63230-507-201A1
03/2007

Instruction Bulletin

Power Meter 750
Reference Manual

Retain for future use.

Schneider Electric

HAZARD CATEGORIES AND SPECIAL SYMBOLS

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

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

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

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

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

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

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

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

PLEASE NOTE

Electrical equipment should be installed, operated, serviced, and maintained only by qualified personnel. No responsibility is assumed by Schneider Electric for any consequences arising out of the use of this material.

FCC NOTICE

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.

Consult the dealer or an experienced radio/TV technician for help.

SECTION 1— INTRODUCTION

POWER METER HARDWARE

Figure 1–1 below shows the parts of the Power Meter 750. Table 1–1 describes the parts.

Figure 1–1: Parts of the Power Meter 750

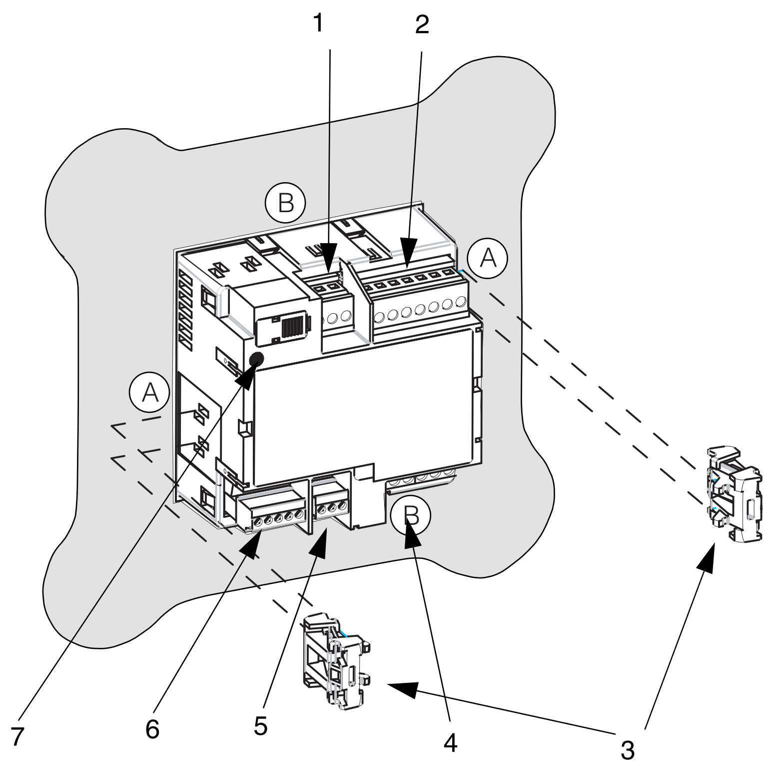


Table 1–1: Parts of the Power Meter

Number	Part	Description
1	Control power supply connector	Connection for control power to the power meter.
2	Voltage inputs	Voltage metering connections.
3	Retainer clips	Used to hold power meter in place.
4	Current inputs	Current metering connections.
5	RS485 port (COM1)	The RS485 port is used for communications with a monitoring and control system. This port can be daisy-chained to multiple devices.
6	I/O	Digital inputs (S1 and S2) connections; digital output connection.
7	LED	Steady = OFF/ON. Flashing = communications indicator.
A	Retainer slots, position A	Use for installation locations thinner than 3 mm (1/8 in.).
B	Retainer slots, position B	Use for installation locations 3 - 6 mm (1/8 to 1/4 in.).

Power Meter Parts and Accessories

Table 1–2: Power Meter Parts and Accessories

Description	Model Number
Power Meter with Integrated Display	PM750 PM750MG

Box Contents

- One (1) power meter
- Two (2) retainer clips
- One (1) installation sheet
- One (1) RS485 Terminator (MCT2W)

FIRMWARE

This instruction bulletin is written to be used with firmware version 3.000 and later. See “View the Meter Information” on page 12 for instructions on how to determine the firmware version.

SECTION 2— SAFETY PRECAUTIONS

BEFORE YOU BEGIN

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

⚠ DANGER

HAZARD OF ELECTRIC SHOCK, EXPLOSION, OR ARC FLASH

- Apply appropriate personal protective equipment (PPE) and follow safe electrical work practices. In the USA, see NFPA 70E.
- Only qualified electrical workers should install this equipment. Such work should be performed only after reading this entire set of instructions.
- NEVER work alone.
- Before performing visual inspections, tests, or maintenance on this equipment, disconnect all sources of electric power. Assume that all circuits are live until they have been completely de-energized, tested, and tagged. Pay particular attention to the design of the power system. Consider all sources of power, including the possibility of backfeeding.
- Turn off all power supplying the power meter and the equipment in which it is installed before working on it.
- Always use a properly rated voltage sensing device to confirm that all power is off.
- Before closing all covers and doors, carefully inspect the work area for tools and objects that may have been left inside the equipment.
- Use caution while removing or installing panels so that they do not extend into the energized bus; avoid handling the panels, which could cause personal injury.
- The successful operation of this equipment depends upon proper handling, installation, and operation. Neglecting fundamental installation requirements may lead to personal injury as well as damage to electrical equipment or other property.
- NEVER bypass external fusing.
- NEVER short the secondary of a PT.
- NEVER open circuit a CT; use the shorting block to short circuit the leads of the CT before removing the connection from the power meter.
- Before performing Dielectric (Hi-Pot) or Megger testing on any equipment in which the power meter is installed, disconnect all input and output wires to the power meter. High voltage testing may damage electronic components contained in the power meter.
- The power meter should be installed in a suitable electrical enclosure.

