -3.0000 to +3.0000 in 10,000ths (Nominal = 1.0000) **Function**: This value is used for calibration of the CM and is set at the factory. This register cannot be written to in the field. **Restored at power-up / reset:** Yes

<table>
<tr><th>Local Reg #</th><th>Register Name</th><th>Register Description</th></tr>
<tr><td>211</td><td>Channel B Current Gain</td><td>Type: Write/Read Size: 1 Register Units: None
Range: 0.0000 - 3.0000 in 10,000ths (Nominal = 0.0000)

Function: Same as reg # 209 except for channel B.

Restored at power-up / reset: Yes</td></tr>
<tr><td>212</td><td>Channel B Current Offset</td><td>Type: Write/Read Size: 1 Register Units: None
Range: -3.0000 to +3.0000 in 10,000ths (Nominal = 1.0000)

Function: Same as reg # 210 except for channel B.

Restored at power-up / reset: Yes</td></tr>
<tr><td>213</td><td>Channel C Current Gain</td><td>Type: Write/Read Size: 1 Register Units: None
Range: 0.0000 - 3.0000 in 10,000ths (Nominal = 0.0000)

Function: Same as reg # 209 except for channel C.

Restored at power-up / reset: Yes</td></tr>
<tr><td>214</td><td>Channel C Current Offset</td><td>Type: Write/Read Size: 1 Register Units: None
Range: -3.0000 to +3.0000 in 10,000ths (Nominal = 1.0000)

Function: Same as reg # 210 except for channel C.

Restored at power-up / reset: Yes</td></tr>
<tr><td>215</td><td>CM Operating Mode Selections</td><td>Type: Write/Read Size: 1 Register Units: None
Range: Bit mapped field, see below.

Bit Positions
1 1 1 1 1 1 1
6 5 4 3 2 1 0 9 8 7 6 5 4 3 2 1
_ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _
|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|

Bit 1: This bit tells the CM to do either signed or unsigned energy calculations. (This effects only the value stored in registers 24-27). A zero (0) indicates that energy will be accumulated as positive regardless of the direction of power flow. A one (1) instructs the CM to consider the direction of power flow when doing energy calculations, thus allowing the accumulated energy magnitude to both increase and decrease. A change in this field will not affect the reporting of energy previously accumulated. If it is desired to clear a negative accumulated energy total, the user would have to reset the energy total in addition to setting this field to 0. Stated another way, energy totals are always reported as signed quantities. This field only affects how the accumulated energycalculation is done.

Bits 2-16: Reserved

Restored at power-up / reset: Yes</td></tr>
</table>

Local Reg #	Register Name	Register Description
216	Demand Interval	**Type**: Write/Read **Size**: 1 Register **Units**: Minutes **Range**: 5 - 60, in whole numbers **Function**: This value is the time interval (sliding window) used in the Average Demand calculations for Real Power (registers 35). It is recommend that this value be a multiple of 5, i.e. (5, 10, 15, 20, 25, ..., 60). Values in the range 5..60 that are not divisible by 5 will work but will introduce a slight error in demand calculations. **Restored at power-up / reset:** Yes
217	Reserved	
218-219	CM Label	**Type**: Write/Read **Size**: 2 Registers **Units**: ASCII Characters **Range**: 20 hex(space) - 7A hex("z") **Function**: These 4 characters are a label associated with this circuit monitor. It can be assigned by the user. **Restored at power-up / reset:** Yes
220-227	CM Nameplate	**Type**: Write/Read **Size**: 8 Registers **Units**: ASCII Characters **Range**: 20 hex(space) - 7A hex("z") **Function**: These 16 characters are a name by which the circuit being monitored can be identified or associated with. For example if the circuit being monitored supplied power to the welder on production line three the nameplate may be "Welder Line #3". **Restored at power-up / reset:** Yes
228-230	Set Date/Time	**Type**: Write/Read **Size**: 3 Registers **Units**: Month, Day, Year, Hour, Minutes, and Seconds **Range**: Month (byte 1) = 1 - 12, Day (byte 2) = 1 - 31, Year (byte 3) = 0 - 199, Hour (byte 4) = 0 - 23, Minutes (byte 5) = 0 - 59, Seconds (byte 6) = 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 as109). **Function**: By writing to these three registers together, the date and time are set in this CM. From that point on the CM will advance the date and time based on its internal clock. This register can be read to get the date and time. Upon power up, the date is set to 1-1-1900 and the time to 00:00:00. **Restored at power-up / reset:** No

Local Reg #	Register Name	Register Description
231	Software Revision Level	**Type**: Write/Read **Size**: 1 Register **Units**: Release:Revision, Release:Revision **Range**: 0-15 : 0-15, 0-15 : 0-15 **Function:** This register represents the firmware release and revision numbers. The least significant byte (bits 1-8) represents the communications processor release and revision, where bits 1-4 are the revision number and bits 5-8 are the release number. The most significant byte (bits 9-16) represents the metering processor release and revision, where bits 9-12 are the revision number and bits 13-16 are the release number. A release is a major upgrade or change in firmware features whereas a revision is a change to the current feature set to improve performance. For example, release level 2.0 may provide some new calculated values that were not available in release 1.0. Revision 2.1 may change the format of the new calculated values. This register can only be written to at the factory. **Restored at power-up / reset:** Yes
232-234	Date/Time Of Calibration	**Type**: Write/Read **Size**: 3 Registers **Units**: Same as regs # 88-90 **Range**: Same as regs # 88-90 **Function**: These registers store the date/time when the CM was tested and calibrated at the factory. This register can only be written to at the factory. NOTE: The Circuit Monitor's date and time (Regs 228-230) must be set prior to calibration of the unit to ensure accuracy of the value stored in this register. This register is updated every time a register in the range 203-214 is written to. **Restored at power-up / reset:** Yes
235	Reserved	
236	Reserved	

<table>
<tr><th>Local Reg #</th><th>Register Name</th><th>Register Description</th></tr>
<tr><td>237</td><td>Command Register</td><td>Type: Write/Read Size: 1 Register Units: None
Range: Bit mapped field

Function: Writing to this register with specific bits set to a 1 will cause certain values to be zeroed, cleared, or set to the most recent metered values as appropriate.

