MOORE INDUSTRIES

April 2016
328-701-00 D

PPM

Programmable AC Power
Monitor & Display

PPM Programmable AC Power Monitor & Display

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Introduction

This is the users' manual for Moore Industries Programmable AC Power Monitor and Display, or PPM. It contains all the information needed to configure, install, operate, and maintain the PPM.

The following guidelines are used in this manual:

WARNING - Hazardous procedure or condition that could injure the operator.

Caution - Hazardous procedure or condition that could damage or destroy the unit.

Note - Information that is helpful for a procedure, condition, or operation of the unit.

The PPM

Contained in a space-saving panel-mount housing, the PPM monitors input signals (such as phase voltage, power, and current) from three independent phases, records data such as peak voltage, peak current, peak rolling demand, and energy registers, then outputs this information to a large, three-row display.

The measurement process is continuous with all signals scanned simultaneously at high speed. Unlike many other sampling systems, which sample one phase after another, this ensures that all input cycles, including time-varying inputs, are detected. The speed of sampling also allows distorted input waveforms, with harmonics to the 20th, to be detected accurately.

Specifications

Performance

Accuracy: See Table 1 for details
Isolation: 2500V isolation from input to digital output
Burden: 0.1 VA per phase
Surge Withstand Capability: Surge withstand voltage x2 for 2 seconds maximum; Surge withstand current x40 for 0.5 seconds maximum
Auxillary Power Load: 5 VA maximum; With –MBR, 8VA maximum
Scaling: Input current and voltage are user scaled for the respective CT and PT ratios
Maximum CT Primary: 6,500 Amps
Maximum PT Primary: 60,000 Volts

Display

Type: LCD; Three rows of 12mm (0.47 inch) black digits and 4mm (0.16 inch) black legends on a backlit background
Format: Two rows of four alphanumeric characters plus legends; Bottom row of six alphanumeric characters plus legends
Decimal Point: Auto-adjusting
Engineering Units: Auto-adjusting

Ambient Conditions

Operating & Storage Range: -10°C to +65°C (-14°F to +149°F)
Relative Humidity: <75% non-condensing
Ambient Temperature Effect: Negligible within specified limits

Modbus Option

Bus Type: RS-422 & RS-485 available
Protocol: Modbus RTU with 16-bit CRC
Baud Rate: User programmable to 4800, 9600, or 19200
Address: User programmable from 1-247
Response Time: 100ms maximum from command end to reply start
Command Rate: New command within 5ms of previous one

Analog Output Option

Output Accuracy: I_{out} < 5.6mA, ±0.75% reading + PPM errors; I_{out} ≥ 5.6mA, ±0.5% reading + PPM errors
Response Time: Outputs updated every second (as PPM)

Analog Output Option (Continued)

Load Impedance: External Supply, 600Ω per channel (maximum 950Ω) at 24V supply; Internal (Unreg) Supply, 250Ω per channel (maximum 500Ω) at nominal V_{aux}
Overrange: 21mA Maximum output
Load Effect: ±0.02% of span from 0 to 250Ω on current output
Supply Voltage Effect: ±0.05% for V_{aux} ±15% (Internal supply, 250Ω load)
Power Load: 4 VA maximum
Isolation: 2.5kV continuous (supply internally wired to PPM auxillary mains inputs)

Adjustment

Four buttons on the front of the unit provide adjustment for all settings

Weight

PPM: 403g (14 ounces)
PPM with –MBR or –4AO Option: 596g (1 lb., 5 oz)

Specifications and information subject to change without notice.

Table 1. PPM Input Type & Accuracy

Input	Per Phase Accuracy	3-Phase Accuracy
Current 5% to 120% FS	±0.2% FS ±1% Reading	N/A
Voltage LN 20% to 120% FS	±0.2% FS ±1% Reading	N/A
Voltage LL 20% to 120% FS	±0.3% FS ±1% Reading	N/A
Watts 5% to 120% FS	±0.4% FS ±1% Reading	±0.6% FS ±1% Reading
VA 5% to 120% FS	±0.6% FS ±1.5% Reading	±1% FS ±1.5% Reading
var 5% to 120% FS	±0.8% FS ±2% Reading	±1.5% FS ±2% Reading
PF Frequency (45-65Hz range)	±0.2°	±0.2° ±0.05Hz
Neutral Current 5% to 120% FS	N/A	±0.6% FS ±2% Reading
Wh Register VAh Register varh Register	N/A N/A N/A	Class 1 EN 61036 Class 2 Class 2 IEC 1268

Note: all accuracies specified are ±1 digit

Installation

Installation of the PPM is divided into two phases: mounting and electrical connections. In most cases, it is easier to mount the PPM before completing the electrical connections.

Mounting

The PPM is designed to be mounted on a panel that is between 1mm and 4mm (0.04 to 0.16 inches) thick with a square cut-out of 92mm (3.62 inches). A minimum depth of 72mm (2.83 inches) without the –MBR or –4AO options or 135mm (5.31 inches) with the –MBR or –4AO options should be allowed behind the panel for the meter.

To mount, remove the panel mounting clips and insert the meter into the cut-out from the front of the panel. Ensure the screws in each panel mount clip are fully retracted and insert the clips. Tighten the screws to secure the meter firmly in the panel.

Electrical Connections

Four different sets of electrical connections must be made to the PPM: current transformer, voltage, auxiliary power supply, and pulse output. There are also instructions in Appendix A for connecting the Modbus (–MBR) option; for instructions on connecting and configuring the Analog Output (–4AO) option, see Appendix B. Figures 9 and 10 describe terminal numbers and locations.

Current Transformer Connections

The PPM is designed for use with external current transformers (CTs). Recommended types should conform to Class 1 per IEC 60044-1. The secondary of the CT must be rated at 5A. Cables used for the current circuit should have a maximum conductor size of 11 AWG (4mm^2) and should be as short as possible to reduce cable losses loading the CT secondary.

WARNING:

Never leave the secondary of a current transformer open while a primary current flows. This can cause dangerous voltages to be produced at the secondary terminals. The secondary of the CT must be rated at 5A.

CT inputs to the meter are isolated from each other and all other parts of the circuit. This allows use on a wide variety of systems including those requiring common and/or grounded CT secondaries.

Voltage Connections

Cables used for the voltage measurement circuit should be insulated to a minimum of 600Vac and have a minimum current rating of 250mA. The maximum conductor size is 11 AWG (4mm^2).

External protection fuses are recommended for voltage measurement inputs. These should be rated at 160mA maximum, Type F, and should be able to withstand voltages greater than the maximum input to the meter.

Caution:

If external potential transformers (PT's) are used, the secondary of the PT's must match the nominal line-line input voltage specified on the unit's label.

Auxilary Power Supply Connections

The PPM uses an isolated auxilary power supply separate from the voltage measurement inputs. This may be connected separately or in parallel with the measurement inputs provided the ratings detailed on the instrument label are not exceeded.

Separate connection of the auxilary power supply is required when:

1. A suitable supply voltage is not available locally.
2. Measurement voltages are expected to vary over a wide range.
3. A backup supply is required to maintain meter display.

The auxilary power supply is internally fused at 250V, 100mA, type T.

