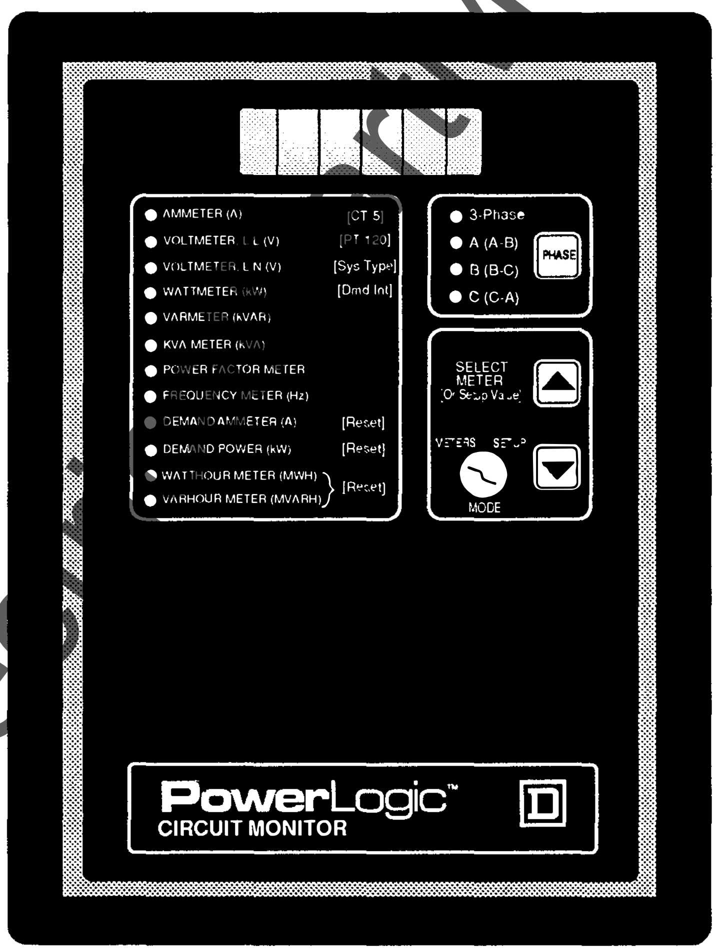
August 6, 1990 Bulletin: 63210-130-01

Instruction Bulletin

PowerLogic™
Circuit Monitor with Digital Display
(Models CM-150, CM-250)
Class 3020



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THIS EQUIPMENT COMPLIES WITH THE REQUIREMENTS IN PART 15 OF FCC RULES FOR A CLASS A COMPUTING DEVICE. OPERATION OF THIS EQUIPMENT IN A RESIDENTIAL AREA MAY CAUSE UNACCEPTABLE INTERFERENCE TO RADIO AND TV RECEPTION REQUIRING THE OPERATOR TO TAKE WHATEVER STEPS ARE NECESSARY TO CORRECT THE INTERFERENCE.

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1.0 INTRODUCTION

1.1 General

Square D's PowerLogic™ Circuit Monitor(CM) is a multifunction 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 personal computer, local display, 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 PowerLogic™ Circuit Monitor is available in eight functional versions. Circuit Monitor model CM-100 offers extensive circuit instrumentation. Model CM-108 provides instrumentation and eight digital inputs. Model CM-144 provides instrumentation, four inputs and four digital outputs. Model CM-150 offers full instrumentation plus an onboard digital display for local display of metered values.

Four additional models provide the capability of the models described above but are also equipped with a "waveform capture" feature which offers the ability to capture and analyze data points from a circuit's current and voltage waveforms.

The Circuit Monitor's eight functional versions are listed below.

CM-100 - Instrumentation
CM-108 - Instrumentation, 8 Inputs
CM-144 - Instrumentation, 4 Inputs, 4 Outputs
CM-150 - Instrumentation, Digital Display
CM-200 - Instrumentation, Waveform Capture
CM-208 - Instrumentation, 8 Inputs, Waveform Capture
CM-244 - Instrumentation, 4 Inputs, 4 Outputs, Waveform
CM-250 - Instrumentation, Display, Waveform Capture

1.3 Manual Use

This manual describes the Circuit Monitor with digital display, Models CM-150 and CM-250. It provides all of the information necessary to apply and operate the Circuit Monitor with display as a standalone metering device, and includes information on the Circuit Monitor's RS-485 communications. The manual is suitable to familiarize a potential user with the device and contains enough information for use by an application engineer who is applying the device in power equipment. For a complete list of Circuit Monitor register usage, refer to the Circuit Monitor Communications Reference #63210-203-01.

Circuit Monitor Features
• 6 Digit LED Display for Local Display of 24 Values • Quick, easy setup and operation from faceplate • 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 1-1 *- Model CM-150, CM-250 Features*

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2.0 FUNCTIONAL DESCRIPTION

2.1 Data Available for Local Display

The PowerLogic Circuit Monitor with digital display provides twenty-four metered values for local display including current, voltage, power factor, real power, reactive power, apparent power, frequency, peak demand current, peak demand power, accumulated energy and accumulated reactive energy. All demand readings and energy readings may be reset from the faceplate of the Circuit Monitor. Section 6.0 describes the Reset procedure.

Table 2-1 provides a list of the data displayed by the Circuit Monitor.

Additional data including dates and times, minimum and maximum historical data, temperature indication, energy management alarms and more are available via RS-485 data communications. Section 2.2 describes the data available via the communications channel. For a complete list of Circuit Monitor registers, refer to the Circuit Monitor Communications Reference Manual #63210-203-01.

Meter		Reported Value	Range / Units	Per Phase	3 Phase
Instantaneous:					
Ammeter		RMS Current	0 to 9999 A	Yes	Yes
Voltmeter L-L		RMS Voltage, Line-to-Line	0 to 32,767 V	Yes	No
Voltmeter L-N	(❑)	RMS Voltage, Line-to-Neutral	0 to 32,767 V	Yes	No
Wattmeter		Real Power, 3-Phase Total	0 to +/- 32,767 kW	No	Yes
Varmeter		Reactive Power, 3-Phase Total	0 to +/- 32,767 kVAR	No	Yes
kVA Meter		Apparent Power, 3-Phase Total	0 to 32,767 kVA	No	Yes
Power Factor Meter	(✛)	Power Factor	-0 to 1.00 to 0	Yes	Yes
Frequency Meter		System Frequency	23.00 to 65.00 Hz	No	Yes
Demand:					
Demand Ammeter		Peak Demand Current	0 to 9999 A	Yes	No
Demand Power		Peak Demand Real Power	0 to +/- 32,767 kW	No	Yes
Energy:					
Watthour Meter	(❋)(▲)	Accumulated Energy	0.00000 to 9999.99 MWH	No	Yes
Varhour Meter	(❋)(▲)	Accumulated Reactive Energy	0.00000 to 9999.99 MVARH	No	Yes

NOTES:
- (❑) For 3-Phase/3-Wire connections, these values will be displayed as "- - - - -".
- (✛) A negative value indicates a lagging power factor.
- (❋) The Watthour Meter and Varhour Meter are each displayed with an "auto-ranging" decimal location to provide a high degree of energy metering resolution. The decimal point location auto-ranges from x.xxxxx to xxxx.xx. When the energy values are reset to 0, there are 5 digits to the right of the decimal point. When an energy reading exceeds 9.99999, the decimal position automatically moves one place to the right for a reading of 10.0000. The decimal moves again at 100.000 and again at 1000.00. The decimal point will remain fixed with two digits to the right until the energy values are reset or until 9999.99 is exceeded. When energy exceeds 9999.99, the display rolls over to 0.00000.
- (▲) Accumulated energy is displayed as an absolute value.

***Table 2-1** - Instrumentation Displayed by CM-150 and CM-250*

2.2 Data Available Via RS-485 Communications

All PowerLogic™ Circuit Monitors are equipped with industry standard RS-485 data communications for connection to a personal computer (equipped with a SY/LINK® network interface board), PowerLogic™ System Display, PowerLogic™ Network Interface Module (PNIM), SY/MAX® processor or other SY/MAX® compatible device. Over 70 metered values are made available for display and manipulation using PowerLogic application software or custom applications.

The data available via the communications channel is a superset of the data available for display on the faceplate of Circuit Monitor models CM-150 and CM-250. The following sections describe the data available via communications.

2.2.1 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:

- Instantaneous Readings
- Demand Readings
- Accumulated Energy Readings

Table 2-3 lists the instrumentation available via the communications channel.

In addition to the values listed in Table 2-3, the Circuit Monitor will report, on command, a complete set of all sampled points on a given phase's current or voltage waveform. Section 2.2.2 discusses the optional Waveform Capture feature.

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 2-3. 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

Reset	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 (✱)	Accumulated Energy Accumulated Reactive Energy
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:** All values may be reset via the communications channel using PowerLogic Software. Energy and Demand values may also be reset from the faceplate of the Circuit Monitor with Display - See Section 6.0).

Table 2-2 *- Summary of Values Which May Be Reset Via the Communications Channel*

Reported Value		Range / Units	Per Phase	3 Phase
Instantaneous Readings (☛):				
Frequency		23.00 to 65.00 Hz	No	Yes
Temperature		-100.00 to +100.00 C	N/A	N/A
RMS Current	(❑)	0 to 9999 A or 0 to 999.9 A	Yes	Yes
Current, Apparent rms	(❑)	0 to 9999 A or 0 to 999.9 A	No	Yes
RMS Voltage L-L		0 to 32,767 V	Yes	No
RMS Voltage L-N	(✿)	0 to 32,767 V	Yes	No
Power Factor	(▲)	-0 to 1.00 to 0 (✤)	Yes	Yes
Real Power, 3-Phase Total		0 to +/- 32,767 kW	No	Yes
Reactive Power, 3-Phase Total		0 to +/- 32,767 kVAr	No	Yes
Apparent Power, 3-Phase Total		0 to 32,767 kVA	No	Yes
Demand Readings:				
Average Demand Current	(❑)	0 to 9999 A or 0 to 999.9 A	Yes	No
Average Demand, Real Power		0 to +/- 32,767 kW	No	Yes
Predicted Demand, Real Power		0 to +/- 32,767 kW	No	Yes
Peak Demand, Real Power		0 to +/- 32,767 kW (✓)	No	Yes
Peak Demand Current	(❑)	0 to 9999 A or 0 to 999.9 A (✓)	Yes	No
Energy Readings:				
Energy, Accumulated		0 to +/- 9999999999999999 WHr	No	Yes
Reactive Energy, Accumulated		0 to +/- 9999999999999999 VARH	No	Yes

NOTES:
(☛) For each instantaneous reading, running minimums and maximums are also stored.
(❑) The user may specify that Current values be reported in tenths of amps. This can be done via the communications channel using PowerLogic software. The "Current Reporting Precision" **cannot** be changed to tenths of amps from the faceplate of the Circuit Monitor.
(✿) For 3-Phase/3-Wire connections, these values are reported at 32,767.
(▲) For 3-Phase/3-Wire connections, per-phase values are reported equal to 3-Phase Total PF.
(✤) High order bit indicates leading / lagging. A negative value indicates a lagging PF.
(✓) Time and Date of peak are stored for all Peak Demand values.