Bit Positions
1 1 1 1 1 1 1
6 5 4 3 2 1 0 9 8 7 6 5 4 3 2 1
_ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _
|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|

Bit 1 = Reset all Min/Max values associated with instantaneous measurements (regs # 38-57, 61-80) to their present values and record the date and time in regs 106-108.
Bit 2 = Zero Accumulated Energy values (regs #24-31) and record the date and time in registers 115-117.
Bit 3 = Reset all Peak Demand Current values (regs #84-86) to their most recent values and record the date and time in registers 103-105.
Bit 4 = Reset the Peak Demand (Max of Real Power Avg Demand) (regs #37) to its present value and record the date and time in registers 112-114.
Bit 5 = Software restart and record the date and time in registers 88-90.
Bit 6 = Zero communication counters (regs # 133-141)
Bit 7 = Reset Energy Management Level 1 Setpoint Last Exceeded Level to zero (reg. 121) and reset associated date and time (reg 124-126) to 01-01-1900, 00:00:00
Bit 8 = Reset Energy Management Level 2 Setpoint Last Exceeded Level to zero (reg. 122) and reset associated date and time (reg 127-129) to 01-01-1900, 00:00:00
Bit 9 = Reset Energy Management Level 3 Setpoint Last Exceeded Level to zero (reg. 123) and reset associated date and time (reg 130-132) to 01-01-1900, 00:00:00</td></tr>
</table>

Local Reg #	Register Name	Register Description
237	(Continued)	Bit 10= Writing a 1 to this bit will initiate the transfer of raw voltage and current waveform samples from the metering uP to the comm. uP (registers2000 -2767). After requesting this transfer, the user should wait for bit 10 of this register to be set to a 1, indicating that the transfer is complete. Writing to this register with bit 10 = 1 will clear bit 11. Bit 11= When set to a 1, this bit indicates that raw sample data is available in registers 2000 to 2767. The bit is reset to a 0 by writing to this register with bit 10 = 1. Bits 12 - 16 = Reserved When this register is read, all bits except bit 10 are zero. **Restored at power-up / reset:** No
238	Circuit Tracker™ Setpoint Register	**Type :** Read Only **Size:** 1 Register **Units:** None **Range:** -32767 to 32767 **Function:** This register contains a setpoint value which is written to and read by the host. This register is passive in regard to the CM in that it requires no action except to record the date/time (reg 109-111) when this register was written to. **Restored at power-up / reset:** Yes
239	Level 1 Energy Management Setpoint	**Type**: Write/Read **Size**: 1 Register **Units**: Kilowatts **Range**: 0 to +32,767 **Function**: This is an alarm set point that is checked after the most recent Real Power Average Demand calculation. It is used in updating the values in registers 121, 124-126. **Restored at power-up / reset:** Yes
240	Level 2 Energy Management Setpoint	**Type**: Write/Read **Size**: 1 Register **Units**: Kilowatts **Range**: 0 to +32,767 **Function**: This is an alarm set point that is checked after the most recent Real Power Average Demand calculation. It is used in updating the values in registers 122, 127-129. **Restored at power-up / reset:** Yes
241	Level 3 Energy Management Setpoint	**Type**: Write/Read **Size**: 1 Register **Units**: Kilowatts **Range**: 0 to +32,767 **Function**: This is an alarm set point that is checked after the most recent Real Power Average Demand calculation. It is used in updating the values in registers 123, 130-132. **Restored at power-up / reset:** Yes

NOTE: While the three preceding energy management setpoints are specified as unsigned values, the energy management reporting system functions in a bipolar mode, that is for both positive and negative excursions of Average Demand Real Power.Therefore, specifying a single value is equivalent to specifying both positive and negative setpoints of equal magnitude.

Local Reg #	Register Name	Register Description
242	Square D ID No.	**Type:** Read/Write **Size**: 1 Register **Units**: None **Range:** 450-455 **Function:** Square D ID number indicating CM model, where 450=CM-100, 451=CM-200, 452=CM-108, 453=CM-208, 454=CM-110, 455=CM-210. The CM firmware automatically copies this value to CM register 8188. This register cannot be written to in the field.
243-245		Reserved
246-255	Utility Registers	**Type:** Read/Write **Size:** 10 Registers **Units:** None **Range:** -32,767 to +32,767 **Function:** These 10 registers have been established for use by the application programmer as required. **Restored at power-up / reset:** Yes

The following registers (700-795) contain Circuit Monitor date/time fields in a format compatible with the date/time format used by SY/MAX® Processors. Date/time values stored in Circuit Monitor registers 88-120, 124-132, and 228-234 are mapped into CM registers 700-795. Each of the date/time fields occupies six storage registers. Seconds, minutes, hours, day, month, and year each occupy a register. For example, if a specific date/time field began in register n, then the field would be organized as follows:

ITEM	**REGISTER**
Seconds	n
Minutes	n+1
Hours	n+2
Day	n+3
Month	n+4
Year	n+5

Refer to registers 700-705 for a specific example.