Figure 1. *Electrical Connections for 3-Phase, 3-Wire, 2CT's (Not suitable for neutral current measurements)*

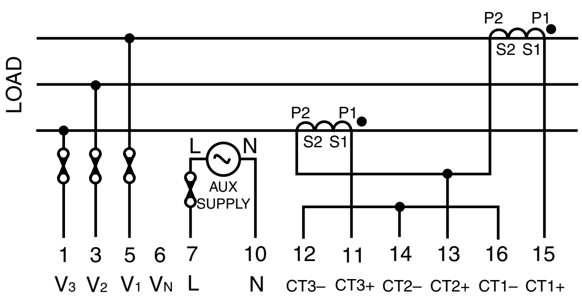


Figure 2. *Electrical Connections for 3-Phase, 3-Wire, 3CT's*

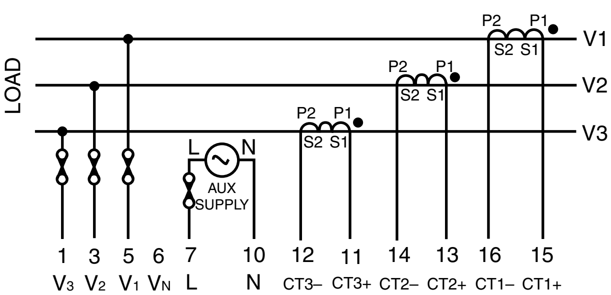


Figure 3. *Electrical Connections for 3-Phase, 4-Wire*

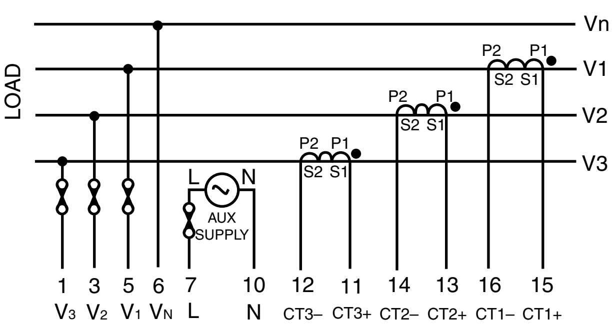


Figure 4. *Electrical Connections for Single-Phase*

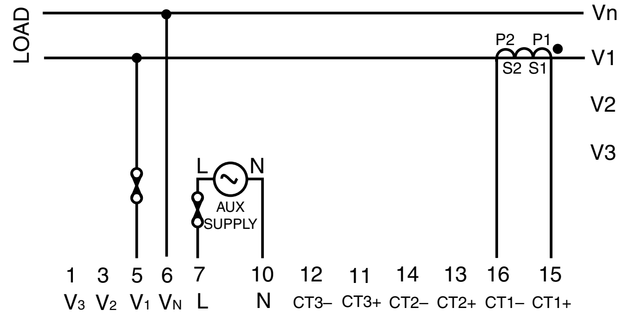
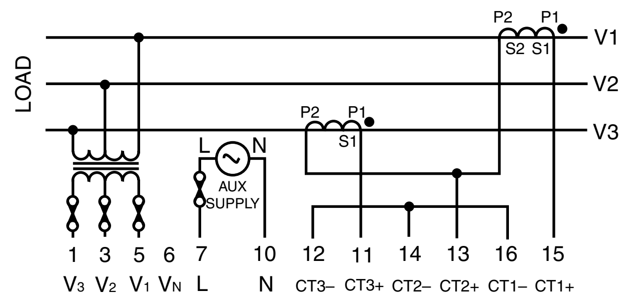


Figure 5. *Electrical Connections for 3-Phase, 3-Wire, using Potential Transformers*



Pulse Output Connections

The PPM's pulse outputs provide a simple interface to external systems such as building management systems. Each output takes the form of a normally open, volt-free contact pair which provides low resistance, for 100ms, at the end of a preset number of increments of the associated energy register (pulse rate). The pulse rate of each output may be programmed by the user to match the requirements of the external system.

Figure 6. *Pulse Output Connection Diagram*

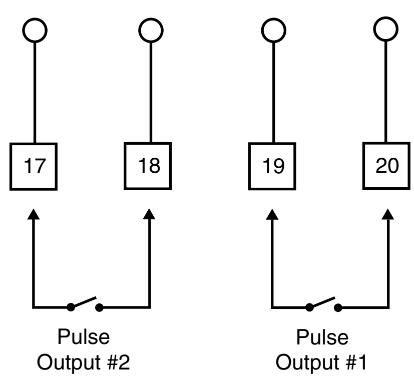


Figure 7. PPM dimensional diagram

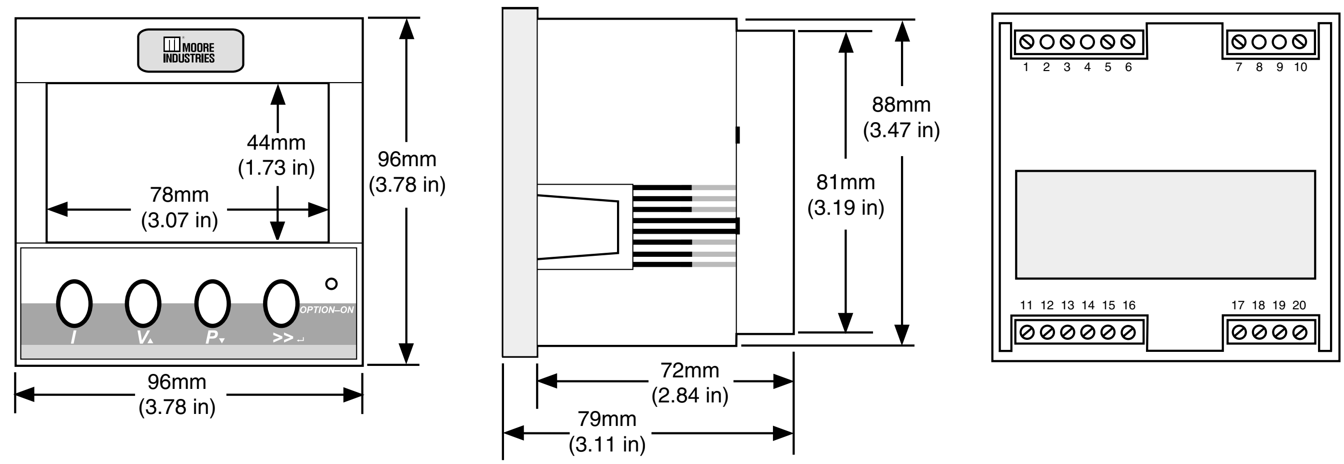
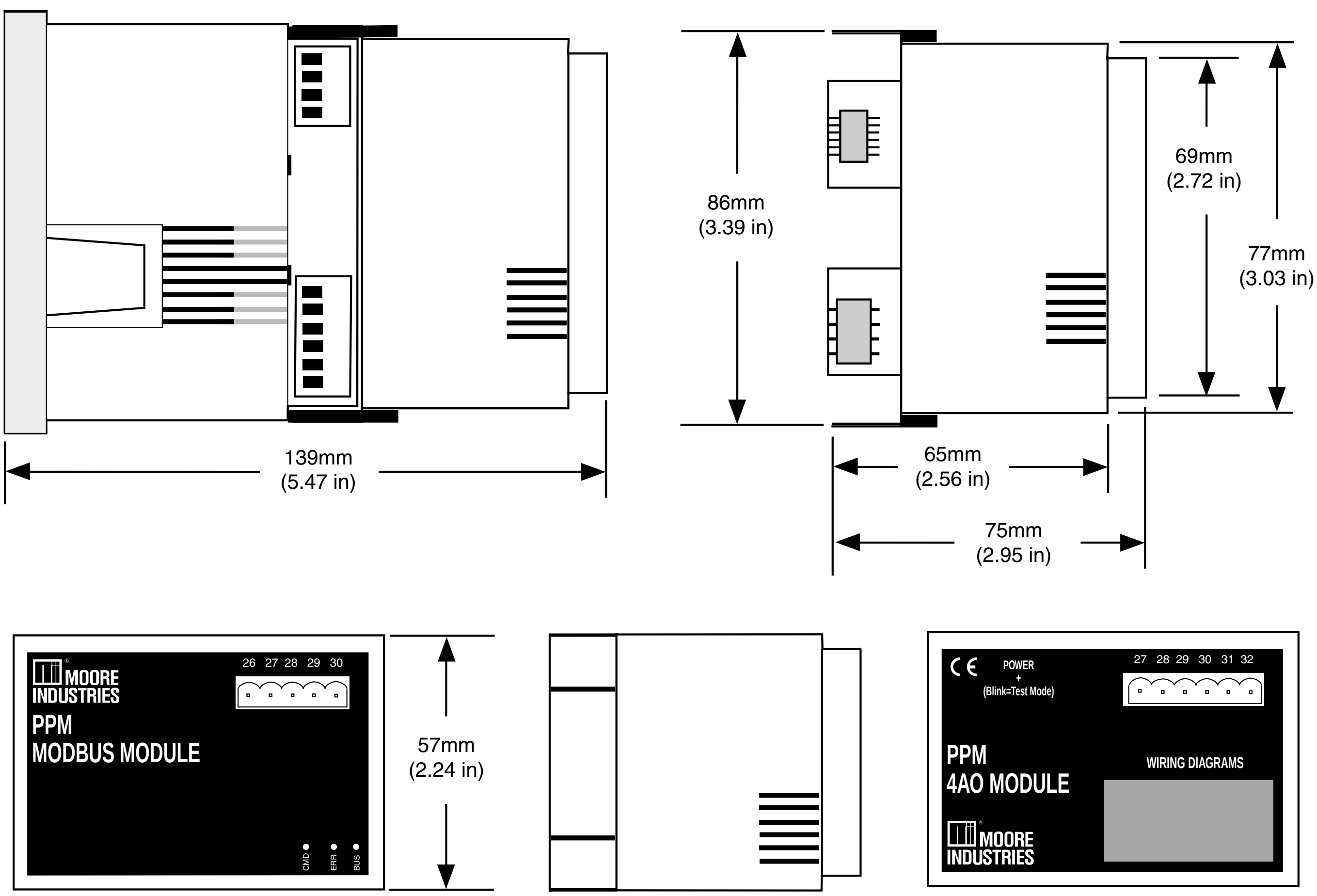