Failure to follow this instruction will result in death or serious injury

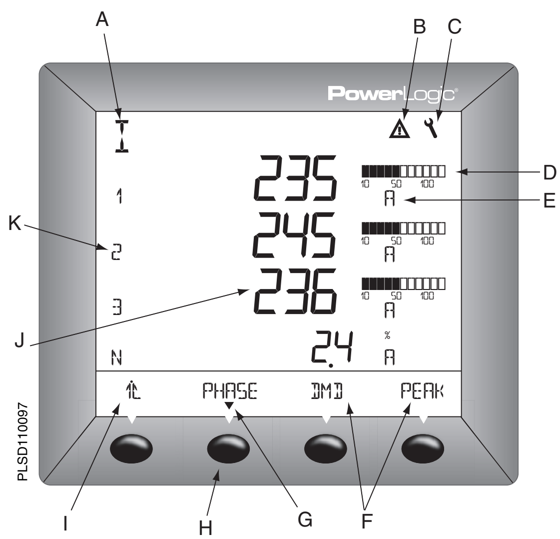
SECTION 3— OPERATION

OPERATING THE DISPLAY

The power meter is equipped with a large, back-lit LCD display. It can display up to five lines of information plus a sixth row of menu options. Figure 3– 1 shows the different parts of the power meter display.

Figure 3– 1: Power Meter Display

A. Type of measurement
B. Alarm indicator
C. Maintenance icon
D. Bar Chart (%)
E. Units
F. Menu items
G. Selected menu indicator
H. Button
I. Return to previous menu
J. Values
K. Phase



How the Buttons Work

The buttons are used to select menu items, display more menu items in a menu list, and return to previous menus. A menu item appears over one of the four buttons. Pressing a button selects the menu item and displays the menu item's screen. When you have reached the highest menu level, a black triangle appears beneath the selected menu item. To return to the previous menu level, press the button below ⮤. To cycle through the menu items in a menu list, press the button below - - - ▸. Table 3– 1 describes the button symbols.

Table 3– 1: Button Symbols

Navigation	
- - - ▸	View more menu items on the current level.
⮤	Return to the previous menu level.
▼	Indicates the menu item is selected and there are no menu levels below the current level.
Change Values	
+	Change values or scroll through the available options. When the end of a range is reached, pressing + again returns to the first value or option.
◂- -	Select the next position in a number.
OK	Move to the next editable field or exit the screen if the last editable field is selected.

NOTE:

- *Each time you read "press" in this manual, press and release the appropriate button beneath a menu item. For example, if you are asked* *to "Press PHASE," you would press and release the button below the PHASE menu item.*

- *Changes are automatically saved and take effect immediately.*

Changing Values

When a value is selected, it flashes to indicate that it can be modified. A value is changed by doing the following:

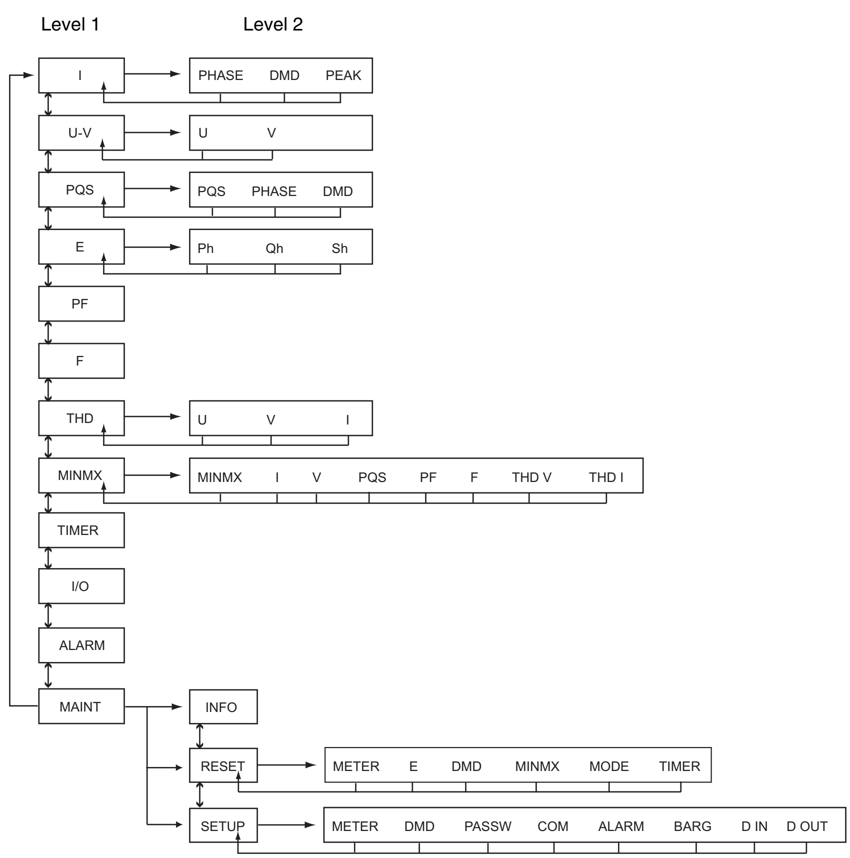
- Press ⁺ or ◂-- to change numbers or scroll through available options.
- If you are entering more than one digit, press ◂--- to move to the next digit in the number.
- To save your changes and move to the next field, press OK.