Local Reg #	Register Name	Register Description
700-705	Last Restart Date/time (Extended)	**Type:** Read only **Size:** 6 Registers **Units**: Sec, Min, Hour, Day, Month, Year **Range:** 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 **Function:** The date/time in these registers is the last time the CM was restarted from the host by writing to register 237 with bit 5 = 1. The date and time are mapped from CM registers 88-90. **Restored at power-up / reset:** Yes
706-711	Date/time of Peak Demand Current,Phase A (Extended)	**Type**: Read only **Size:** 6 Registers **Units:** Sec, Min, Hour, Day, Month, Year **Range:** Same as regs # 700-705 **Function:** These registers store the date/time when a new peak demand for current phase A was recorded (reg 84). The date and time are mapped from CM registers 91-93. **Restored at power-up / reset:** Yes

Local Reg #	Register Name	Register Description
712-717	Date/time of Peak Demand Current, Phase B (Extended)	**Type:** Read only **Size:** 6 Registers **Units:** Sec, Min, Hour, Day, Month, Year **Range:** Same as regs # 700-705 **Function:** These registers store the date/time when a new peak demand for current phase B is recorded (reg 85). The date and time are mapped from CM registers 94-96. **Restored at power-up / reset:** Yes
718-723	Date/time of Peak Demand Current, Phase C (Extended)	**Type:** Read only **Size:** 6 Registers **Units:** Sec, Min, Hour, Day, Month, Year **Range**: Same as regs # 700-705 **Function**: These registers store the date/time when a new peak demand for current phase C was recorded (reg 86). The date and time are mapped from CM registers 97-99. **Restored at power-up / reset:** Yes
724-729	Date/time of Peak Demand, (Average Real Power) (Extended)	**Type**: Read only **Size:** 6 Registers **Units**: Sec, Min, Hour, Day, Month, Year **Range:** Same as regs # 700-705 **Function**: These registers store the date/time when the last peak demand (reg # 37) was recorded. The date and time are mapped from CM registers 100-102. **Restored at power-up / reset:** Yes
730-735	Date/time of Last Reset of Peak Demand Current (Extended)	**Type:** Read only **Size:** 6 Registers **Units:** Sec, Min, Hour, Day, Month, Year **Range:** Same as regs # 700-705 **Function:** The date/time in these registers record the last time a write to register 237 with bit 3 = 1 occurred. The date and time are mapped from CM registers 103-105. **Restored at power-up / reset:** Yes
736-741	Date/time of Last Min/Max Clear of Instantaneous Values (Extended)	**Type:** Read only **Size:** 6 Registers **Units**: Sec, Min, Hour, Day, Month, Year **Range:** Same as regs # 700-705 **Function**: These registers store the date/time when a write to register 237 with bit 1 = 1 last occurred causing the instantaneous max and min values to be reset to their present values. The date and time are mapped from CM registers 106-108. **Restored at power-up / reset:** Yes
742-747	Date/time of Last Write to Circuit Tracker™ Setpoint Register (Extended)	**Type:** Read only **Size:** 6 Registers **Units:** Sec, Min, Hour, Day, Month, Year **Range:** Same as regs #700-705 **Function:** This is the date/time when reg 238 was last written to by the host.The date and time are mapped from CM registers 109-111. **Restored at power-up / reset:** Yes

Local Reg #	Register Name	Register Description
748-753	Date/time When Peak Demand (Average Real Power) Was Last Cleared (Extended)	**Type**: Read only **Size:** 6 Registers **Units:** Sec, Min, Hour, Day, Month, Year **Range**: Same as regs # 700-705 **Function:** The date/time in these registers record the last occurrence of a write to reg. 237 with bit 4 = 1, causing the peak demand to be set equal to the current average demand, real power. (Register 35). The date and time are mapped from CM registers 112-114. **Restored at power-up / reset:** Yes
754-759	Date/time When Accumulated Energy Last Cleared (Extended)	**Type**: Read only **Size**: 6 Registers **Units**: Sec, Min, Hour, Day, Month, Year **Range:** Same as regs # 700-705 **Function:** These registers store the date/time when the accumulated energy values, both real and reactive, in registers 24-31 are zeroed. This is accomplished by a write to register 237 with bit 2 = 1. The date and time are mapped from CM registers 115-117. **Restored at power-up / reset:** Yes
760-765	Date/time When The Control Power Failed Last (Extended)	**Type:** Read only **Size:** 6 Registers **Units**: Sec, Min, Hour, Day, Month, Year **Range:** Same as regs # 700-705 **Function:** These registers store the date/time when the control power to the CM failed last. The date and time are mapped from CM registers 118-120. **Restored at power-up / reset:** Yes
766-771	Date/time When Level 1 Energy Management Set-Point Alarm Period Was Last Entered (Extended)	**Type:** Read only **Size**: 6 Registers **Units:** Sec, Min, Hour, Day, Month, Year **Range:** Same as regs # 700-705 **Function:** These registers store the date/time when the level 1 energy management setpoint (regs # 239) was exceeded and entered a level 1 alarm period. This date/time does NOT indicate when the highest exceeded value (regs #121) was recorded. The date and time are mapped from CM registers 124-126. **Restored at power-up / reset:** Yes
772-777	Date/time When Level 2 Energy Management Set-Point Alarm Period Was Last Entered (Extended)	**Type:** Read only **Size**: 6 Registers **Units:** Sec, Min, Hour, Day, Month, Year **Range**: Same as regs # 700-705 **Function**: The date/time in these registers is when the level 2 energy management setpoint (regs # 240) was exceeded and entered a level 2 alarm period. This date/time does NOT indicate when highest exceeded value (regs #122) was recorded. The date and time are mapped from CM registers 127-129. **Restored at power-up / reset:** Yes