Figure 8. Dimensional Diagram of the PPM with Modbus (–MBR) or Analog Output (–4AO) option

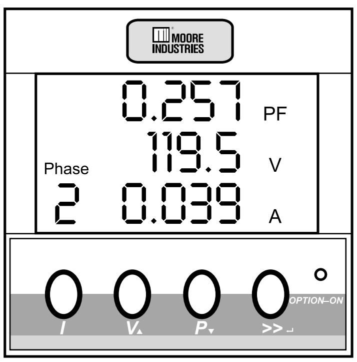


Configuring the PPM

The versatile PPM is designed for use in a wide variety of systems. A range of programmable features allow the unit to be setup for a specific application. Programming is available using the front panel keypad and display while the unit is operational.

To enter configuration mode, press "I" and "V" together and hold for five seconds. When you are completely finished configuring your unit, press "I" and "V" together again and hold for five seconds to return to measurement mode.

Figure 9. *Configure the PPM using the front-mounted push buttons.*



Configuring the Current Transformer Primary Current (Ct Pri)

The first item in the programming menu allows the user to set the CT Primary Current in the range from 5A to 6500A, to match the primary of the current transformers connected to the PPM inputs. The secondary of the CT's must match the nominal input current specified on the meter label. Once set, the constant acts as a multiplying factor in the internal calculation of relevant measurements.

Press ∆ to increase the Current Transformer Primary Constant by 1 Amp.

Press ∇ to decrease the Current Transformer Primary Constant by 1 Amp.

Press ↵ and hold for 2 seconds when done.

Configuring the Potential Transformer Primary Voltage (Pt Pri)

The next item in the programming menu allows the user to set the Potential Transformer Primary Voltage in the range from 60V to 50,000V, to match the primary of the potential transformers connected to the PPM inputs. The secondary of the PT's must match the nominal line-line input voltage specified on the meter label. If no potential transformers are fitted, the PT setting must match the nominal line-line input voltage specified on the meter label.

Press ∆ to increase the Potential Transformer Primary Constant by 1 Volt.

Press ∇ to decrease the Potential Transformer Primary Constant by 1 Volt.

Press ↵ and hold for 2 seconds when done.

Configuring the Pulse Output 1 (PL 1 rAtE)

Isolated pulse output 1 provides a single pulse at the end of every 1, 10, or 100 increments of the Wh register irrespective of display scaling and decimal point. This allows the unit to be configured to suit a wide variety of data logging building management type applications.

During programming, the pulse output 1 rate is displayed scaled as the Wh register for convenience. For example, a display of ***PL 1 rAtE 10.0 kWh*** indicates that one pulse will occur, at output 1, at the end of each 10 kWh.

Press ∆ to increase the Pulse Output Rate by 10.

Press ∇ to decrease the Pulse Output Rate by 10.

Press ↵ and hold for 2 seconds when done.

Configuring the Pulse Output 2 (PL 2 rAtE)

Isolated pulse output 2 provides a single pulse at the end of every 1, 10, or 100 increments of the total varh (or kvah using the –KVAH option) register irrespective of display scaling and decimal point. This allows the unit to be configured to suit a wide variety of data logging and building management type applications.

During programming, the pulse output 2 rate is displayed scaled as the total varh register. For example, a display of ***PL 2 rAtE 10.0 kVArh*** indicates that one pulse will occur, at output 2, at the end of 10 kvarh.

Press ∆ to increase the Pulse Output Rate by 10.

Press ∇ to decrease the Pulse Output Rate by 10.

Press ↵ and hold for 2 seconds when done.

Configuring KW Rolling Average (P AV PEr)
The averaging period used in calculation of kW Rolling Demand may be set in the range of 1 to 60 minutes. This period may be selected to match specific standards, or to set a convenient filter for short term fluctuations in input power, as required. During programming, the Averaging Period is displayed in minutes.

Press ∆ to increase the Averaging Period by 1 minute.

Press ∇ to decrease the Averaging Period by 1 minute.

Press ↵ and hold for 2 seconds when done.

Configuring the Ampere/Voltage Demand Period (I AV SEC)
The averaging period used in calculation of Ampere and Voltage Rolling Demand may be set in the range of 10 to 2,500 seconds (10 second increments). This period may be selected to set a convenient filter for short term fluctuations in input power, as required. During programming, the Averaging Period is displayed in seconds.

Press ∆ to increase the Averaging Period by 10 seconds.

Press ∇ to decrease the Averaging Period by 10 seconds.

Press ↵ and hold for 2 seconds when done.

Setting the Baud Rate (–MBR Only)
Remote serial communication speeds of 4800, 9600, or 19200 may be selected to suit external system requirements. Higher speeds will provide faster data access while a slower speed may be required in electrically noisy environments.

Press ∆ to select the next highest baud rate setting.

Press ∇ to select the next lowest baud rate setting.

Press ↵ and hold for 2 seconds when done.

Setting the Meter Address (–MBR Only)
Each PPM on a multi-drop Modbus system is identified to the master by a unique address. The PPM may be addressed anywhere in the full Modbus range of 1-247.

Press ∆ to increase the Modbus address by one.

Press ∇ to decrease the Modbus address by one.

Press ↵ and hold for 2 seconds when done.

Resetting Recorded Values
The PPM records a variety of different values for use in calculations and for storage in registers. Resetting these values allows you to erase all previously recorded values and begin recording fresh values

.

Note:
Resetting any of the parameters below permanently erases all accumulated data.