***Table 2-3** - Circuit Monitor Instrumentation Available Via RS-485 Communications Link* 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.

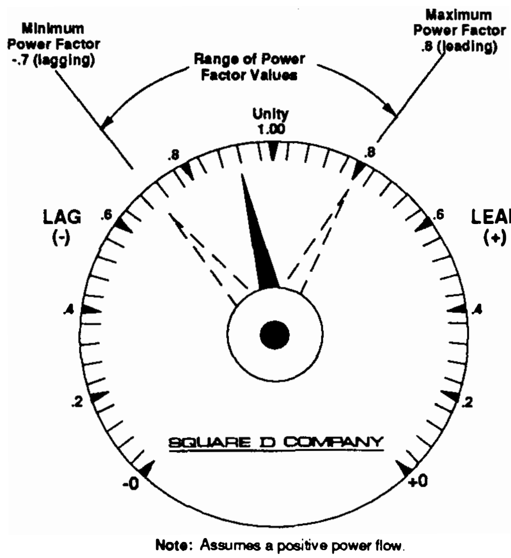


Figure 2-1 - Power Factor meter example.

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).

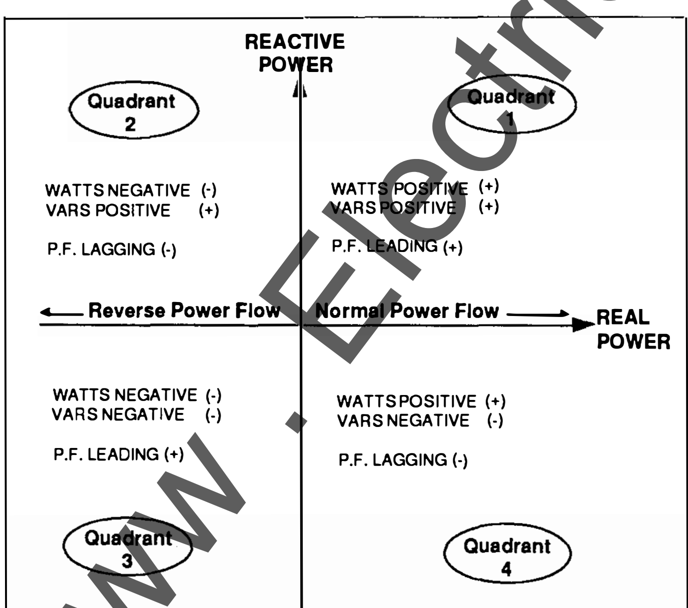


Figure 2-2 - Power Quadrants Diagram

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 2-2 for a complete listing of the values which may be reset via the communications link). The date and time of the last reset operation are stored upon execution of the reset command.

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 2-3). 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 (5 - 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 $|D_{avg}| > |D_{peak,old}|$ 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 $|D_{peak,old}|$ 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 2-2). These values may also be reset from the faceplate of the Circuit Monitor with digital display. (See Section 6.0). The date and time of the last reset operation are stored in non-volatile memory.

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 2-3). These values may also be reset from the faceplate of the Circuit Monitor with digital display. (See Section 6.0). The date and time of the last reset operation are stored in non-volatile memory.

2.2.2 Waveform Capture

Circuit Monitor model CM-250 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.

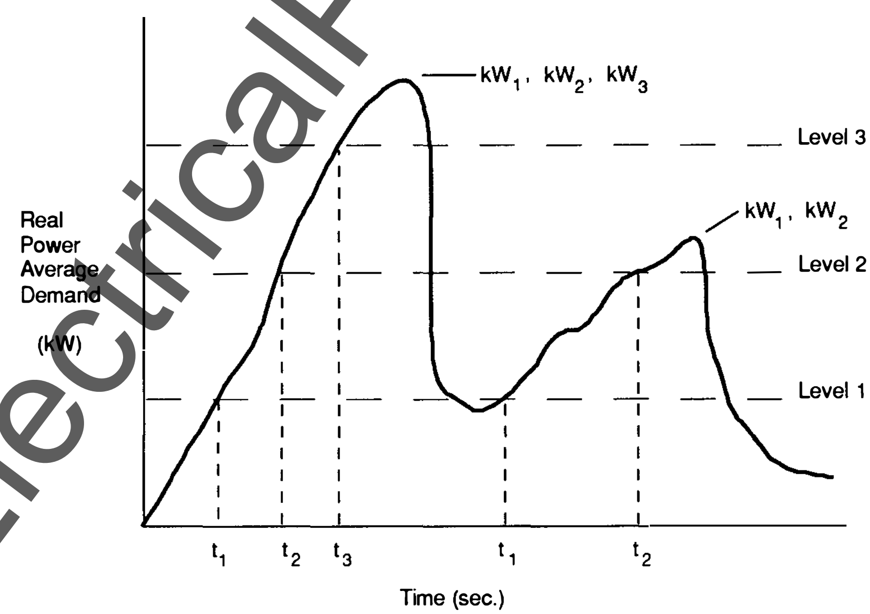
Captured data may be imported to a personal computer allowing the waveform to be viewed using PowerLogic application software. In addition, waveform data may be imported into powerful waveform analysis packages which offer spectral analysis and more.

2.2.3 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.



Values Stored by the Circuit Monitor:

<u>Time/Date</u>

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

<u>Maximum Level Reached</u>

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*

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3.0 HARDWARE DESCRIPTION

3.1 General

PowerLogic™ Circuit Monitor Models CM-150 and CM-250 are equipped with a six-digit LED display for local display of twenty-four metered values. (See Figure 3-1). Three color-coded keys provide for simple operation of the Circuit Monitor. Two blue SELECT METER keys are used to select the meter being displayed. Each of the twelve meters has an associated red LED which illuminates when the meter is selected. A yellow PHASE key allows the user to select the phase for values which offer per phase and/or 3-phase indication. Four red LEDs indicate the phase being viewed. A two position keyswitch is used to change between METERS and SETUP mode.

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. 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 3-2). Table 3-1 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 3-2). This door allows access to two ten-position rotary switches which determine the communications address of the Circuit Monitor and are used to set the communication baudrate. Section 7.0 describes Circuit Monitor communications.

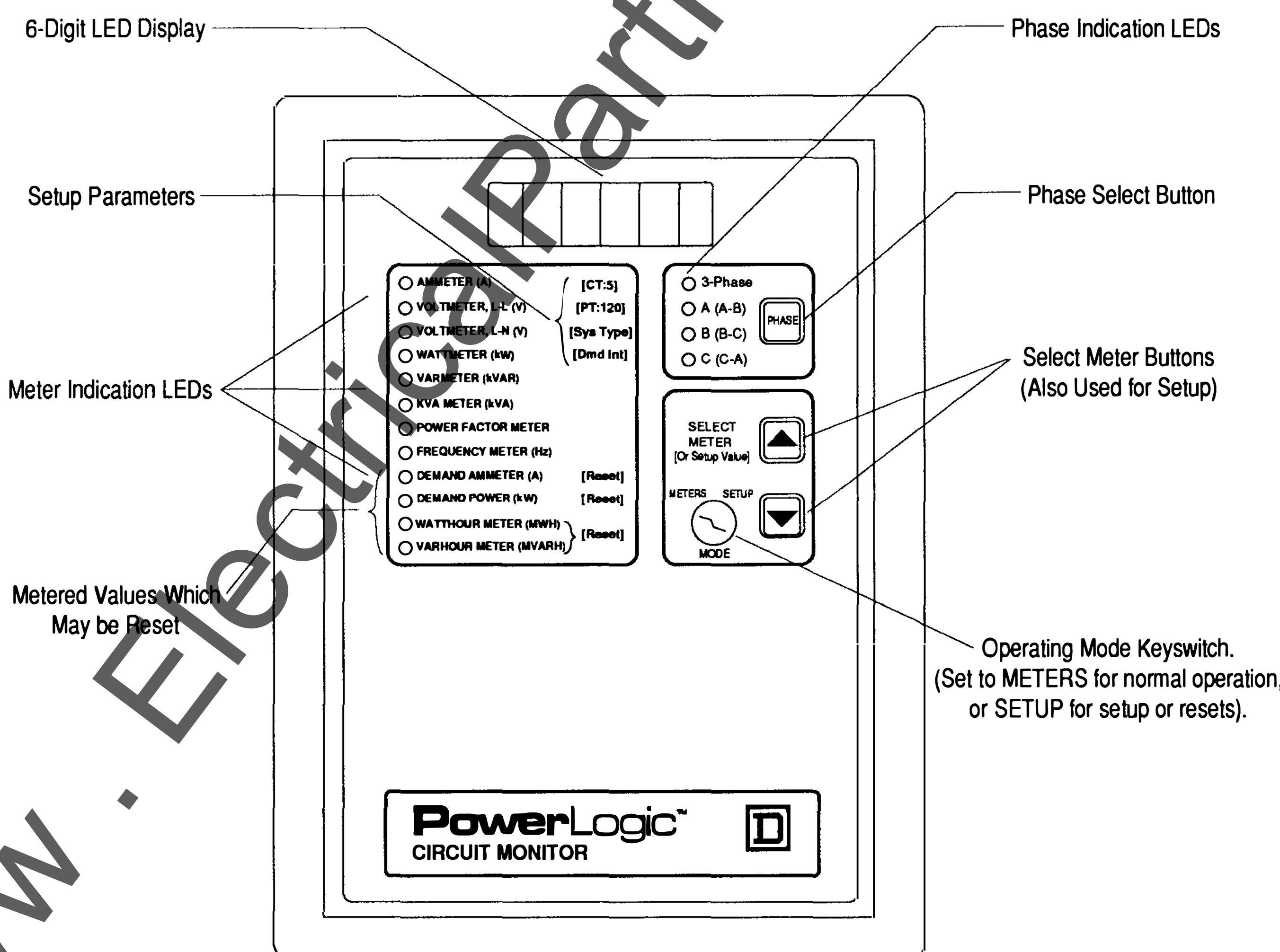

***Figure 3-1** - Circuit Monitor with Digital Display*

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 3-1 - *Description of Circuit Monitor Terminal Connections*