Local Reg #	Register Name	Register Description
778-783	Date/time When Level 3 Energy Management Set-point Alarm Period Was Last Entered (Extended)	**Type**: Read only **Size:** 6 Registers **Units**: Sec, Min, Hour, Day, Month, Year **Range**: Same as regs # 700-705 **Function**: The date/time in these registers is when the level 3 energy management setpoint (regs # 241) was exceeded and entered a level 3 alarm period. This date/time does NOT indicate when highest exceeded value (regs #123) was recorded. The date and time are mapped from CM registers 130-132. (See Section 2.3). **Restored at power-up / reset:** Yes
784-789	Set Date/Time (Extended)	**Type**: Write/Read **Size**: 6 Registers **Units**: Sec, Min, Hour, Day, Month, Year **Range**: Same as regs # 700-705 **Function**: By writing to these three registers together, the date and time are set in this CM. From that point on the CM will advance the date and time based on its internal clock. This register can be read to get the date and time. Upon power up, the date is set to 1-1-1900 and the time to 00:00:00. The date and time are mapped from CM registers 228-230. Writing to registers 228-230 will cause the date/time to be automatically mapped into registers 784-789; likewise, writing to registers 784-789 will cause the date/time to be automatically written to regs 228-230. **Restored at power-up / reset:** No
790-795	Date/Time Of Calibration (Extended)	**Type**: Write/Read **Size**: 6 Registers **Units**: Sec, Min, Hour, Day, Month, Year **Range**: Same as regs # 700-705 **Function**: These registers store the date/time when the CM was tested and calibrated at the factory. This register can only be written to at the factory. NOTE: The Circuit Monitor's date and time in regs 228-230 or in regs 784-789 must be set prior to calibration of the unit to ensure accuracy of the value stored in this register. This register is updated every time a register in the range 203-214 is written to. The date and time are mapped from CM registers 232-234. Writing to registers 232-234 will cause the date/time to be automatically mapped into registers 790-795; likewise, writing to registers 790-795 will cause the same date/time to be automatically written to regs 232-234. **Restored at power-up / reset:** Yes

6.10.1 Sampled Waveform Data Register Usage

Registers 2000-2767 are used to store the sampled waveform data available in Models CM-200 and CM-210. 256 data points are sampled from each phase's current and voltage waveforms upon each read request from the host. To initiate the transfer of sampled waveform data from the metering microprocessor to the communications microprocessor, the user must write to register 237 with bit 10=1 (See the definition for Reg 237). The values stored in registers 2000-2767 will remain unchanged until another transfer is initiated by the user.

Each sampled data point requires 1/2 register of storage; therefore, the 256 data points sampled from each waveform require 128 storage registers each. Table 6.1 shows the registers utilized by each phase's voltage and current waveforms.

6.10.2 Registers Required To Maintain SY/MAX® Compatibility

To maintain compatibility with other SY/MAX equipment the CM must respond correctly to read operations from specific registers. These read only registers are shown in Table 6.2 along with the default value that will be returned to the host.

	Waveform Sampled	
Registers Used	**4 Wire System**	**3 Wire System**
2000-2127	Phase A-N Voltage	Phase A-B Voltage
2128-2255	Phase B-N Voltage	Phase C-B Voltage
2256-2383	Phase C-N Voltage	Phase A Current
2384-2511	Phase A Current	Phase C Current
2512-2639	Phase B Current	Not Used
2640-2767	Phase C Current	Not Used
2768	Intersample Interval*	Intersample Interval*

* The time, in multiples of 100 nanoseconds, between samples.This is updated along with regs 2000-2767.

Note: The contents of registers 2000-2768 are not saved at power fail / reset therefore they are not restored when power is restored.

Table 6.1 - Register Usage For Sampled Waveform Data

Reg #	Register Description	Default Value
8172	Scan Time	0
8173	End Fenced Register	8176
8174	Begin Fenced Register	1
8175	Error number	0
8176	Processor Control/Status Bits	0
8177	Password Register	0
8178	Restriction Register	0
8179-8180	Not Used	
8181-8182	Memory Size Available for ladder	0
8183-8184	Secondary Error Register,	0 further defines 8175
8185	Number of Rack Addresses	0
8186	Processor/Keyswitch Status	4
8187	Number of Rungs	0
8188	I.D. and revision	450
8189-8190	Memory Size in bytes	0
8191-8192	Memory Used in bytes	0

Note: Registers 8172-8192 are not saved at power fail but are initialized to default values on power-up / reset.

Table 6.2 -CM default values for SY/MAX compatibility registers

7.0 THEORY OF OPERATION

7.1 Introduction

This section touches upon the Circuit Monitor's internal operation. Its intent is to provide a general description of Circuit Monitor operational theory and does not enter into extensive detail.

7.2 Basic Overview

The Circuit Monitor is controlled by two 8 bit microprocessors, each with specific duties. One microprocessor performs the metering functions while the other responds to the communications link and service commands from the host.

The metering microprocessor does the real time monitoring of the current and voltage inputs. All calculated results are sent to the communications microprocessor. The communications microprocessor performs the following functions:

- Communication to/from Host
- Receive data from metering microprocessor
- Accurately maintain clock and calendar
- Keep the min/max of calculated values

Figure 7-1 offers a simple block diagram illustrating the Circuit Monitor's multi-processor architecture.