Resetting the Energy Registers
All accumulating energy registers may be simultaneously reset to zero using the front panel keys.
To reset all energy registers:

1. Use the front panel keys to select any energy display page
2. Press "P" and ">>" keys together and hold for 5 seconds

Resetting the Peak Voltage
The Peak Voltage readings may be simultaneously reset to zero using the front panel keys. To reset the Peak Voltages:

1. Use the front panel keys to select the Peak Voltage display page
2. Press "P" and ">>" keys together and hold for 5 seconds

Resetting the Peak Current
The Peak Current readings may be simultaneously reset to zero using the front panel keys. To reset the Peak Current:

1. Use the front panel keys to select the Peak Current display page
2. Press "P" and ">>" keys together and hold for 5 seconds

Resetting the Peak Rolling Demand
The Peak Rolling Demand (I, Peak V, or kW MD) reading may be simultaneously reset to zero using the front panel keys. To reset the Peak Rolling Demand:

1. Use the front panel keys to select the Peak (V, I, or kW) Rolling Demand display page
2. Press "P" and ">>" keys together and hold for 5 seconds

Display Configuration

The PPM has a wide range of display views. The default views are scrolling pages showing PF, Volts, and Amps on each phase. To cycle to a specific page (as listed in Table 2), repeatedly press and hold the appropriate button until the PPM displays the correct page. For current measurements, press and hold the "I" button; for voltage measurements, press and hold the "V" button; for power/energy measurements, press and hold the "P" button. To return to the default scrolling pages press and hold the ">>" button.

Table 2. *PPM Display Menus*

I	V	P	>>
Phase Currents Peak Hold Currents Neutral Current Ampere Demand Peak Ampere Dem.	Phase Voltages Line-Line Voltages Peak Hold Voltages Voltage Demand Peak Voltage Dem.	System PF, Hz, W System PF, Hz, VA System PF, Hz, var Phase Watts Phase VA Phase var Peak MD, Rolling MD, kW Wh Register VAh Register Total varh Register Inductive varh Register Capacitive varh Register	Phase 1, PF, V, I Phase 2, PF, V, I Phase 3, PF, V, I

Display Descriptions

Current

Phase Currents
Instantaneous true rms current on phases 1, 2, and 3, scaled by user programmable CT primary.

Peak Hold Currents
The largest reading of phase 1, 2, and 3 currents (above) individually recorded since the last reset.

Balance Current
The true rms sum of the three instantaneous current waveforms scaled as phase current (above). This is equivalent to neutral current in a three phase, 4-wire system.

Ampere Demand
Maximum Demand (MD) based on rolling averages of per-phase Amps. User programmable sub-period 10s to 2500s. Average based on 10 sub-period values (1s to 250s). Display updated at the end of each sub-period.

Peak Ampere Demand
The largest reading of per-phase Ampere Demand values (above) recorded since the last reset.

Voltage

Phase Voltages
Instantaneous true rms voltages on phases 1, 2, and 3 with respect to neutral. These readings are scaled by user programmable PT primary.

Line-Line Voltages
Instantaneous true rms line to line voltages scaled by user programmable PT primary.
1 = Line1 - Line2
2 = Line2 - Line3
3 = Line3 - Line1

Peak Hold Voltages
The largest instantaneous readings of phase voltages (above) individually recorded since last reset.

Voltage Demand
Maximum Demand (MD) based on rolling averages of per-phase Volts. User programmable sub-period 10s to 2500s. Average based on 10 sub-period values (1s to 250s). Display updated at the end of each sub-period.

Peak Voltage Demand
The largest reading of per-phase Voltage Demand (above) recorded since the last reset.

Power

System PF, Hz, W
1 = Three phase Power Factor ("-" denotes capacitive).
2 = Frequency measured on phase 1 voltage.
3 = Three phase instantaneous Watts calculated as $W_1 + W_2 + W_3$.

System PF, Hz, VA
1 = Three phase Power Factor ("-" denotes capacitive).
2 = Frequency measured on phase 1 voltage.
3 = Three phase instantaneous VA calculated as $VA_1 + VA_2 + VA_3$.

System PF, Hz, VAR
1 = Three phase Power Factor ("-" denotes capacitive).
2 = Frequency measured on phase 1 voltage.
3 = Three phase instantaneous var calculated as $var_1 + var_2 + var_3$.

Phase Watts
Instantaneous true rms Watts on phases 1, 2, and 3, scaled by user programmable CT and PT values.

Phase VA
Per phase instantaneous VA calculated as:
$VA_1 = V_1 \times I_1$
$VA_2 = V_2 \times I_2$
$VA_3 = V_3 \times I_3$
Where V_n and I_n are rms values.

Phase var
Per phase instantaneous var calculated as:
$Var_1 = \sqrt{(VA_1^2 - W_1^2)}$
$Var_2 = \sqrt{(VA_2^2 - W_2^2)}$
$Var_3 = \sqrt{(VA_3^2 - W_3^2)}$
Capacitive var shown as negative.

kW Rolling Maximum Demand
Maximum Demand (MD) based on rolling average of system kW.
1 = Peak kW MD (largest since last reset).
2 = Current period kW MD.
3 = Instantaneous kW.

Wh Register
Systems Watts integrated over time to give accumulating, import, watt-hours.

VAh Register
System VA integrated over time to give accumulating, import, volt-ampere-hours.

Total varh Register
The absolute sum of Inductive + Capacitive varh.

Inductive varh Register
System var integrated over time is accumulated in this register while the load measured is inductive.

Capacitive varh Register
System var integrated over time is accumulated in this register while the load measured is capacitive.

Scrolling Display

Phase 1 PF, Volts, and Amps
Phase 1 PF ("-" denotes capacitive).
Phase 1 Voltage (scaled as above).
Phase 1 Current (scaled as above).

Phase 2 PF, Volts, and Amps
Phase 2 PF ("-" denotes capacitive).
Phase 2 Voltage (scaled as above).
Phase 2 Current (scaled as above).

Phase 3 PF, Volts, and Amps
Phase 3 PF ("-" denotes capacitive).
Phase 3 Voltage (scaled as above).
Phase 3 Current (scaled as above).

Maintenance

Moore Industries suggests a quick check for terminal tightness and general unit condition every 6-8 months. The meter may be cleaned by wiping lightly with a soft cloth. Do not use solvents or cleaning agents. All inputs and supplies must be isolated before cleaning any part of the equipment.

Customer Support

Moore Industries is recognized as the industry leader in delivering top quality to its customers in products and services. We perform a battery of stringent quality assurance checks on every unit we ship. If any Moore Industries product fails to perform up to rated specifications, call us for help. Factory phone numbers are listed on the back cover of this manual.

If problems involve a particular PPM, there are several pieces of information that can be gathered before you call the factory that will help our staff get the answers you need in the shortest time possible. For the fastest service, gather the complete model and serial number of the problem unit and the job number of the original sale.

Appendix A: Programming the Modbus (–MBR option)

The –MBR option provides communications to external systems through either a RS-422 or a RS-485 cable. See Figures 7 and 8 for a description of how to connect each type of cable to the PPM. Each meter on a Modbus network must be assigned a unique address between 1 and 247. This is carried out in configuration mode as described in "Setting the Meter Address" on page 11. If two or more meters in a network have the same address, data on the network will be corrupted and communication will fail.

The following information will aid you in programming the PPM (–MBR).

RTU Transmission Mode

The RTU (Remote Terminal Unit) mode is used by the PPM because it provides the most efficient throughput of data at any particular baud rate. In RTU mode, the start and end of each message is marked by a silent period of at least 3.5 character periods.

Table 3. *PPM Transmission Framing*

Start	Address	Function	Data	CRC	End
Silent Period	8-Bits	8-Bits	n x 8-Bits	16-Bits	Silent Period

The host (PC) initiates all transactions. Slave devices monitor the network, accepting messages framed by silent periods and determined to be error-free.