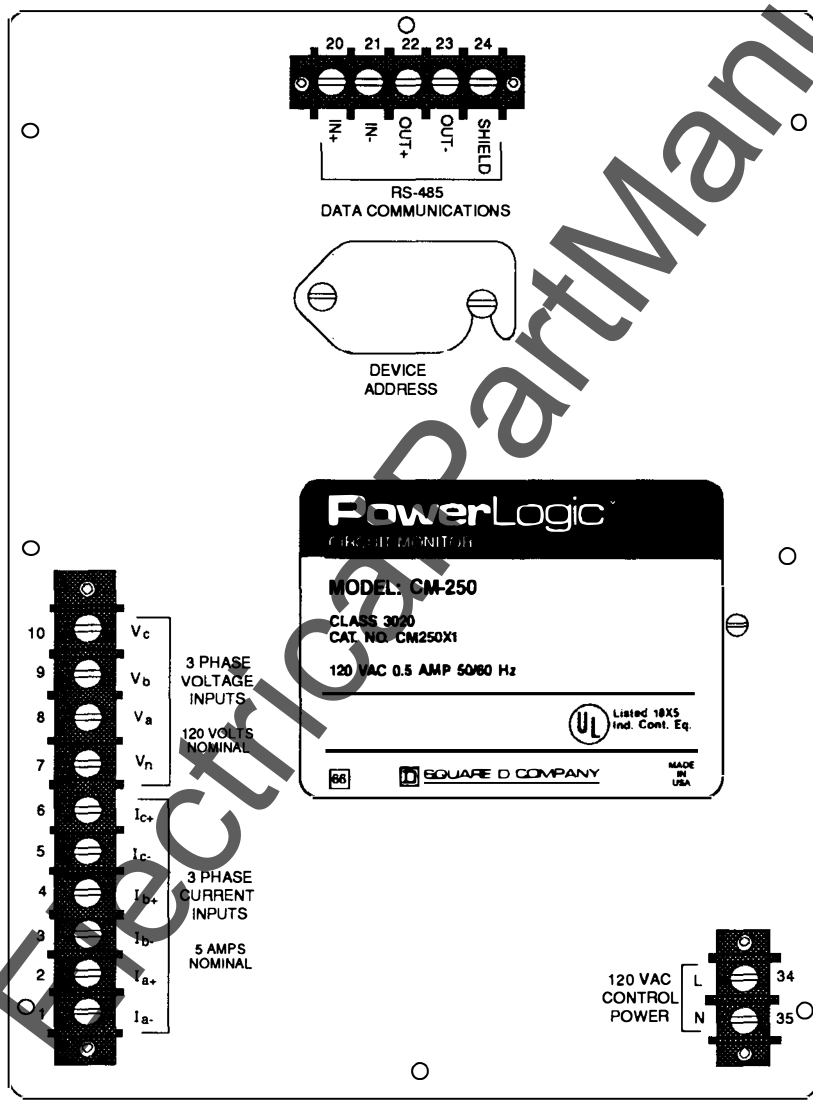

Figure 3-2 - *Back of Circuit Monitor with Digital Display*

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)

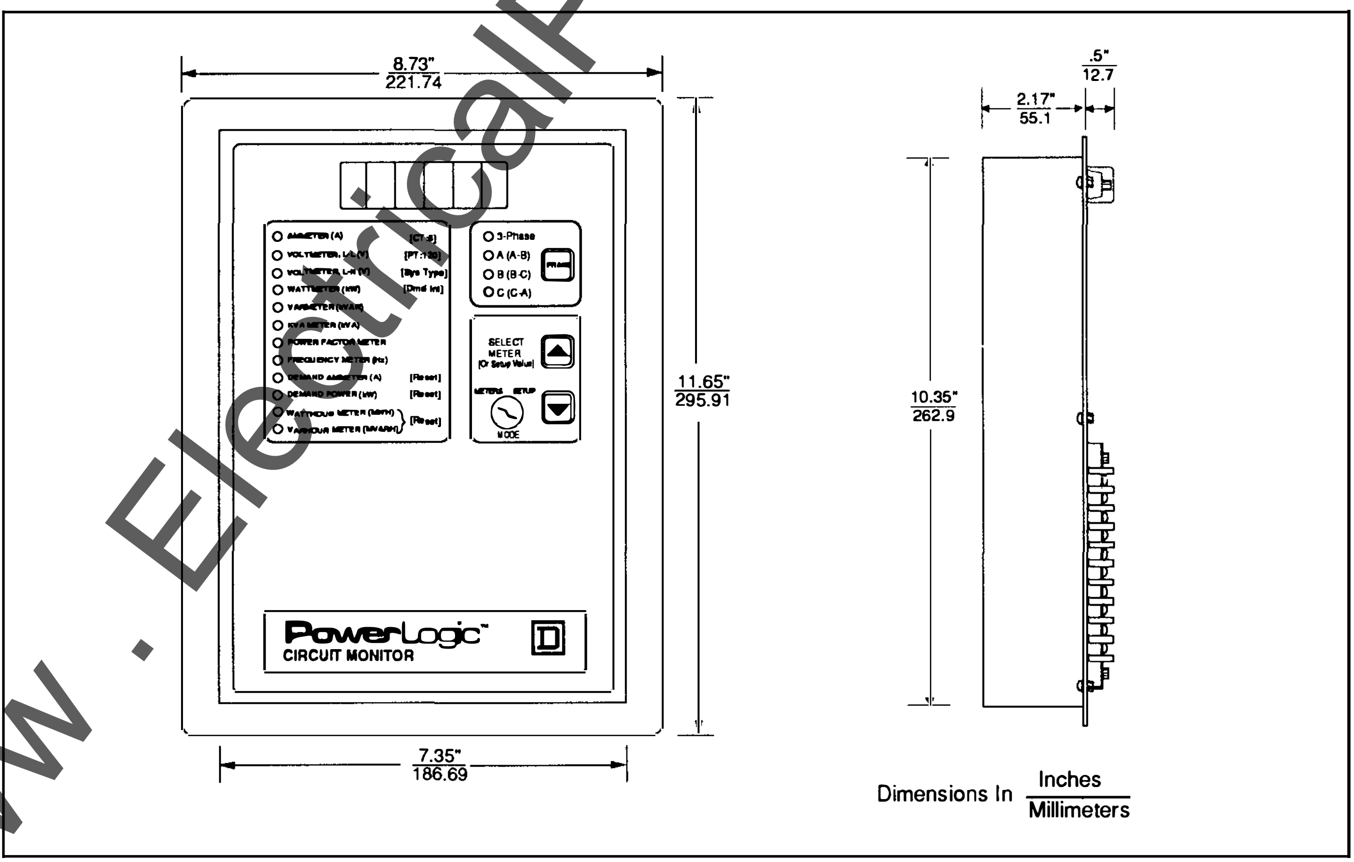

Figure 3-3 *- Circuit Monitor with Dimensions*

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4.0 INSTALLATION

4.1 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 3-3 and verify that the required clearances exist).

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 4-1 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.

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.

4.3 Wiring CTs, PTs, and Control Power

Figures 4-3 and 4-4 offer typical wiring plans for Circuit Monitors in 3-phase/3-wire and 3-phase/4-wire systems, respectively. Figure 4-5 illustrates a 3-phase load on a 4-wire system. Figure 4-6 offers a one-line diagram illustrating the wiring for multiple Circuit Monitors. Note that voltage inputs are paralleled allowing CMs to share one set of 3-phase PTs. (This wiring method requires that PT secondaries are grounded in only one location). Also, multiple Circuit Monitors may be wired to a single control power transformer (CPT). Unlike the PTs and CPT, each Circuit Monitor requires a *separate* set of CTs. The following list summarizes important wiring considerations.

- Multiple Circuit Monitors may be connected to a single set of three phase PTs
- Multiple Circuit Monitors may be connected to a single CPT
- 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.

⚠WARNING

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

⚠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 4-1 *- Typical Circuit Monitor Mounting Locations*

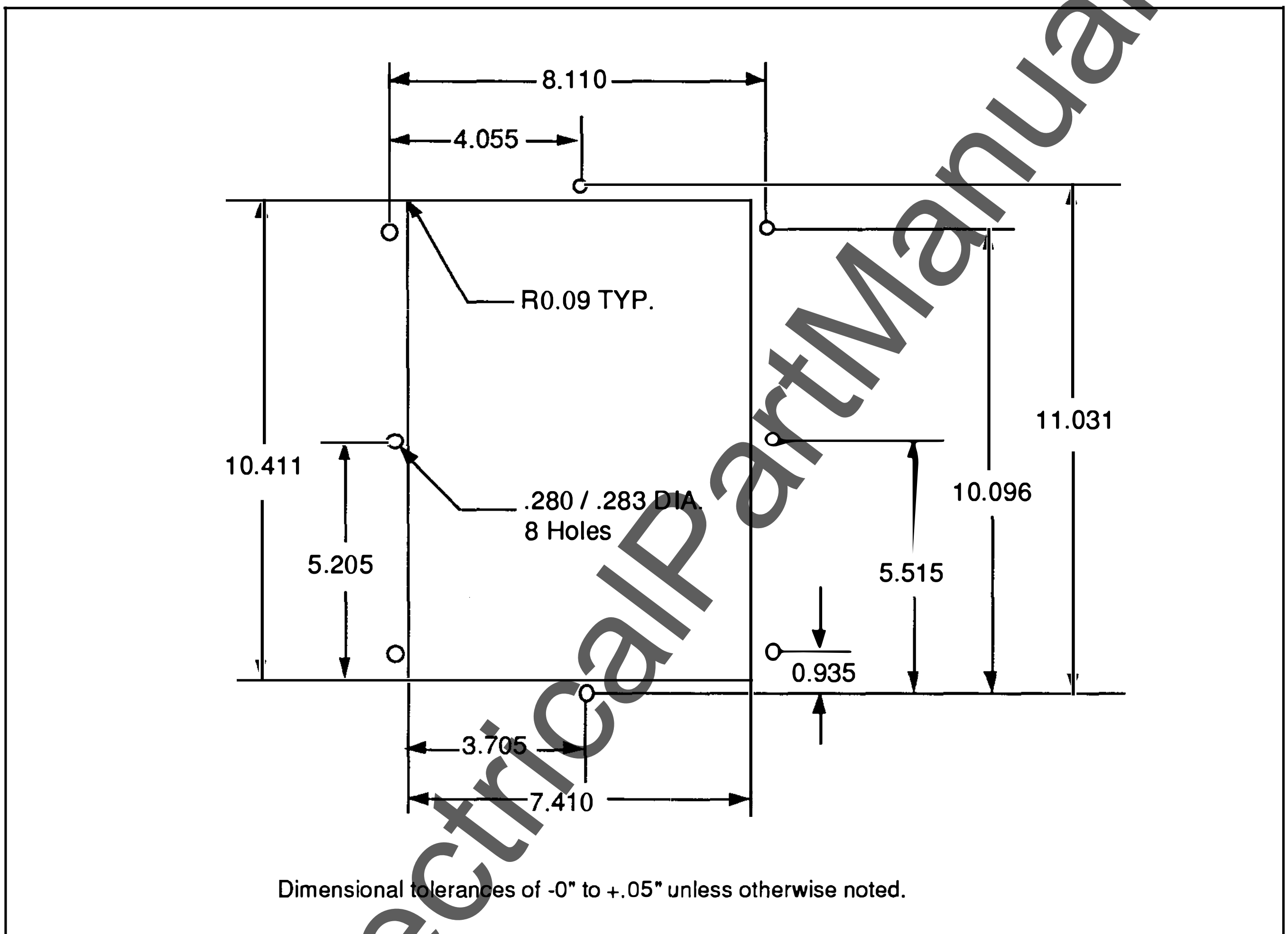

Figure 4-1 *- Panel Preparation*

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)	