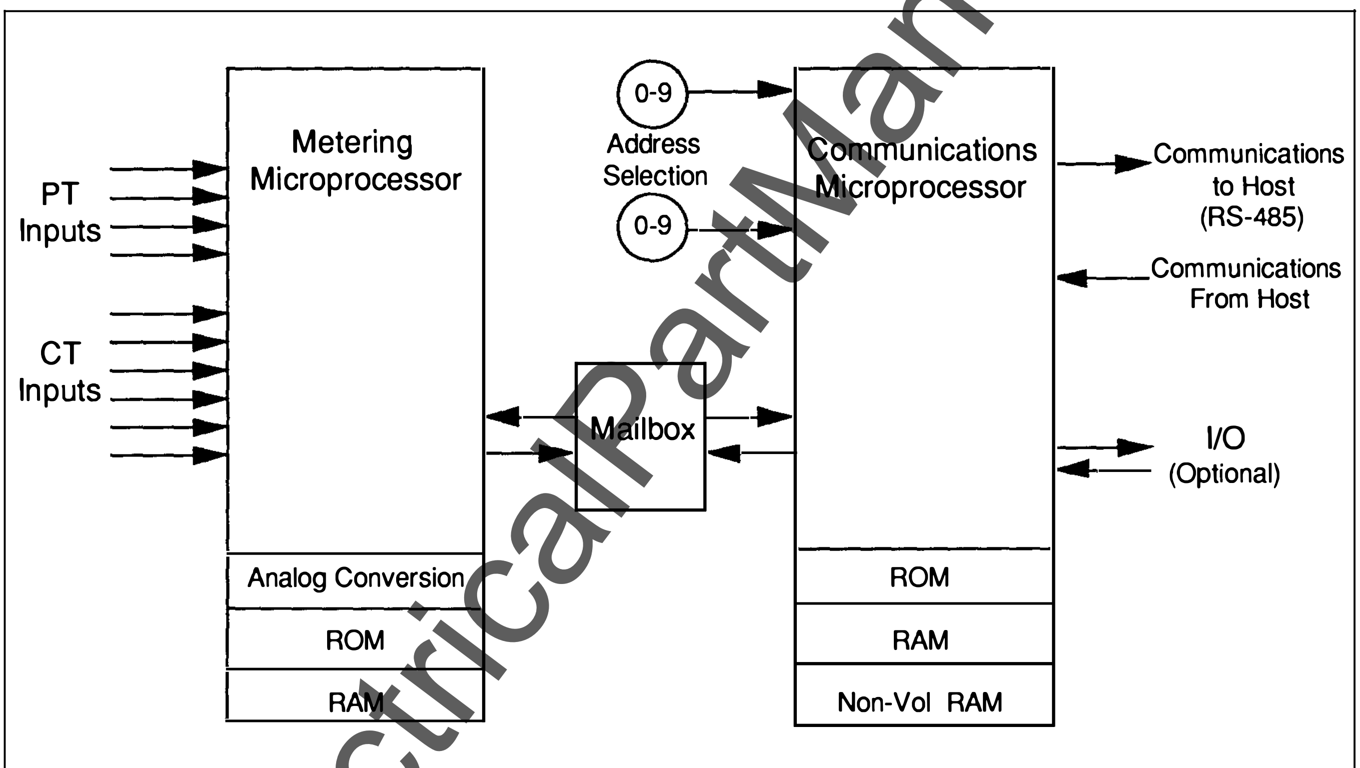


Figure 7-1 - Circuit Monitor Block Diagram

8.0 MAINTENANCE AND TROUBLESHOOTING

8.1 Introduction

This section covers Circuit Monitor maintenance and troubleshooting. It offers a list of potential problems along with checks and/or solutions for each. Because problems may arise due to improper installation or operation, a thorough understanding of sections 5.0 and 6.0 prior to troubleshooting may be helpful.

⚠WARNING

CT and PT inputs may contain potentially hazardous currents and voltages. Only authorized Square D service personnel should be allowed to service the Circuit Monitor.

8.2 Maintenance

If it is determined that improper Circuit Monitor operation is due to failure of the unit, contact a qualified Square D field service representative. Only authorized service personnel familiar with the equipment should be allowed to service the Circuit Monitor.

8.3 Troubleshooting

Table 8.1 offers a list of potential problems and causes along with checks and/or solutions for each. If after completing the listed checks the problem has not been located, contact a qualified Square D service representative. Be prepared to describe the nature of the problem, the results of any troubleshooting checks, and, if the Circuit Monitor in question is on line to a modem, the phone number. A modem connection will allow remote diagnostics to be performed.

Problem	Possible Cause(s)	Check or Cure
CM will not acknowledge attempts at communication from the host	CM not receiving necessary power	Check that the L and N connections (terminals 34 & 35) are receiving 120V control power
	CM addressed incorrectly	Check device address switches to insure that they are properly set per Section 5.1 of this document Note: Device Address switches are only read at power-up. (See Section 5.1).
	CM set to operate at incorrect baud rate	Reset the CM to communicate at the desired baud rate. Refer to section 5.2
	Communication lines on last CM improperly terminated	Check last CM on the link for proper termination. See section 6.3.1 for instructions on terminating the last CM on the link.
	Communication lines improperly biased	When multiple CMs are in a lineup, be sure that the multidrop communications adapter is being used (See Section 6.3.1). When a lineup has only one CM, be sure that its address switches are set to 00.

Table 8.1 - Circuit Monitor Troubleshooting Guide

Problem	Possible Cause(s)	Check or Cure
Communication possible, but receiving incorrect values from the CM	System wired improperly	Check that the CTs are connected correctly (proper polarity observed) and energized. Refer to Section 4.3.
	Incorrect Voltage inputs	Check terminals V_a, V_b, and V_c (#8, 9, 10) to see that the correct voltage is present
	CM grounded improperly	Refer to Section 4.0
	Communicating to wrong CM	Check address of target CM. Check ladder code for incorrect use of route statements
	Incorrect use of READ/WRITE instructions in ladder code	Refer to sections 6.6 and 6.7 of this document and appropriate SY/MAX bulletins for proper use of READ/WRITE instructions
	Incorrect User-defined parameter values have been transmitted to the CM	Check to see that the proper values for CT rating, PT rating, System Connection, etc.. have been transmitted to the CM. See Table 2.2 Be sure to force a software restart, by writing to bit #5 of register 237, after writing to registers 200, 201, or 202. See Section 5.3.