The function code is a command telling the PPM what type of operation to perform. The PPM will respond to any of the five Modbus codes below.

Table 4. *PPM Function Codes*

Function Code	Operation	Broadcast
03	Read Multiple Registers	No
04	Read Multiple Registers	No
06	Preset A Single Register	Yes
08	Loop Back Diagnostic	No
16	Preset Multiple Registers	Yes

CRC Error Checking

A 16-bit CRC (Cyclic Redundancy Check) field is tagged on to the end of all messages. Use the CRC to reduce the effects of bit errors in noisy environments by checking the validity of the entire message. The meter will not reply to commands with an invalid CRC, and the host should retransmit the command.

Modbus Addresses & Modbus PLC's

The Modbus addresses listed in Tables 5-11 apply to those programming a PPM using any Modbus system. However, some PLC's supporting Modbus protocol differ from standard Modbus specifications.

Modbus PLC's may (or may not) modify the Modbus address by subtracting one from the number before sending it to the PPM. This is most common in PLC's configured specifically for accessing Modicon PLC register spaces using the Modbus communications protocol. If this occurs, correct the error by adding one to the Modbus address listed in the table (i.e., Energy Scale High would change from 512 to 513).

Data Groups

Data in the (–MBR) is arranged in several groups for convenience. Data in each group is pointed to in a Modbus command by two consecutive data address bytes. The first byte defines the group number and the second byte the offset of the data in the group. For example, 'address 2, 1' would access Group 2, Entry 1 (3-Phase kWh). The Modbus standard defines data addresses using a 16-bit integer.

A Modbus integer may be calculated as:
Modbus Address = (256 x Group#) + Group Offset.

Integer Types

Three types of integers are contained in the groups: Signed, Unsigned, and Unsigned Long Integers. With each integer type, the most significant byte is always transmitted first.

Signed integers are 16-bit values transmitted as two 8-bit bytes. They range from -32,767 to +32,767, although some registers have a limited range of acceptable values. The most significant bit defines the sign, with zero indicating positive values.

Unsigned integers are 16-bit values transmitted as two 8-bit bytes. They range from 0 to 65,535, although some registers have a limited range of acceptable values.

Unsigned long integers are 32-bit values transmitted as four 8-bit bytes. These values vary in the range of 0 to 4,294,967,295 although the energy registers in the PPM are limited to the range of 0-999,999.

Function Codes

Writing to Energy Registers

Function 6 or 16 may be used to write to the energy registers in Group 2. Upper integers have a maximum write value of 0x00F, preventing out of range data from being sent to the PPM. To be valid, command 16 must send an even number of integers (2 individual integers per unsigned long integer) starting at an even address in Group 2.

***Table 5.** PPM Group 2: Accumulated Energy Readings*

Offset	Address	Contents	Format	Bytes	Words	Access
0	512	Energy Scale Hi	Unsigned Long	4	2	Read Only
1	513	Energy Scale Lo				
2	514	kWh Hi	Unsigned Long	4	2	Read/Write
3	515	kWh Lo				
4	516	kVAh Hi	Unsigned Long	4	2	Read/Write
5	517	kVAh Lo				
6	518	kvarh (Ind) Hi	Unsigned Long	4	2	Read/Write
7	519	kvarh (Ind) Lo				
8	520	kvarh (Cap) Hi	Unsigned Long	4	2	Read/Write
9	521	kvarh (Cap) Lo				

Energy Scaling

Energy readings are stored as unsigned long integer values. A single scaling factor is provided to enable conversion of the raw data to real numbers in basic unit form (Wh, VAh, or varh).

To convert raw data to real numbers:

$$E = L \times 10^{(K-3)}$$

Where: L = Long Integer Number
K = Energy Scaling Factor
E = Scaled Energy Result

Instantaneous/Peak Values

Instantaneous and peak measurements available for display on a PPM are sorted in Groups 11-13 as signed integers. Negative values are used to represent capacitive loads.

Scaling Instantaneous/Peak Values

Scaling factors are provided to enable conversion of the raw data to real numbers in basic unit form (amps, volts, watts, VA, or var). These scaling factors are constant values calculated in the PPM as a function of CT and PT Primary programming.

To convert raw data to real numbers:

$$R = I \times 10^{(K-3)}$$

I = Integer Number
K = Relevant Scaling Factor
R = Real Number Result

***Table 6.** PPM Group 11: Instantaneous Meter Values*

Offset	Address	Contents	Format	Bytes	Words	Access
0	2816	kW 3-Ph	Signed Integer	2	1	Read Only[4]
1	2817	kVA 3-Ph	Signed Integer	2	1	Read Only[4]
2	2818	kvar 3-Ph	Signed Integer	2	1	Read Only[4]
3	2819	PF 3-Ph	Signed Integer	2	1	Read Only
4	2820	Frequency	Signed Integer	2	1	Read Only
5	2821	Phase 1 Volts	Signed Integer	2	1	Read Only[2]
6	2822	Phase 1 Amps	Signed Integer	2	1	Read Only[1]
7	2823	Phase 1 kW	Signed Integer	2	1	Read Only[4]
8	2824	Phase 2 Volts	Signed Integer	2	1	Read Only[2]
9	2825	Phase 2 Amps	Signed Integer	2	1	Read Only[1]
10	2826	Phase 2 kW	Signed Integer	2	1	Read Only[4]
11	2827	Phase 3 Volts	Signed Integer	2	1	Read Only[2]
12	2828	Phase 3 Amps	Signed Integer	2	1	Read Only[1]
13	2829	Phase 3 kW	Signed Integer	2	1	Read Only[4]
14	2830	Phase 1 PF	Signed Integer	2	1	Read Only
15	2831	Phase 2 PF	Signed Integer	2	1	Read Only
16	2832	Phase 3 PF	Signed Integer	2	1	Read Only
17	2833	Ph1-Ph2 Volts	Signed Integer	2	1	Read Only[3]
18	2834	Ph2-Ph3 Volts	Signed Integer	2	1	Read Only[3]
19	2835	Ph3-Ph1 Volts	Signed Integer	2	1	Read Only[3]
20	2836	Neutral Current	Signed Integer	2	1	Read Only[1]
21	2837	Amps Scale	Signed Integer	2	1	Read Only
22	2838	Ph Volts Scale	Signed Integer	2	1	Read Only
23	2839	Ln Volts Scale	Signed Integer	2	1	Read Only
24	2840	Power Scale	Signed Integer	2	1	Read Only

1. Use 'Amps Scale' at Address 2837 to convert to real Amps.
2. Use 'Ph Volts Scale' at Address 2838 to convert to real Volts.
3. Use 'Ln Volts Scale' at Address 2839 to convert to real Volts.
4. Use 'Power Scale' at Address 2840 to convert to real W, VA, or var.