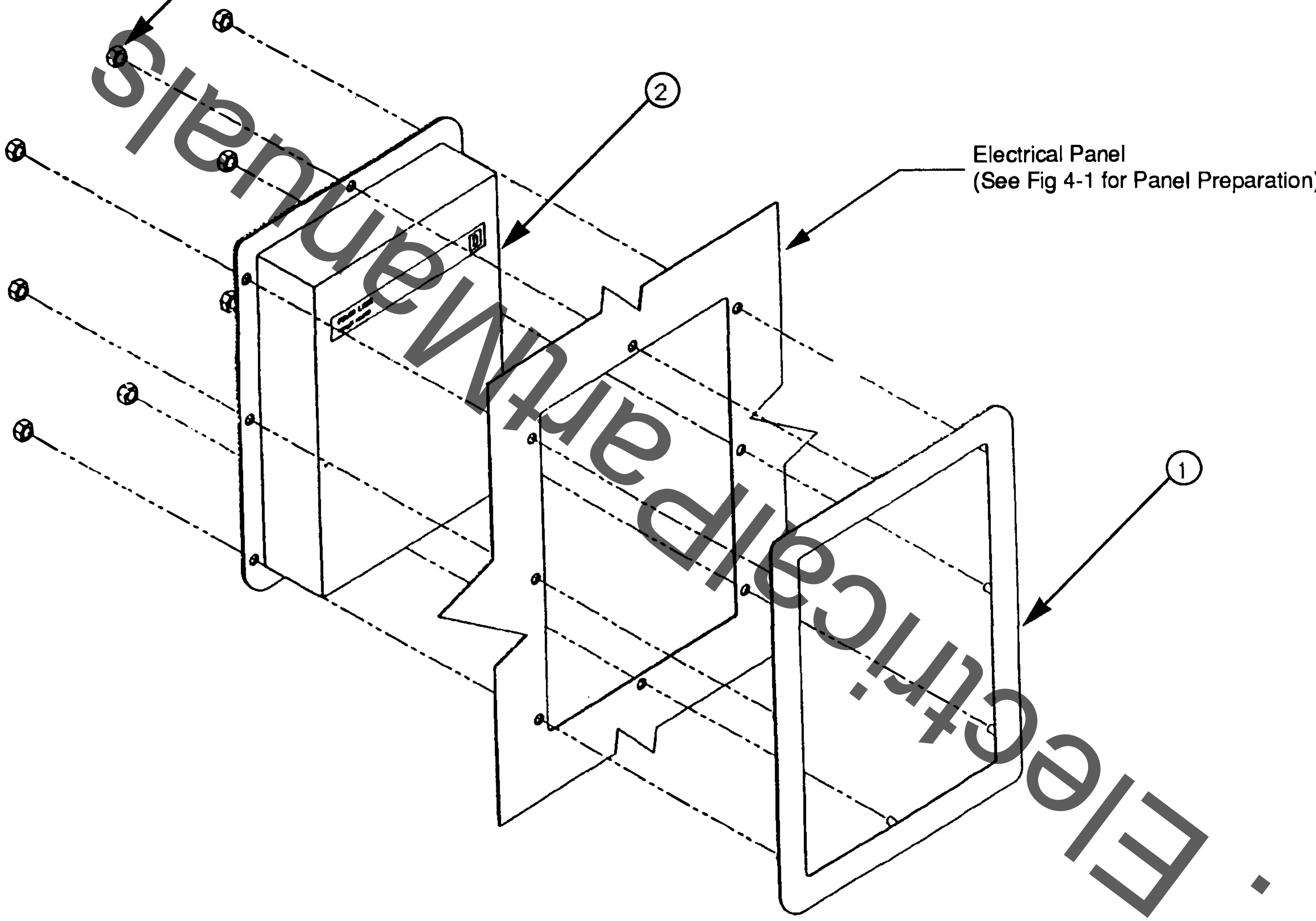

Figure 4-2 *- Circuit Monitor Installation*

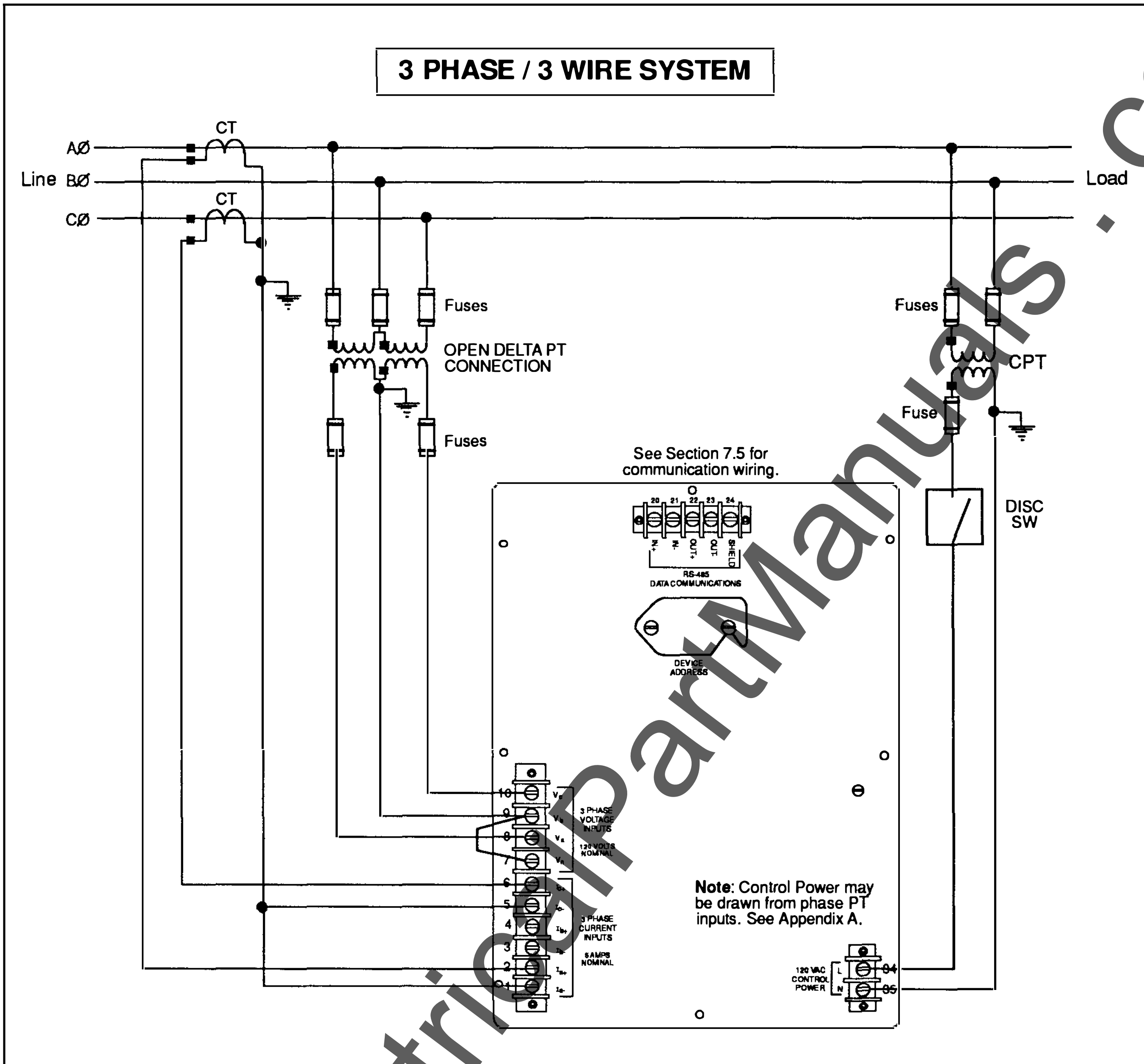

Figure 4-3 *- Circuit Monitor Wiring Diagram for 3 phase/ 3 wire system.*

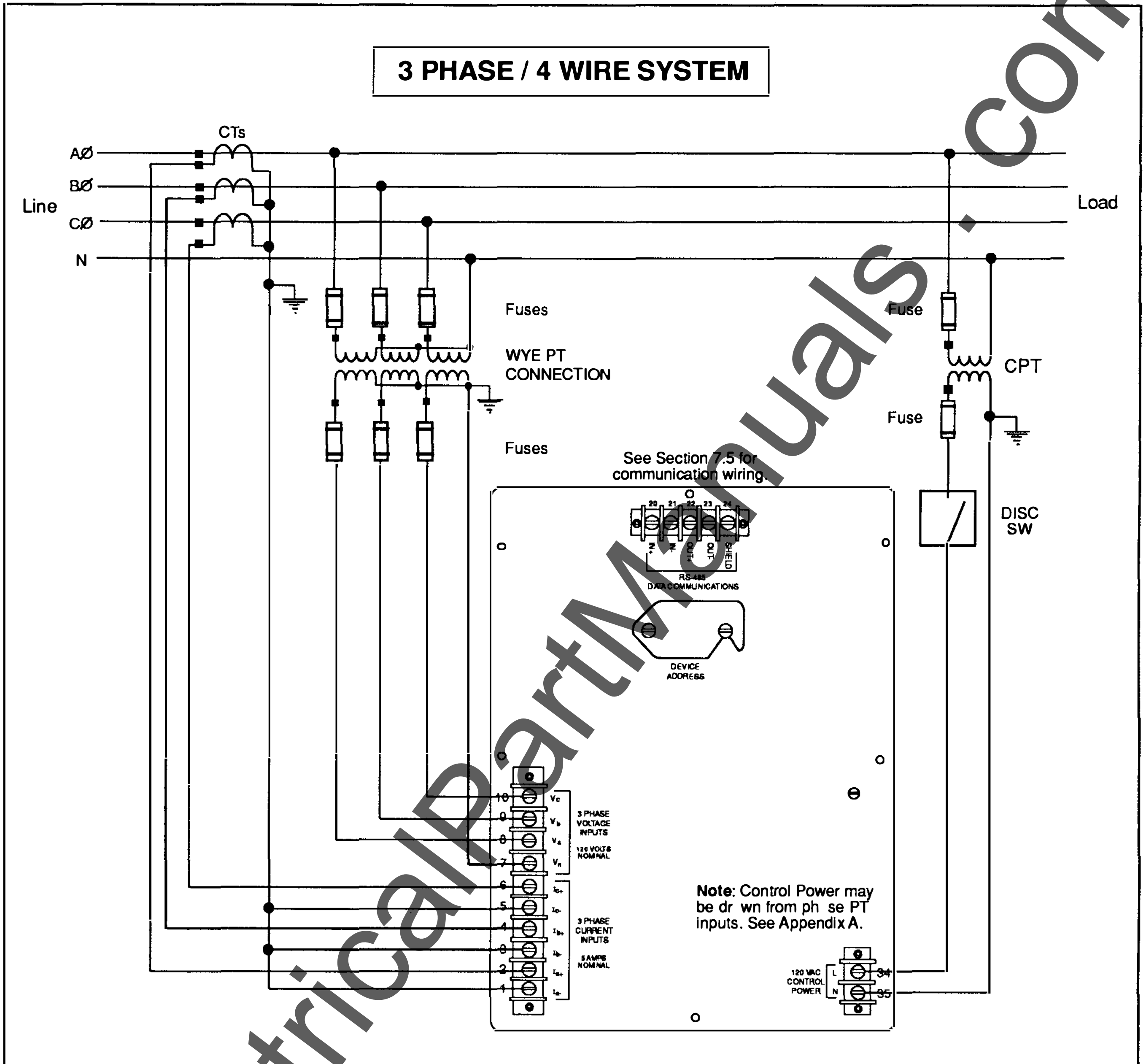

Figure 4-4 - Circuit Monitor Wiring Diagram for 3 phase/4 wire system.

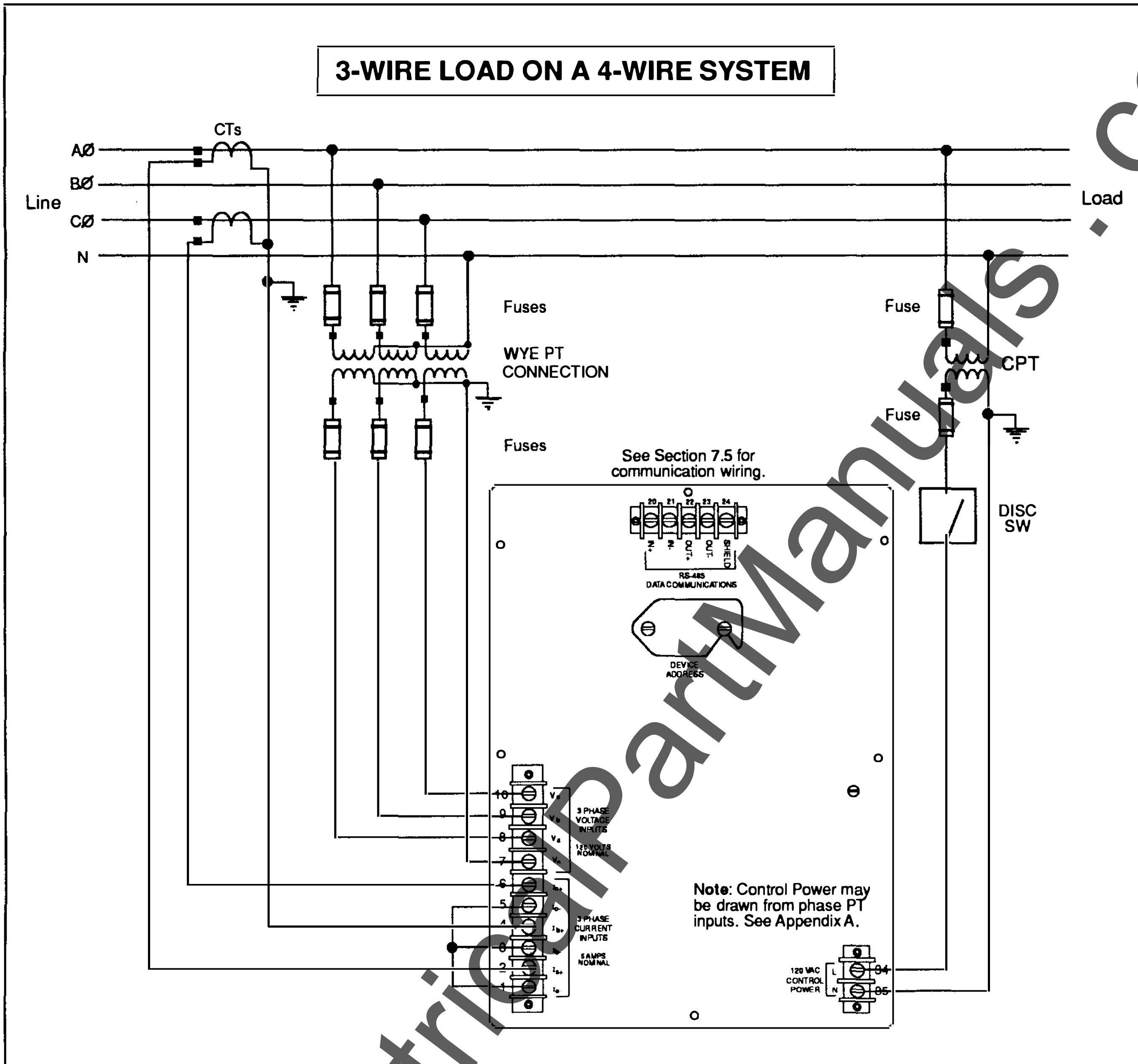

Figure 4-5 - *Circuit Monitor Wiring Diagram for 3 wire load on a 4 wire system.*

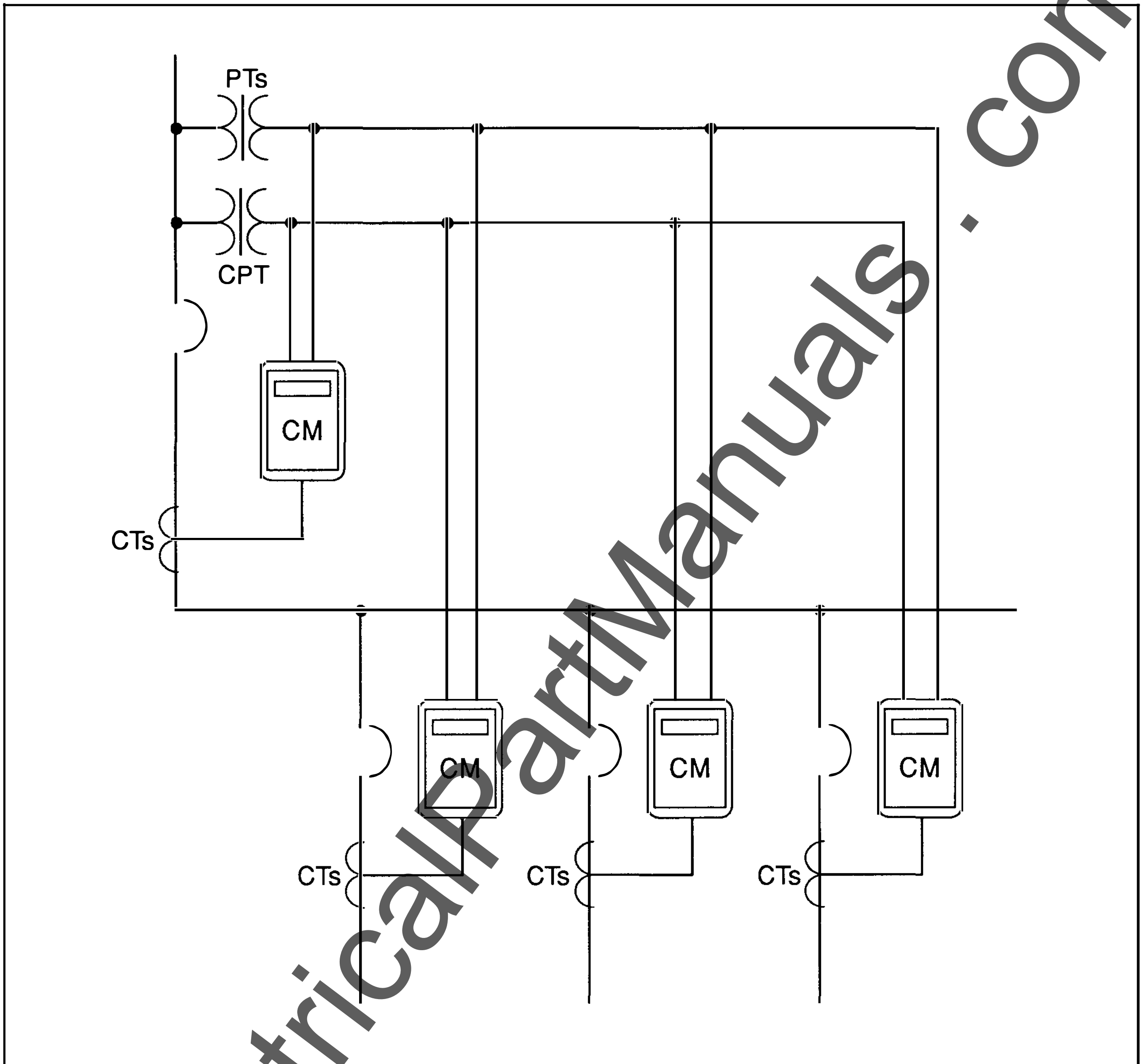

Figure 4-6 *- One-line diagram illustrating multiple CMs connected in parellel to a single set of PTs.*

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5.0 SETUP

5.1 Introduction

PowerLogic Circuit Monitors have a number of setup parameters which must be defined to allow proper operation, including CT rating, PT rating, System Type and Demand Interval. These parameters may be defined via the communications channel or from the faceplate of the Circuit Monitor with digital display. Additional parameters used in data communications may be defined via the communications channel. (For a complete listing of Circuit Monitor registers, refer to the Circuit Monitor Communications Reference #63210-203-01.

The CT rating, PT rating, System Type and Demand Interval are defined from the faceplate of the Circuit Monitor with digital display using the MODE keyswitch and the SELECT METER keys. The four setup parameters are printed in brackets adjacent to the four upper meter selections. (See Figure 3-1). Each setup parameter is activated only when its corresponding meter indication LED is illuminated and the MODE keyswitch is turned to the SETUP position. Instructions for defining each parameter are offered below.