Table 8.1 - Circuit Monitor Troubleshooting Guide (Continued)

⚠CAUTION

Dielectric testing of the Circuit Monitor may damage the unit. DO NOT HI-POT.

Appendix A - Scaling the Data Provided During Waveform Capture

Each raw data point captured by the Circuit Monitor is a byte in 8 bit 2's complement notation. Thus a data point read directly from the CM is returned as a hexadecimal value in the range 0 - FF. This makes it necessary to convert the raw data points captured by the CM to measured currents and voltages.

The equations for performing these conversions are below.

To convert a raw data point (V(R) or I(R)) to its corresponding measured value (V(M) or I(M)) the following equations must be used:

VOLTAGE: $V(M) = PTR * AGV * GFV(K) * V(R)$

Where:

- PTR = Potential Transformer Nominal Primary Voltage / 120V
- AGV = Analog Voltage Gain Factor = 2.040 (Constant for all voltages)
- GFV(K) = Voltage Gain Calibration Factor for phase K {K = A, B, or C in a 4 wire system. In a 3 wire system use the Average of A and B for V(A-B) or C and B in V(C-B)}

CURRENT: $I(M) = CTR * AGI * GFI(K) * I(R)$

Where:

- CTR = Current Transformer Nominal Primary Current / 5A
- AGI = Analog Current Gain Factor = 0.07828
- GFI(K) = Current Gain Calibration Factor for Current I(K)

NOTE: Conversion to I(M) is the same even with RMS currents reported to the nearest 0.1 amps.

EXAMPLES:

A. Assume V(R) for phase A = C5 HEX = -59 Decimal, PT nominal primary voltage is 1200 Volts, and GFV(A) = 1.01. Then:

$$V(M) = (1200/120) * 2.040 * 1.01 * (-59) = -1216 \text{ Volts}$$

B. Assume I(R) for phase C = 4A HEX = 74 Decimal, CT nominal primary current = 1000 AMPS, and GFI(C) = 0.99. Then:

$$I(M) = (1000/5) * 0.07828 * 0.99 * 74 = 1146 \text{ Amps.}$$

NOTE: Current and Voltage Gain Factors are stored in read only registers within the CM and may be read as needed. (See registers 203, 205, 207, 209, 211, and 213 in the register allocation list).

Appendix B - Circuit Monitor Register Formats

Each register in the Circuit Monitor has a total of 16 bits. The bits are numbered from 1 to 16, where 1 is the low bit (least significant), and 16 is the high bit (most significant). Figure B-1 illustrates Circuit Monitor register format.

The majority of the data stored within the Circuit Monitor are single register, decimal values (stored in two's complement format). Exceptions to this include: Power Factor, Date/Time and Accumulated Energy values. The formats used to store these values are described below.

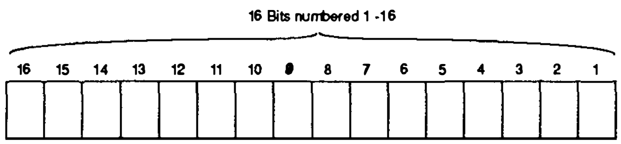


Figure B-1 - Circuit Monitor Register

Power Factor

Each power factor value occupies one register. All power factor values (regs 14-17, 52-54, 74-77) are stored using signed magnitude notation. Bit number 16, the sign bit, is used to indicate leading/lagging. A positive value (Bit 16 = 0) indicates leading. A negative value (Bit 16 = 1) indicates lagging. Bits 1-8, store a value in the range 0-100 (decimal). Power factor values must be divided by 100 to obtain a power factor in the range 0 to 1.00. Figure B-2 offers a graphical representation of a power factor register.

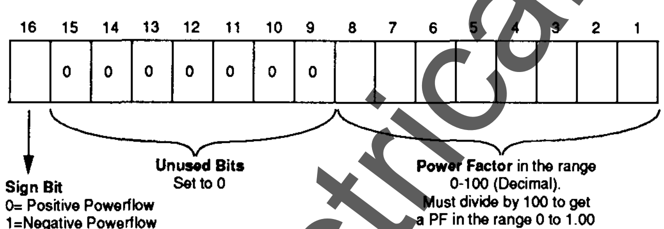


Figure B-2 - Power Factor Register Format

SY/MAX® Compatible Date/Time Values

CM registers 700-795 contain date/time values in a format compatible with SY/MAX® processors. Each of the date/time fields occupies six storage registers. Seconds, minutes, hours, day, month, and year each occupy a register. For example, if a specific date/time field began in register n, then the field would be organized as shown in Table B.1. (The example uses "Last Restart Date/time," regs 700-705).

Energy Accumulated and Reactive Energy Accumulated

The Circuit Monitor calculates values for Energy Accumulated (regs 24-27) and Reactive Energy Accumulated (regs 28-31). Each value occupies four storage registers. Each register contains a decimal value in the range -9999 to +9999.

The values are reported in a modulo 10,000 format. In other words, each register increments from 0 to +/- 9999 and then rolls over to 0 with a carry into the next register. The sign is also carried into the next register as the rollover occurs. Table B.2 shows examples of energy values and their associated storage formats.

ITEM	REGISTER	EXAMPLE
Seconds	n	700
Minutes	n+1	701
Hours	n+2	702
Day	n+3	703
Month	n+4	704
Year	n+5	705

Table B.1 - Circuit Monitor SY/MAX® Compatible Date/Time Storage Format

	Value Stored in Register			
Energy Value	**Reg n+3**	**Reg n+2**	**Reg n+1**	**Reg n**
0,000,000,000,009,999	0000	0000	0000	9999
0,000,000,000,010,000	0000	0000	0001	0000
-0,000,000,000,009,999	0000	0000	0000	-9999
-0,000,000,000,010,000	0000	0000	-0001	-0000
0,000,000,099,999,999	0000	0000	9999	9999
0,000,000,100,000,000	0000	0001	0000	0000

Table B.2 - Storage Format for Energy Values

Appendix C - Glossary of Terminology

Accumulated Energy. A running accumulation over time of the energy monitored in a given circuit. The total energy consumed is obtained by continuously integrating instantaneous real power with respect to time. (See registers 24-27).