Table 7. PPM Group 12: Additional Instantaneous Values

Offset	Address	Contents	Format	Bytes	Words	Access
0	3072	Phase 1 kVA	Signed Integer	2	1	Read[4]
1	3073	Phase 2 kVA	Signed Integer	2	1	Read[4]
2	3074	Phase 3 kVA	Signed Integer	2	1	Read[4]
3	3075	Phase 1 kvar	Signed Integer	2	1	Read[4]
4	3076	Phase 2 kvar	Signed Integer	2	1	Read[4]
5	3077	Phase 3 kvar	Signed Integer	2	1	Read[4]

4. Use 'Power Scale' at Address 2840 to convert to real W, VA, or var.

Table 8. PPM Group 13: Peak Values

Offset	Address	Contents	Format	Bytes	Words	Access
0	3328	Peak Hold I1	Signed Integer	2	1	Read/Write[5]
1	3329	Peak Hold I2	Signed Integer	2	1	Read/Write[5]
2	3330	Peak Hold I3	Signed Integer	2	1	Read/Write[5]
3	3331	Peak Hold V1	Signed Integer	2	1	Read/Write[6]
4	3332	Peak Hold V2	Signed Integer	2	1	Read/Write[6]
5	3333	Peak Hold V3	Signed Integer	2	1	Read/Write[6]
6	3334	Peak kW MD	Signed Integer	2	1	Read/Write[7,8]
7	3335	MD Period	Signed Integer	2	1	Read/Write[8]
8	3336	kW MD	Signed Integer	2	1	Read Only[7]

5. Use 'Amps Scale' at Address 2837 to convert to real peak hold Amps.
6. Use 'Ph Volts Scale' at Address 2838 to convert to real peak hold Volts.
7. Use 'Power Scale' at Address 2840 to convert to real W.
   kW MD and Peak kW MD are scaled as 3-phase kW/10.
8. Peak kW MD & MD Period may NOT be written using Function Code 16 (see page 10).

Table 9. PPM Group 14: Meter Setup

Offset	Address	Contents	Format	Bytes	Words	Access
0	3584	CT Primary	Unsigned Integer	2	1	Read/Write[9]
1	3585	PT Primary	Unsigned Integer	2	1	Read/Write[9]
2	3586	Pulse 1 Rate	Unsigned Integer	2	1	Read/Write[9]
3	3587	Pulse 2 Rate	Unsigned Integer	2	1	Read/Write[9]
4	3588	Baud Rate	Unsigned Integer	2	1	Read/Write[9]
5	3589	Modbus ID	Unsigned Integer	2	1	Read/Write[9]
6	3590	Meter Model	Unsigned Integer	2	1	Read Only
7	3591	Meter Type	Unsigned Integer	2	1	Read Only
8	3592	Meter Software	Unsigned Integer	2	1	Read Only
9	3593	V/I MD Period	Unsigned Integer		1	Read/Write[9]

9. Values in Group 14 may not be written using Function Code 16 (see page 10).

Meter Setup Values

The PPM's setup values are stored in Group 14. The list below defines each of the values in the table:

CT Primary (5-6,500A) CT Primary as displayed during meter setup.

PT Primary (60-50,000V) PT Primary as
displayed during meter setup.

Pulse 1 Rate (1-255) Number of counts of kWh register per pulse.

Pulse 2 Rate (1-255) Number of counts of kvarh register per pulse.

Baud Rate (48, 96, or 192) RS-485/-422 baud rates of 4800, 9600, or 19200.

Modbus ID (1-247) Modbus meter address.

Meter Model (PPM = 100) A constant identifying the product range.

Meter Type The PPM is considered a type 4 meter.

Meter Software Hexadecimal byte defines the PPM software version (e.g. 0x0103 = Version 103).

V/I MD Period (1-255) Time period (seconds/10) for Current and Voltage Demand.

Table 10. PPM Group 15: Peak Current and Voltage Demand

Offset	Address	Contents	Format	Bytes	Words	Access
0	3840	Peak I1 MD	Unsigned Integer	2	1	Read/Write[5]
1	3841	Peak I2 MD	Unsigned Integer	2	1	Read/Write[5]
2	3842	Peak I3 MD	Unsigned Integer	2	1	Read/Write[5]
3	3843	Peak V1 MD	Unsigned Integer	2	1	Read/Write[6]
4	3844	Peak V2 MD	Unsigned Integer	2	1	Read/Write[6]
5	3845	Peak V3 MD	Unsigned Integer	2	1	Read/Write[6]

5. Use 'Amps Scale' at Address 2837 to convert to real peak Amp demand.
6. Use 'Ph Volts Scale' at Address 2838 to convert to real peak Volt demand.

Table 11. PPM Group 16: Current and Voltage Demand

Offset	Address	Contents	Format	Bytes	Words	Access
0	4096	I1 Demand	Unsigned Integer	2	1	Read Only[5]
1	4097	I2 Demand	Unsigned Integer	2	1	Read Only[5]
2	4098	I3 Demand	Unsigned Integer	2	1	Read Only[5]
3	4099	V1 Demand	Unsigned Integer	2	1	Read Only[6]
4	4100	V2 Demand	Unsigned Integer	2	1	Read Only[6]
5	4101	V3 Demand	Unsigned Integer	2	1	Read Only[6]

5. Use 'Amps Scale' at Address 2837 to convert to real Amp demand.
6. Use 'Ph Volts Scale' at Address 2838 to convert to real Volt demand.

Table 12. PPM Exception Codes

Code	Meaning
1	Data out of range
2	Group and/or offset out of range for this function
3	Odd number of integers written to long integer register
9	Communications from (–MBR) to PPM have failed

Exception Function Code

In an exception response, the data field is used to return the type of error that occurred as an exception code (above).

Connecting the Modbus unit to the PPM

To connect the **–MBR** module to the PPM:

1. Isolate all inputs and outputs to the PPM.
2. Check the ratings on the module and PPM to ensure compatibility.
3. Use a sharp knife to remove the cutout section from the rear of the PPM. Ensure that the knife blade does not penetrate >3mm (0.12 in).
4. Insert the **–MBR** module into the slot on the back of the PPM.
5. Slide the **–MBR** module in until all four mounting lugs 'click' into place. When the PPM is powered on, it will confirm that it is correctly connected by permanently illuminating the front panel "Options" LED.

RS-422 Connection

Shielded 2x twisted-pair cable is recommended in order to minimize signal errors due to noise. For optimum performance, use an optional fifth wire connecting the common (0V). The first pair should be used for RXA & RXB and the second for TXA & TXB. The cable shield should be connected to the connector housing (ground) at the host only. To reduce cable reflections over long distances, RS-422 systems require line termination. Fit two 120Ω resistors as shown in Figure 10. One resistor should be fitted at the Host input/output buffer and the other at the buffer of the most remote device.

RS-485 Connection

Shielded twisted-pair cable is recommended in order to minimize signal errors due to noise. For optimum performance, use an optional third wire connecting the common (0V). The cable screen should be connected to the connector housing (ground) at the host only. To reduce cable reflections over long distances, RS-485 systems require line termination. Fit two 120Ω resistors as shown in Figure 11. One resistor should be fitted at the Host input/output buffer and the other at the buffer of the most remote device.