5.2 Defining the CT Ratio

The Circuit Monitor assumes a nominal secondary Current Transformer rating of 5 amps. The user must define a primary rating in the range 5 to 9999. To define the primary CT rating, follow the steps below:

1) Use the SELECT METER keys to select AMMETER(A). (The red LED next to AMMETER should be illuminated). The setup parameter [CT:5] is printed to the right.

2) To activate the setup mode, insert the key into the MODE keyswitch and turn it to SETUP. The present CT rating will be displayed. (The CT rating is set to 5 at the factory).

3) Use the SELECT METER keys to increment or decrement the value until the correct rating is displayed. (Press and release the keys to move slowly. Hold down the keys to move quickly).

4) Return the MODE key to the METERS position.

The Circuit Monitor will enter a reset mode as the new CT ratio is stored in its memory. A firmware revision number will be displayed, (for example, **r=01**), and when the reset is complete the AMMETER reading based on the new CT ratio will appear.

5.3 Defining the PT Ratio

The Circuit Monitor assumes a nominal secondary Potential Transformer rating of 120 amps. The user must define a primary rating in the range 120 to 32767. To define the primary PT rating, follow the steps below:

1) Use the SELECT METER keys to select VOLTMETER, L-L(V). (The red LED next to VOLTMETER, L-L(V) should be illuminated). The setup parameter [PT:120] is printed to the right.

2) To activate the setup mode, insert the key into the MODE keyswitch and turn it to SETUP. The present PT rating will be displayed. (The PT rating is set to 120 at the factory).

3) Use the SELECT METER keys to increment or decrement the value until the correct rating is displayed. (Press and release the keys to move slowly. Hold down the keys to move quickly).

4) Return the MODE key to the METERS position.

The Circuit Monitor will enter a reset mode as the new PT ratio is stored in its memory. A firmware revision number will be displayed, (for example, **r=01**), and when the reset is complete the VOLTMETER reading based on the new PT ratio will appear.

5.4 Defining the System Type

The Circuit Monitor must know whether it should use the 3-wire or 4-wire algorithm in instrumentation calculations. This is done by defining the System Type, where 3 indicates a 3-phase 3-wire system and 4 indicates a 3-phase 4-wire system. (Refer to Section 4.3 for wiring diagrams illustrating 3-wire and 4-wire systems). To define the System Type, follow the steps below:

1) Use the SELECT METER keys to select VOLTMETER, L-N(V). (The red LED next to VOLTMETER, L-N(V) should be illuminated). The setup parameter [Sys. Type] is printed to the right.

2) To activate the setup mode, insert the key into the MODE keyswitch and turn it to SETUP. The present System Type will be displayed. (The System Type is set to 4 at the factory).

3) Use the SELECT METER keys to increment or decrement the value until the correct rating is displayed.

4) Return the MODE key to the METERS position.

The Circuit Monitor will enter a reset mode as the new System Type is stored in its memory. A firmware revision number will be displayed, (for example, **r=01**), and when the reset is complete the present VOLTMETER reading will appear.

5.5 Defining the Demand Interval

The Circuit Monitor uses a sliding window method to calculate Average Demand Real Power. The user must supply the time interval (Demand Interval) used in the calculation. The Demand Interval must be a value from 5 to 60 in five minute increments. To define the Demand Interval, follow the steps below:

1) Use the SELECT METER keys to select WATTMETER (kW). (The red LED next to WATTMETER (kW) should be illuminated). The setup parameter [Dmd. Int.] is printed to the right.

2) To activate the setup mode, insert the key into the MODE keyswitch and turn it to SETUP. The present Demand Interval will be displayed. (The Demand Interval is set to 15 at the factory).

3) Use the SELECT METER keys to increment or decrement the value until the correct Demand Interval is displayed.

4) Return the MODE key to the METERS position.

The Demand Interval will be updated, and the present WATTMETER reading will reappear.

6.0 RESETS

Peak Demand Current (A), Peak Demand Real Power (kW), Accumulated Energy (MWH) and Accumulated Reactive Energy (MVARH) may all be reset from the Circuit Monitor faceplate. Instructions for resetting these values follow.

6.1 Resetting Peak Demand Currents

The Circuit Monitor displays a Peak Demand Current value for each phase. A reset operation causes all three values to be set equal to the present Average Demand Current values. These values **may not** be reset individually. To reset Peak Demand Currents, follow the steps below:

1) Use the SELECT METER keys to select DEMAND AMMETER (A). (The red LED next to DEMAND AMMETER (A) should be illuminated).

2) Insert the key into the MODE keyswitch and turn it to SETUP. All three Peak Demand Current values will be set equal to present Average Demand Current values.

3) Return the key to the METERS position.

6.2 Resetting Peak Demand Real Power

Resetting Peak Demand Real Power causes it to be set equal to the present Average Demand Real Power value. To reset Peak Demand Real Power, follow the steps below:

1) Use the SELECT METER keys to select DEMAND POWER (kW). (The red LED next to DEMAND POWER (kW) should be illuminated).

2) Insert the key into the MODE keyswitch and turn it to SETUP. The Peak Demand Real Power will be set equal to the Average Demand Real Power.

3) Return the key to the METERS position.

6.3 Resetting Accumulated Energy and Accumulated Reactive Energy

Accumulated Energy and Accumulated Reactive Energy are reset simultaneously. These values cannot be reset individually. Resetting the values causes them to be zeroed. To reset the energy values, follow the steps below:

1) Use the SELECT METER keys to select WATTHOUR METER (MWH) or VARHOUR METER (MVARH). (The red LED next to the selected meter should be illuminated).

2) Insert the key into the MODE keyswitch and turn it to SETUP. Both Energy and Reactive Energy will be set to 0.

3) Return the key to the METERS position.

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7.0 COMMUNICATIONS

7.1 General

The PowerLogic Circuit Monitor utilizes an industry standard RS-485 (RS-422 compatible) electrical interface for data communications to remote personal computers, PowerLogic™ System Displays, SY/MAX® processors and other SY/MAX compatible devices.

The RS-485 standard allows asynchronous, multipoint communication to up to 16 Circuit Monitors per communications channel. For example, 16 Circuit Monitors may be daisy-chained to the communications port of a System Display. The following section describes Circuit Monitor communication options.

7.2 Communication Options

The PowerLogic™ Circuit Monitor provides four communication alternatives. They are:

1) Connection to a PowerLogic System Display.
2) Connection to a Personal Computer via the RS-422 port of a SY/LINK® card.
3) Connection to a PowerLogic Network Interface Module for communication on the SY/NET® network.
4) Connection to a SY/MAX® programmable logic controller (PLC).

Each of these communication options is described below.

7.2.1 Connection to a PowerLogic System Display

The PowerLogic™ System Display provides real-time access to information from PowerLogic Circuit Monitors (up to 16 on a single communications channel). All instrumentation, status, and historical data stored in the Circuit Monitor are available on user command. Menu selections allow the user to reset metering and historical information and perform Circuit Monitor setup operations.

Where power equipment is in an inaccessible location, the System Display can be remote mounted (e.g., at floor level) for operator convenience and safety. The System Display can be located up to 10,000 feet from the farthest Circuit Monitor.

Up to 16 Circuit Monitors may be directly connected to the RS-485 communications port on the bottom of the System Display. (See Figure 7-1). When two or more Circuit Monitors are connected, a Multi-point Communications Adapter (3090 MCA-485) is required. A Multi-point Communications Terminator (3090 MCT-485) is always required on the last Circuit Monitor in a chain. Section 7.5.1 describes the use of these devices.

For additional information on the PowerLogic System Display, refer to the System Display instruction bulletin #63210-150-01.

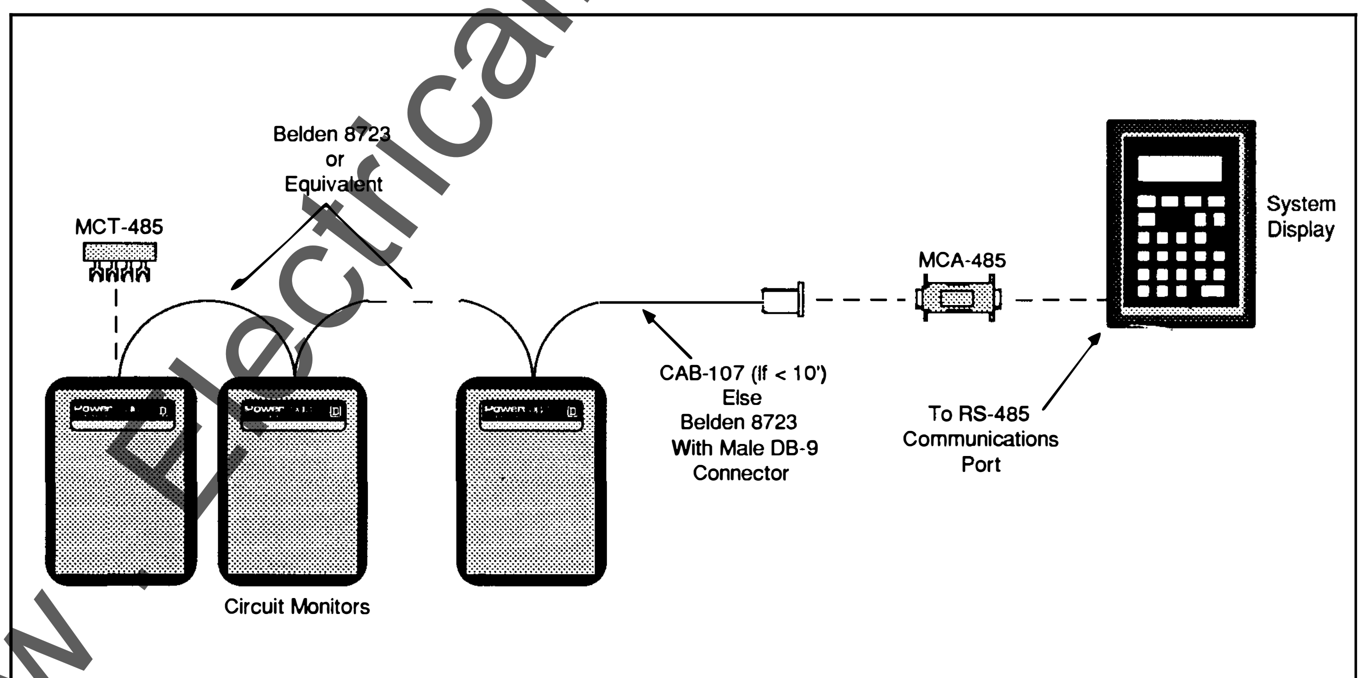


Figure 7-1 *- Circuit Monitors Connected to a PowerLogic System Display*

7.2.2 Connection to a Personal Computer

Up to sixteen Circuit Monitors may be directly connected to a personal computer to allow remote monitoring of circuit data. (See Figure 7-2). The personal computer may be located up to 10,000 feet from the farthest Circuit Monitor.