Accumulated Reactive Energy. A running accumulation over time of the reactive energy monitored in a given circuit. (See registers 28-31).

Analog*. A physical quantity, such as voltage or shaft position, that normally varies in a continuous manner.

Apparent Power, 3-phase total. The total volt-amps consumed in a 3-phase circuit. (See register 20).

Average Demand Current, Phase A. Average demand for Phase A Current calculated using a sliding window over a given time interval. (See reg 32). Also known as thermal demand current.

Average Demand Current, Phase B. Average demand for Phase B Current calculated using a sliding window over a given time interval. (See reg 33). Also known as thermal demand current.

Average Demand Current, Phase C. Average demand for Phase C Current calculated using a sliding window over a given time interval. (See reg 34). Also known as thermal demand current.

Average Demand Real Power. Average demand for Real Power calculated using a sliding window over a given time interval (ranging from 1-60 minutes in 1 minute increments for the CM). (See reg 35).

Baud Rate. The rate of speed at which information is transmitted over communication lines, expressed in bits per second.

Circuit Monitor Label. A user-definable, alphanumeric field associated with the Circuit Monitor. (See registers 218-219).

Circuit Monitor Nameplate Data. A user-definable, sixteen character field used to identify a CM and its use. For example, if the Circuit Monitor supplied power to the welder on production line 3, the nameplate may be "Welder Line 3". (See registers 220-227).

Communications Link. Equipment, especially transmission cables and interfaces, which complete the communications connections and permit the transmission of digital signal data.

Communications Microprocessor. The Circuit Monitor microprocessor which is responsible for communication to/from the host, receiving data from metering microprocessor, accurately maintaining clock and calendar, keeping the min/max of calculated values, and control of digital inputs/outputs.

CT Rating. A user-definable parameter which represents the primary rating of the current transformers connected to the Circuit Monitor.

Current, Percent Apparent Distortion. The difference in percent between the true rms current and the rms value of a pure sinusoid with the same peak current as the measured waveform. (See reg 7).

Current Phase-A. The measured rms current of the A Phase (See register 3).

Current Phase-B. The measured rms current of the B Phase (See register 4).

Current Phase-C. The measured rms current of the C Phase (See register 5).

Current, 3-phase Average. The simple arithmetic mean of the rms current flowing in the 3 phases. (See register 7).

Current Transformer*. An instrument transformer intended to have its primary winding connected in series with the conductor carrying the current to be measured or controlled.

Demand Interval. The time interval used in the Average Demand calculations for Real Power. (See register 216).

Device Address Door. The sliding door located on the rear of the Circuit Monitor which covers the device address switches.

Device Address Switches. Two ten position rotary switches, accessed from the rear of the Circuit Monitor, which are used to set the address of the Circuit Monitor as well as the unit's baud rate.

Digital. The representation of numerical quantities by means of discrete numbers.

Energy Management Alarms. A user-definable parameter which indicates when the alarm set point has been exceeded, records the date and time of the event, and records the maximum level of Average Demand Power eventually reached.

Frequency*. The number of complete cycles of sinusoidal variation per unit time.

kVA*. The abbreviation for *kilovoltampere*, a standard measure of power.

Metering Microprocessor. The Circuit Monitor microprocessor which does the real time monitoring of the current and voltage inputs. It reads the A/D converters and makes the required calculations on the raw data.

Multipoint Communications. Method of communication in which a single device can communicate to multiple devices.

Non-volatile Memory. Memory which retains its contents upon loss of power. The Circuit Monitor stores many values in non-volatile memory.

Peak Demand Current Phase-A. The maximum value recorded for average demand current for phase A since last reset. (See register 84).

Peak Demand Current Phase-B. The maximum value recorded for average demand current for phase B since last reset. (See register 85).

Peak Demand Current Phase-C. The maximum value recorded for average demand current for phase C since last reset. (See register 86).

Peak Demand Real Power. The maximum value recorded for average demand real power since last reset. (See register 37).

Point-to-point communications. Method of communication in which a device communicates to only one other device at a time.

Potential Transformer*. An instrument transformer that is intended to have its primary winding connected in shunt with a power-supply circuit, the voltage of which is to be measured or controlled.

Power Factor, 3-phase total. The total power factor of a 3 phase circuit calculated as the 3 phase Total Real Power divided by the 3 phase Total Apparent Power. (See register 14).

Power Factor, phase A. The cosine of the angular difference between the vector's phase A current and phase A-N voltage. (See register 15).

Power Factor, phase B. The cosine of the angular difference between the vector's phase B current and phase B-N voltage. (See register 16).

Power Factor, phase C. The cosine of the angular difference between the vector's phase C current and phase C-N voltage. (See register 17).

Protocol. A standardized procedure for establishing a communications link between two devices based on such elements as word structure or length.

PT Rating. A user-definable parameter which represents the primary rating of the potential transformers connected to the Circuit Monitor. (Assumes 120V secondary PTs).

Reactive Power, 3-phase total. The sum of the reactive power values for each of the 3 phases. (See register 19).

Real Power, 3-phase total. The sum of the real power values for each of the 3 phases. (See register 18).

Register. A storage area consisting of two bytes or 16 bits of storage.

Routing. A technique which allows information to be sent from one device along a specified path (or route) to another device. The path is mapped by a statement offering the address of each device along the route.

RS-422 interface. An electrical interface which offers a standard of communication for electronic devices. The Circuit Monitor's RS-485 interface is RS-422 compatible.