Figure 10. *RS-422 connection diagram*

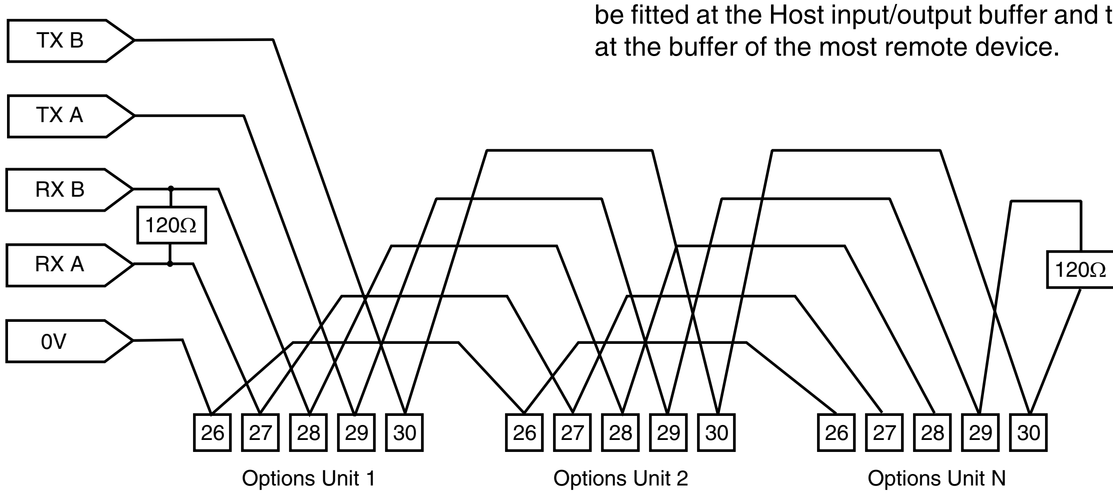
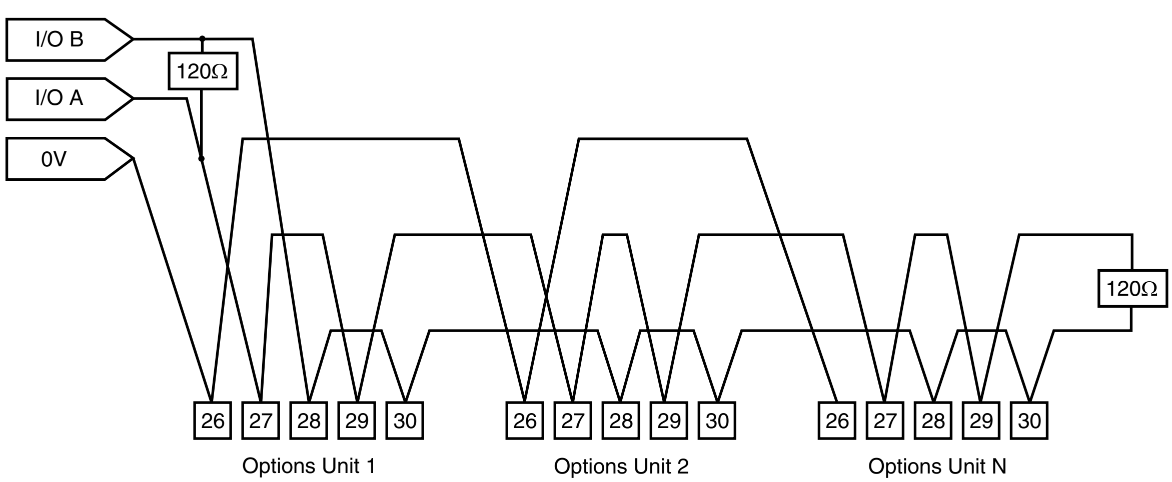


Figure 11. *RS-485 connection diagram*



Appendix B: Configuring the Analog Output Module (–4AO option)

The –4AO option module adds four dc analog outputs to any standard PPM. All outputs are isolated from the metering elements to provide safe connection to external systems. The device uses a high-speed microprocessor to extract information from the meter and a precision digital to analog converter to produce the output signals.

The -4AO option provides four analog outputs (4-20mA) that can be configured as "source" or "sink." This allows connection to PLCs and other equipment fitted with a suitable interface. Analog Output systems are commonly used where the signals require transmission over long distances.

Connecting the –AO Module

To connect the Analog Output Module to the PPM:

1. Isolate all inputs/outputs to the PPM.
2. Check the ratings on the options module and meter to ensure compatibility.
3. Use a sharp knife to remove the cut-out section from the rear of the PPM. Ensure the knife blade does not penetrate > 3mm.
4. Insert the Option Module into the slot on the rear of the meter.

Slide the Module fully home until all four mounting lugs ‘click’ into place.

Communicating with the Analog Output Module

Once connected and powered up, the PPM and Analog Output Module will begin communicating with each other automatically. All readings taken by the meter are sent to the option module each second along with all meter program settings. The option module replies with confirmation of the values. The PPM will confirm that it is correctly connected to an Option Module by illuminating the *Option-On* LED on its front panel. If, for any reason, the local communications fails, this LED will switch off.

Setting Output Parameters

Each of the four analog output channels may be setup to provide a 4-20mA signal in proportion to one of 16 selected parameters measured by the PPM to which it is attached. Selection is carried out using DIP switches located on the underside of the options module, as shown below.

Figure 12. *Analog Output Dip Switch Location*

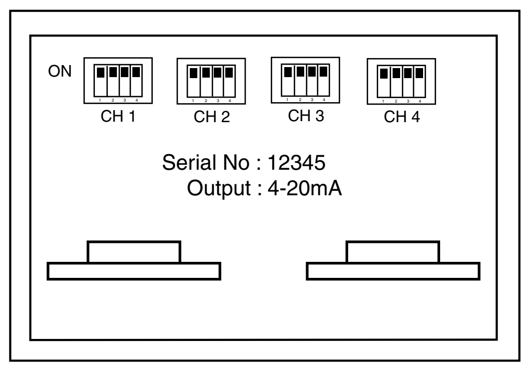


Table 13. Analog Output Dip Switch Table

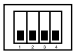
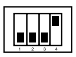
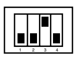
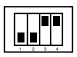
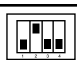
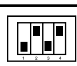
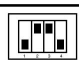
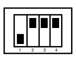
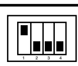
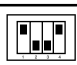
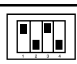
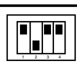
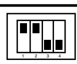
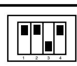
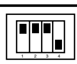
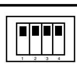
No.	DIP SW	CHANNEL 1	CHANNEL 2	CHANNEL 3	CHANNEL 4
0	ON 	V_1	V_1	V_1	Sys P
1	ON 	V_2	V_2	V_2	2 x Sys P
2	ON 	V_3	V_3	V_3	Sys S
3	ON 	I_1	I_1	I_1	2 x Sys S
4	ON 	I_2	I_2	I_2	2 x (ABS) Sys Q
5	ON 	I_3	I_3	I_3	± Sys Q
6	ON 	P_1	P_2	P_3	ABS (Sys PF)
7	ON 	ABS (PF_1)	ABS (PF_2)	ABS (PF_3)	± Sys PF
8	ON 	± PF_1	± PF_2	± PF_3	Freq (50Hz ±5Hz)
9	ON 	ABS (Sys PF)	ABS (Sys PF)	ABS (Sys PF)	Freq (60Hz ±5Hz)
10	ON 	Sys P	Sys P	Sys P	kW MD
11	ON 	Sys S	Sys S	Sys S	In
12	ON 	ABS (Sys Q)	ABS (Sys Q)	ABS (Sys Q)	5 x In
13	ON 	± Sys Q	± Sys Q	± Sys Q	Ave Volts
14	ON 	2 x I_1	2 x I_2	2 x I_3	Ave Amps
15	ON 	V_1 ± 12.5%	V_2 ± 12.5%	V_3 ± 12.5%	**!Test Mode!**