Circuit Monitors are connected to the personal computer via a SY/LINK® card (8010 SFI-510) installed in an expansion slot of the PC. The SY/LINK® card is a network communications card which handles communications processing and relieves the computer of the task.

The SY/LINK card has two communications ports. The top port is an RS-422 communications port. The bottom port is a network port for communications over the SY/NET® network. Circuit Monitors are connected to the RS-422 port.

When two or more Circuit Monitors are connected, a Multi-point Communications Adapter (3090 MCA-485) is required. A Multi-point Communications Terminator (3090 MCT-485) is always required on the last Circuit Monitor in a chain. Section 7.5.1 describes the use of these devices.

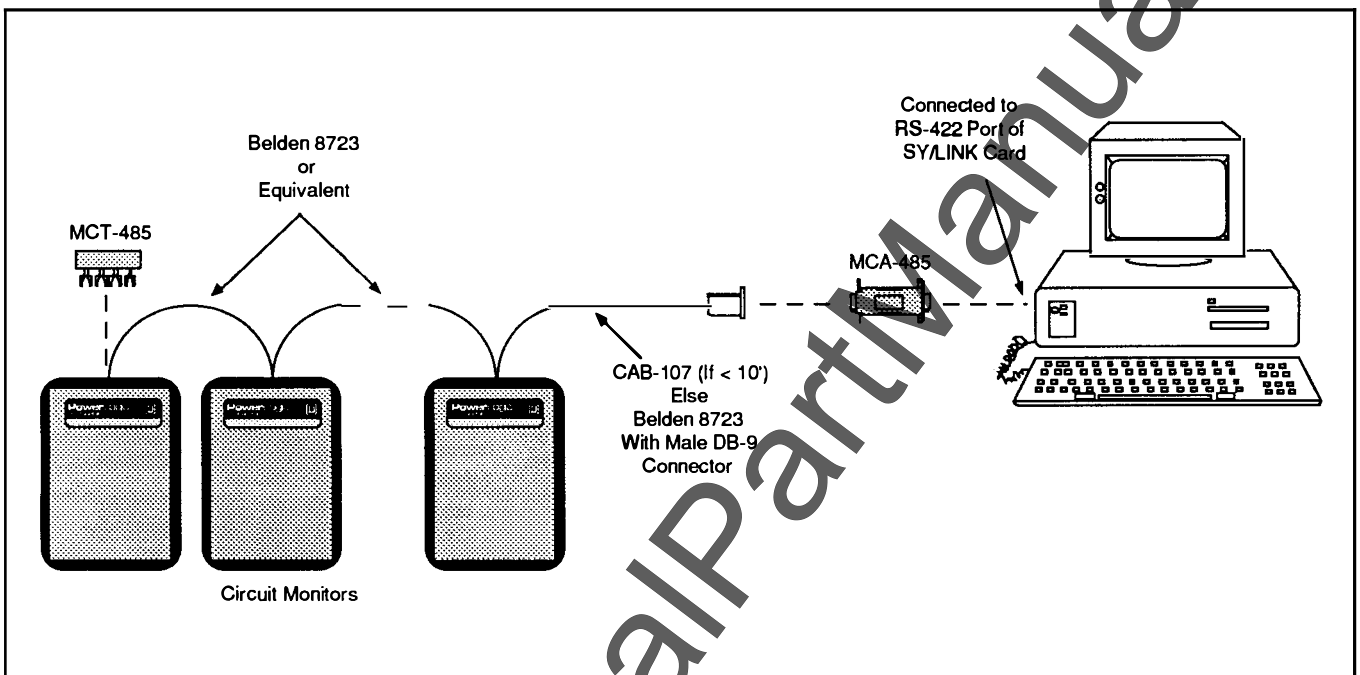


Figure 7-2 *- Circuit Monitors Connected to a Remote Personal Computer*

7.2.3 Connection to a PowerLogic Network Interface Module (PNIM)

When multiple computers, or programmable controllers are used to perform monitoring and control functions, communications are performed over the SY/NET® Local Area Network (LAN). Circuit Monitors are connected to the network via a PowerLogic™ Network Interface Module (PNIM). (See Figure 7-3).

The PNIM has two RS-422 communication ports on its face (labeled 0 and 1) and a network port on its bottom. Circuit Monitors may only be connected to the top RS-422 port (port 0). Port 0 must be configured to operate in PowerLogic mode. For instructions on configuring the PNIM, refer to the PNIM instruction bulletin #30598-756-01.

Up to 16 Circuit Monitors may be daisy-chained to a single PNIM. When two or more Circuit Monitors are connected, a Multi-point Communications Adapter (3090 MCA-485) is required. A Multi-point Communications Terminator (3090 MCT-485) is always required on the last Circuit Monitor in a chain. Section 7.5.1 describes the use of these devices.

7.2.4 Connection to a SY/MAX® Programmable Logic Controller (PLC)

In some cases, it may be desirable to connect Circuit Monitors directly to a SY/MAX® programmable logic controller (PLC). Up to 16 Circuit Monitors may be connected to a processor's RS-422 communications port. When two or more Circuit Monitors are connected to a processor's port, a Multi-point Communications Adapter (3090 MCA-485) is required. A Multi-point Communications Terminator (3090 MCT-485) is always required on the last Circuit Monitor in a chain. Section 7.5.1 describes the use of these devices.

NOTE: The PLC must use a ladder program written to access Circuit Monitor data in specified locations. PowerLogic offers a ladder program written for the SY/MAX® Model 400 processor. For a complete list of Circuit Monitor registers, refer to the Circuit Monitor Communications Reference Manual #63210-203-01.

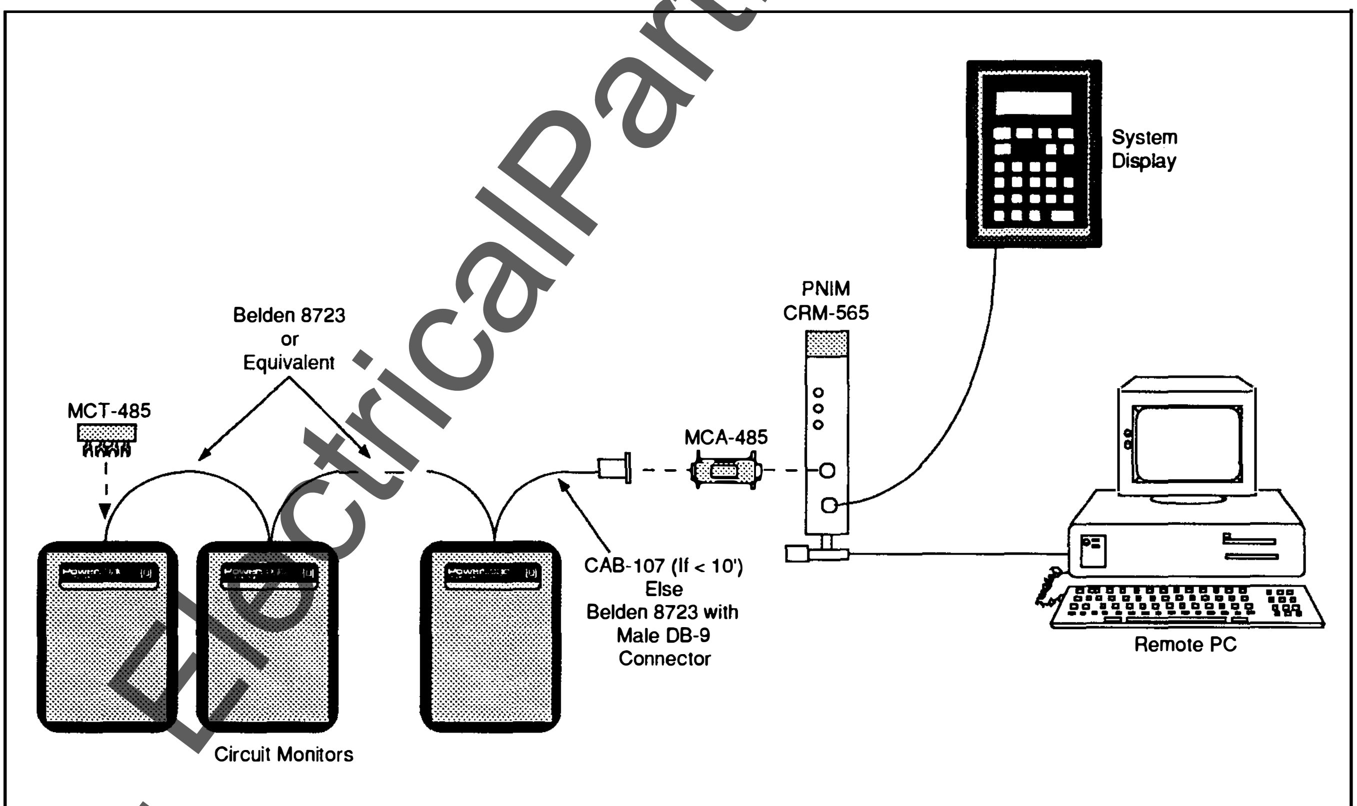


Figure 7-3 *- Circuit Monitors Connected to a PowerLogic Network Interface Module (PNIM)*

7.3 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.

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 7-1 shows the proper switch settings required for each baud rate.

After the baud rate has been changed, the Circuit Monitor's address must be reset. Section 7.4 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 7-1).
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 7.4).
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.

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

Table 7-1 - CM Baud Rate Switch Settings

7.4 Setting the Device Address

Each Circuit Monitor on a single communications channel must have a unique address assigned to it. (In this context, the term communications channel means 1 to 16 Circuit Monitors "daisy chained" to a communications port). Information sent over the communication lines is accompanied by the address of the target Circuit Monitor. In this way, information can be routed to specific CMs 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. 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 37 of those settings, 32 of which are reserved for addressing the unit. Table 7-2 offers a summary of Circuit Monitor switch settings.

The last CM in the chain, i.e. the CM which is located farthest from the port, 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.

When a single Circuit Monitor is connected to a communications port, the address switches on the rear of the unit should be set to 01. If additional Circuit Monitors are added to the communications link, the last Circuit Monitor in the chain should retain the address 01.

NOTE: When a single Circuit Monitor is connected to a communications port, the address switches on the rear of the unit may be set to 00. This allows a single Circuit Monitor to communicate without the need for a Multipoint Communications Adapter. (Section 7.5.1 describes the adapter). If, at a later date, additional Circuit Monitors are added, CM 00 must be changed to 01 and a Multipoint Communications Adapter must be used. It is recommended that in single Circuit Monitor systems, the Circuit Monitor's address be set to 01 and the Multipoint Communications Adapter be used.