RS-485 interface. An electrical interface which offers a standard of communication for electronic devices and offers multipoint communications. The Circuit Monitor utilizes the RS-485 interface.

System Connection. A user-definable variable which indicates whether a specific system is a 3-wire or 4-wire system. (See register 200).

Trim Ring. An optional rectangular ring which is mounted to the Circuit Monitor through an electrical panel.

Root-Mean-Square (RMS). The square root of the mean value of the square of the parameter values during a complete cycle.

Unidirectional Mailbox. A technique used by the Circuit Monitor's microprocessors to exchange information in which each microprocessor has a separate mail box to transmit data and a separate mail box to receive data.

User-defined Parameter. A value which is definable by the user via the communications link. The Circuit Monitor has 13 user-defined parameters.

Var*. The unit of reactive power in the International System of Units (SI).

Varhour*. The unit of quadrature-energy in the International System of Units (SI).

Voltage, Phase A-B. The measured RMS voltage between phases A and B.

Voltage, Phase B-C. The measured RMS voltage between phases B and C.

Voltage, Phase C-A. The measured RMS voltage between phases C and A.

Voltage, Phase A-N. The measured RMS voltage between phase A and Neutral.

Voltage, Phase B-N. The measured RMS voltage between phase B and Neutral.

Voltage, Phase C-N. The measured RMS voltage between phase C and Neutral.

Watt*. The unit of power in the International System of Units (SI).

Watthour*. A measure of power equal to 3600 joules.

Waveform Capture. A Circuit Monitor feature available in Models CM-200 and CM-210 which captures and reports up to 256 data points from a given phase's current and voltage waveforms.

* Definitions taken from IEEE Standard Dictionary of Electrical and Electronics Terms.

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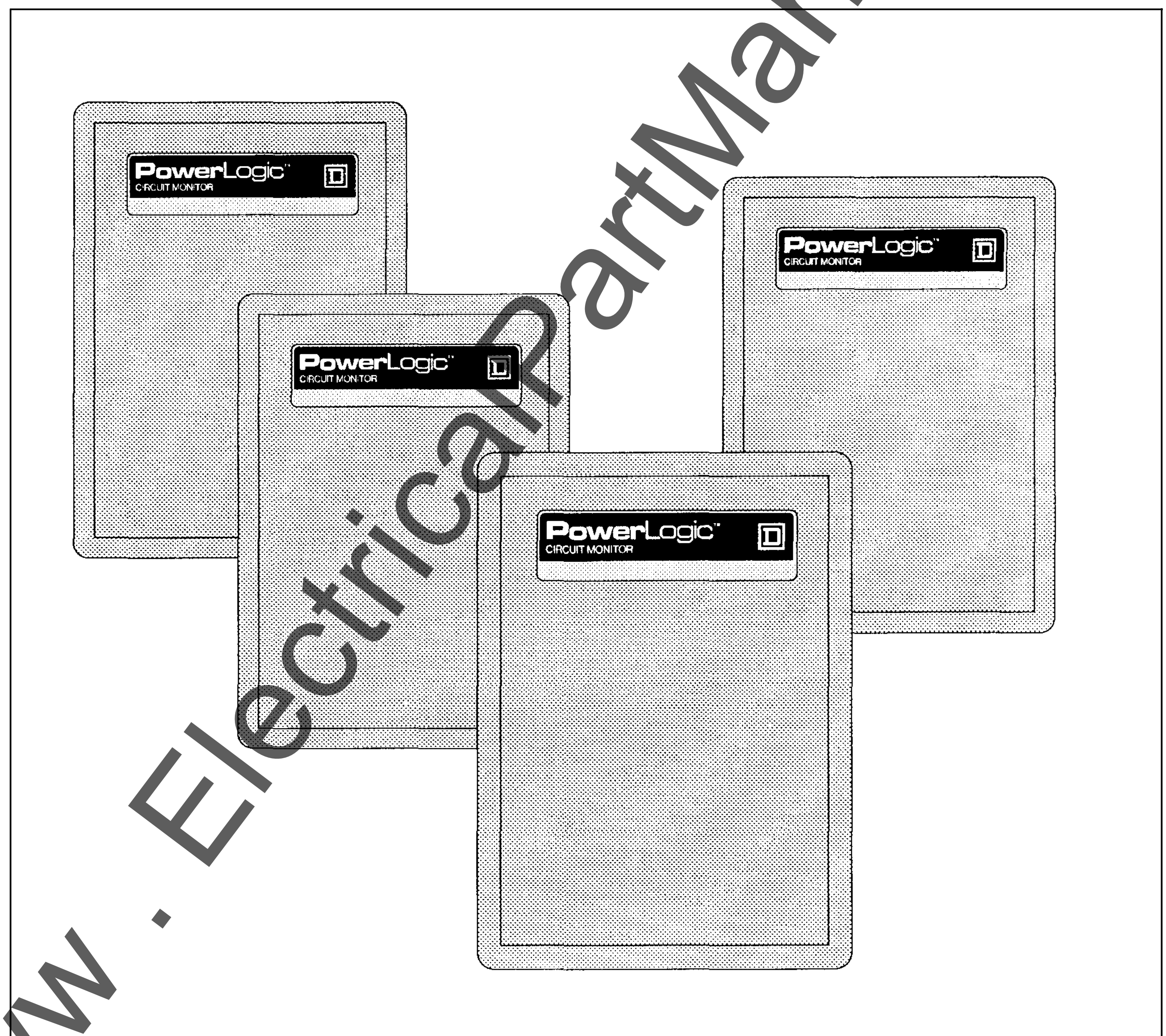
Instruction Bulletin

PowerLogic™

CIRCUIT MONITOR

Class 3020



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