Table 14. Analog Output Parameter Representation Table

SELECTED PARAMETER	DESCRIPTION	4-20mA REPRESENTS
V_1, V_2, V_3	Phase 1-3 Voltage 120% FS = 20mA	4mA = 0.0V 12mA = 60% FS Volts 20mA = 120% FS Volts
V_1 ± 12.5% V_2 ± 12.5% V_3 ± 12.5%	Phase 1-3, ±12.5% Voltage Deviation From Normal	4mA = 87.5% FS Volts 12mA = 100% FS Volts 20mA = 112.5% FS Volts
Ave Volts	$(V_1 + V_2 + V_3) / 3$ 120% FS = 20mA	4mA = 0.0V 12mA = 60% FS Volts 20mA = 120% FS Volts
I_1, I_2, I_3	Phase 1-3 Current	4mA = 0.0A 12mA = 50% FS Amps 20mA = 100% FS Amps
2 x I_1 2 x I_2 2 x I_3	Phase 1-3 Current Scaled x 2	4mA = 0.0A 12mA = 25% FS Amps 20mA = 50% FS Amps
Ave Amps	$(I_1 + I_2 + I_3) / 3$	4mA = 0.0A 12mA = 50% FS Amps 20mA = 100% FS Amps
P_1, P_2, P_3	Phase 1-3 kW	4mA = 0.0kW 12mA = 50% FS kW 20mA = 100% FS kW
Sys P (and kW MD)	System kW (and kW Max Demand)	4mA = 0.0kW 12mA = 50% FS kW 20mA = 100% FS kW
2 x Sys P	System kW Scaled x 2	4mA = 0.0kW 12mA = 25% FS kW 20mA = 50% FS kW
(ABS) Sys Q	Absolute System kVar	4mA = 0.0kvar 12mA = 50% FS kvar 20mA = 100% FS kvar
± Sys Q	Signed System kvar	4mA = 100% kvar (cap) 12mA = 0% kvar 20mA = 100% kvar (ind)
2 x (Abs) Sys Q	Absolute System kvar Scaled x 2	4mA = 0.0kVA 12mA = 25% FS kvar 20mA = 50% FS kvar
Sys S	System kVA	4mA = 0.0kVA 12mA = 50% FS kVA 20mA = 100% FS kVA
2 x Sys S	Absolute System kVA Scaled x 2	4mA = 0.0kVA 12mA = 25% FS kVA 20mA = 50% FS kVA
Frequency (50Hz ±5Hz)	Frequency Deviation From 50Hz	4mA = 45Hz 12mA = 50Hz 20mA = 55Hz
Frequency (60Hz ±5Hz)	Frequency Deviation From 60Hz	4mA = 55Hz 12mA = 60Hz 20mA = 65Hz
I_n	Neutral Current	4mA = 0.0A 12mA = 50% FS Amps 20mA = 100% FS Amps
5 x I_n	Neutral Current Scaled x 5	4mA = 0.0A 12mA = 10% FS Amps 20mA = 20% FS Amps

Test Mode

Test Mode is provided for use during commissioning only. The Test Led situated on the rear of the options module will flash rapidly during test mode.

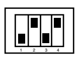
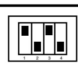
Warning:

Isolate all inputs to the PPM before adding/removing an options module.

During Test Mode, all channels provide test output levels irrespective of PPM measurements. To enter Test Mode, change the option module's dip switch to on Channel 4, number 15, as seen in Table 13.

Test Mode allows the commissioning engineer to test external systems, connected to the PPM –4AO Option Module, without the need to feed three phase measurement signals into the PPM. The –4AO option module must be connected to a working PPM during Test Mode.

Table 15. *Analog Output Test Mode Table*

No.	DIP SW	CHANNEL 1	CHANNEL 2	CHANNEL 3	CHANNEL 4
5	ON 	4.0mA	4.0mA	4.0mA	20.0mA
10	ON 	20.0mA	20.0mA	20.0mA	20.0mA
	OTHER	12.0mA	12.0mA	12.0mA	20.0mA

Connecting to the Analog Output Module (–4AO)

The method of connecting the output of the -4AO module will vary depending on whether you wish the module to provide (source) the loop current or sink the loop current. Pin 27 provides the excitation voltage for use when the module is sourcing the loop current. Pin 32 is the 0v reference when a separate loop power supply is used (sink).

Figure 13. *Analog Output Sink (Channel 3) Connection Diagram*

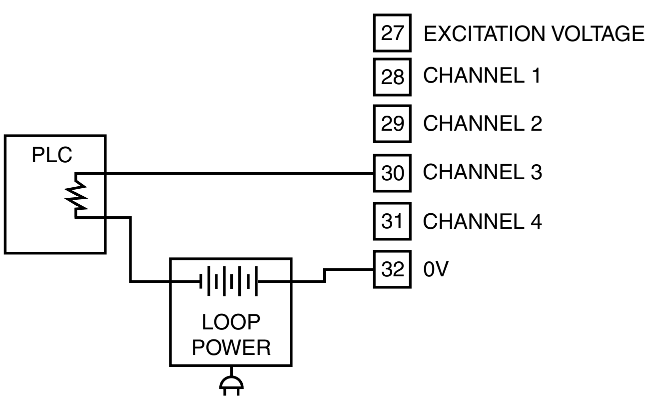
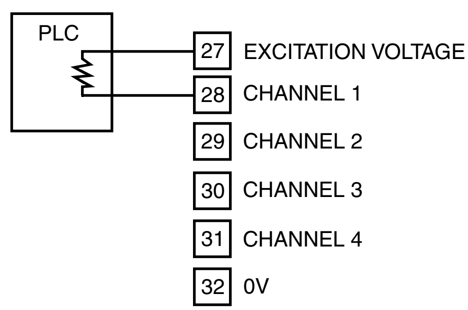


Figure 14. *Analog Output Source (Channel 1) Connection Diagram*



RETURN PROCEDURES

To return equipment to Moore Industries for repair, follow these four steps:

1. Call Moore Industries and request a Returned Material Authorization (RMA) number.

   Warranty Repair –
   If you are unsure if your unit is still under warranty, we can use the unit's serial number to verify the warranty status for you over the phone. Be sure to include the RMA number on all documentation.

   Non-Warranty Repair –
   If your unit is out of warranty, be prepared to give us a Purchase Order number when you call. In most cases, we will be able to quote you the repair costs at that time. The repair price you are quoted will be a "Not To Exceed" price, which means that the actual repair costs may be less than the quote. Be sure to include the RMA number on all documentation.

2. Provide us with the following documentation:
   a) A note listing the symptoms that indicate the unit needs repair
   b) Complete shipping information for return of the equipment after repair
   c) The name and phone number of the person to contact if questions arise at the factory

3. Use sufficient packing material and carefully pack the equipment in a sturdy shipping container.

4. Ship the equipment to the Moore Industries location nearest you.

The returned equipment will be inspected and tested at the factory. A Moore Industries representative will contact the person designated on your documentation if more information is needed. The repaired equipment, or its replacement, will be returned to you in accordance with the shipping instructions furnished in your documentation.

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ANY CAUSE OF ACTION FOR BREACH OF ANY WARRANTY BY THE COMPANY SHALL BE BARRED UNLESS THE COMPANY RECEIVES FROM THE BUYER A WRITTEN NOTICE OF THE ALLEGED DEFECT OR BREACH WITHIN TEN DAYS FROM THE EARLIEST DATE ON WHICH THE BUYER COULD REASONABLY HAVE DISCOVERED THE ALLEGED DEFECT OR BREACH, AND NO ACTION FOR THE BREACH OF ANY WARRANTY SHALL BE COMMENCED BY THE BUYER ANY LATER THAN TWELVE MONTHS FROM THE EARLIEST DATE ON WHICH THE BUYER COULD REASONABLY HAVE DISCOVERED THE ALLEGED DEFECT OR BREACH.

RETURN POLICY

For a period of thirty-six (36) months from the date of shipment, and under normal conditions of use and service, Moore Industries ("The Company") will at its option replace, repair or refund the purchase price for any of its manufactured products found, upon return to the Company (transportation charges prepaid and otherwise in accordance with the return procedures established by The Company), to be defective in material or workmanship. This policy extends to the original Buyer only and not to Buyer's customers or the users of Buyer's products, unless Buyer is an engineering contractor in which case the policy shall extend to Buyer's immediate customer only. This policy shall not apply if the product has been subject to alteration, misuse, accident, neglect or improper application, installation, or operation. THE COMPANY SHALL IN NO EVENT BE LIABLE FOR ANY INCIDENTAL OR CONSEQUENTIAL DAMAGES.

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