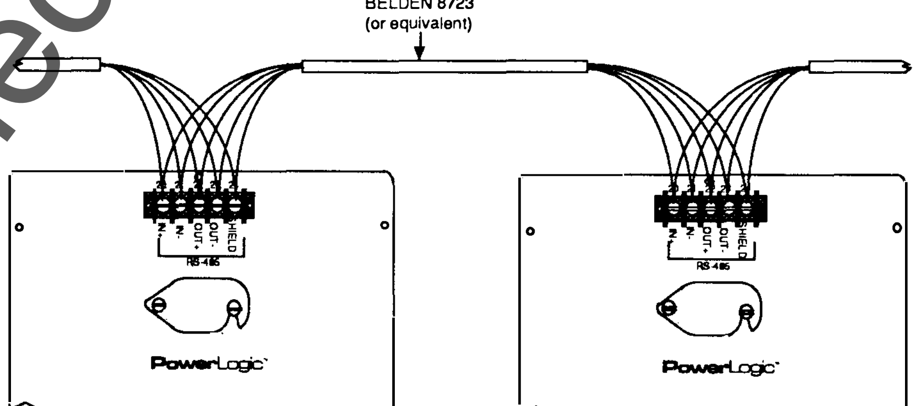
Circuit Monitors are shipped with a default address of 01. To change the address of a Circuit Monitor complete the following steps:

1) Turn the control power to the unit off.
2) Set the address switches to a unique number in the range 1..32.
3) Return control power to the unit.

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.

Switch Setting	Function
1-32	Determines the Device Address
33-93	Reserved
94-98	Used to Set the Unit's Baud Rate
99	Reserved

***Table 7-2** - Summary of Circuit Monitor Address Switch Settings*



IMPORTANT: The communications shield is terminated at each Circuit Monitor.

***Figure 7-4** - Circuit Monitor Communication Wiring*

7.5 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 7-4 illustrates correct communication wiring.

7.5.1 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. 3090 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 7-6).

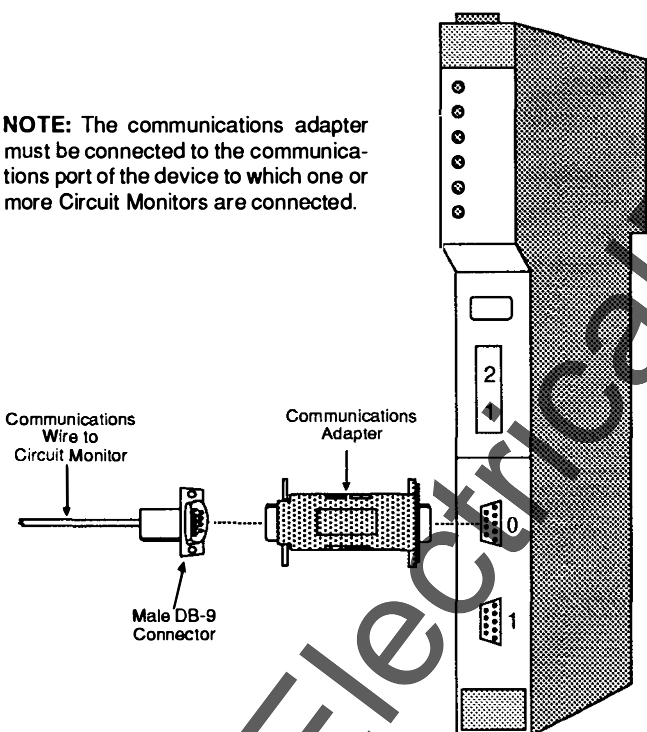


***Figure 7-5** - Multipoint Communications Adapter*

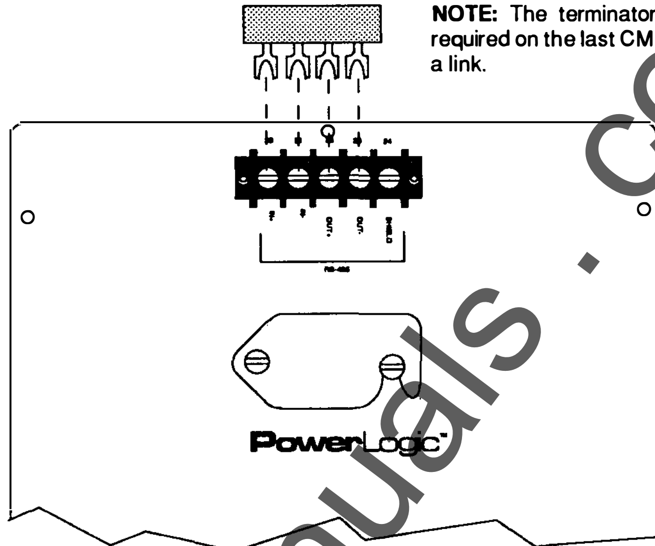


***Figure 7-6** - Multipoint Communications Terminator*

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 7-6 illustrates the proper placement of the terminator. Figures 7-1, 7-2, and 7-3 show the terminator applied in typical systems.

The communication lines are biased with the use of the PowerLogic RS-485 Multipoint Communications Adapter (Catalog No. 3090 MCA-485). The 9-pin, male to female adapter is attached to the host device to which one or more CMs are daisy chained. **NOTE:** If a single CM is connected to a communications port and the adapter is used, the CM's address must be set to 01. (See Section 7.4).

Possible connection points include: the RS-422 port of a SY/LINK Card, the top RS-422 communications port of a PowerLogic Network Interface Module (PNIM), and the communications port of a SY/MAX® processor. Figure 7-5 illustrates the adapter connected to a PNIM. Figures 7-1, 7-2, and 7-3 show the adapter applied in typical systems.

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 4.0 - 7.0 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.

⚠CAUTION

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

Circuit Monitor used as a standalone device

Problem	Possible Cause(s)	Check or Cure
No Data Displayed on Power-up	CM not receiving necessary power	Check that L and N connections (terminals 34 & 35) are receiving 120V control power
Inaccurate data displayed	Incorrect Setup values	Check to see that proper values for System Type, CT rating, PT rating and Demand Interval have been entered. See Section 5.0.
	Circuit Monitor wired improperly	Check that CTs are connected correctly (proper polarity observed) and energized. See Section 4.3. Check CT shorting terminals.
	Incorrect voltage inputs	Check terminals Va, Vb, and Vc (#8,9,10) to see that correct voltage is present

***Table 8-1** - Circuit Monitor Troubleshooting Guide*

Circuit Monitor using RS-485 communications

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 7.4 of this document
	CM set to operate at incorrect baud rate	Reset the CM to communicate at the desired baud rate. Refer to section 7.3.
	Communication lines on last CM improperly terminated	Check last CM on the link for proper termination. See section 7.5.1 for instructions on terminating the last CM on the link.
	Communication lines improperly biased	Verify that the multipoint communications adapter is being used (See Section 7.5.1).
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 4.4
	Communicating to wrong CM	Check address of target CM. Check for correct use of route statements.
	Incorrect Setup parameters 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 Section 5.0.

***Table 8-1** - Circuit Monitor Troubleshooting Guide (Continued)*

Appendix A - Deriving Control Power from Phase PT Inputs

Whenever possible, Circuit Monitor control power should be obtained from a stable 120 VAC source. If such a source is unavailable, CM control power may be derived from phase PT inputs.

To do this, connect the Circuit Monitor's phase A voltage terminal, V_a (terminal 8 on the rear of the CM), to the Line terminal on the CM's control power strip (terminal 34). Also, connect the neutral voltage terminal, V_n (terminal 7), to the neutral terminal on the Circuit Monitor's control power terminal strip (terminal 35). Figure A-1 illustrates the proper connections.

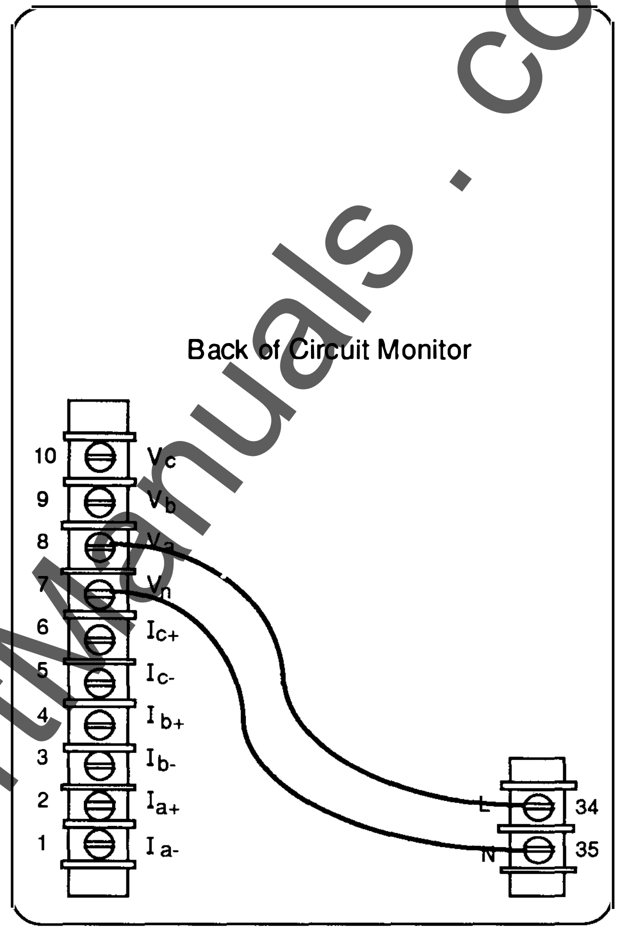


***Figure A-1** - Circuit Monitor Deriving Control Power from PT Inputs*

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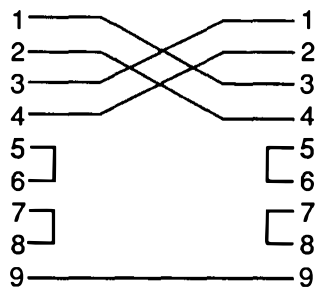
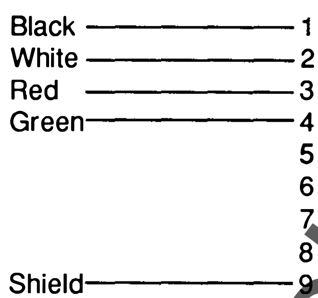
Appendix B - Communication Cable Pinouts

CC-100

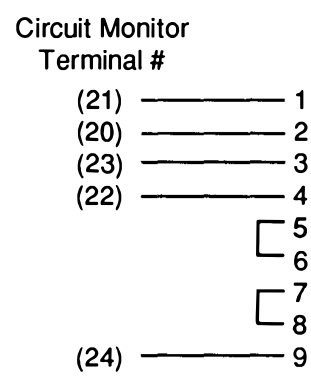


CAB-102, CAB-104

CAB-106



CAB-107



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