MENU OVERVIEW

Menu items are displayed below the horizontal line at the bottom of the screen. Figure 3– 2 below shows the menu items of the first two levels of the power meter menu hierarchy. Selecting a Level 1 menu item takes you to the next screen level containing the Level 2 menu items. Some Level 2 items have Level 3 items. The navigation buttons work consistently across all menu levels.

NOTE: The ----▸ is used to scroll through all menu items on a level.

Figure 3– 2: Abbreviated IEC Menu Items



SETTING UP THE POWER METER

The power meter ships with many default values already set up in the meter. These values may be changed by navigating to the appropriate screen and entering new values. Other values may be changed using the Reset function. Use the instructions in the following sections to change values. See “Reset the Power Meter” on page 12 for more information on the Reset function.

NOTE: New values are automatically saved when you exit the screen.

POWER METER SETUP

To begin power meter setup, do the following:

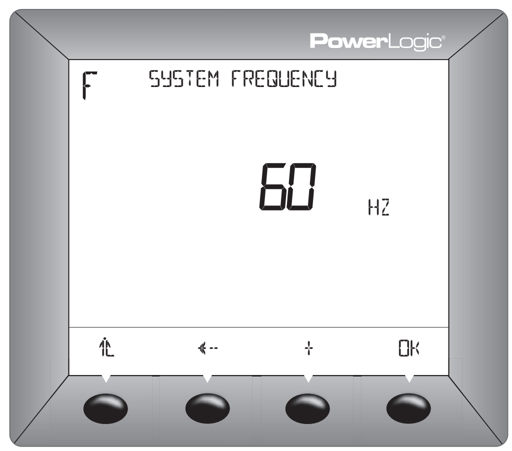
1. Scroll through the menu list at the bottom of the screen until you see MAINT.
2. Press MAINT.
3. Press SETUP.
4. Enter your password.

   NOTE: The default password is 00000. See “Set Up the Passwords” for information on how to change.

Follow the directions in the following sections to set up meter values.

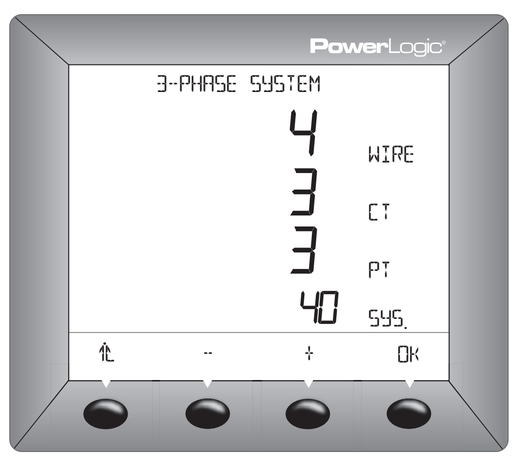
Set Up the System Frequency

1. In SETUP mode, press ⇢ until METER is visible.
2. Press ⇢ until F (system frequency) is visible.
3. Press F.
4. Select the frequency.
5. Press OK to return to the METER SETUP screen.
6. Press ⇑ to return to the SETUP MODE screen.

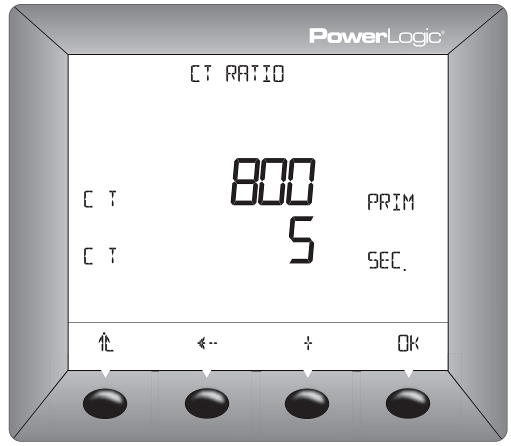


Set Up the Meter System Type

1. In SETUP mode, press ⇢ until METER is visible
2. Press METER.
3. Press ⇢ until SYS (system type) is visible.
4. Press SYS.
5. Select the SYS (system type): 10, 11, 12, 30, 31, 32, 40, 42, 44.
6. Press OK to return to the METER SETUP screen.
7. Press ⇑ to return to the SETUP MODE screen.

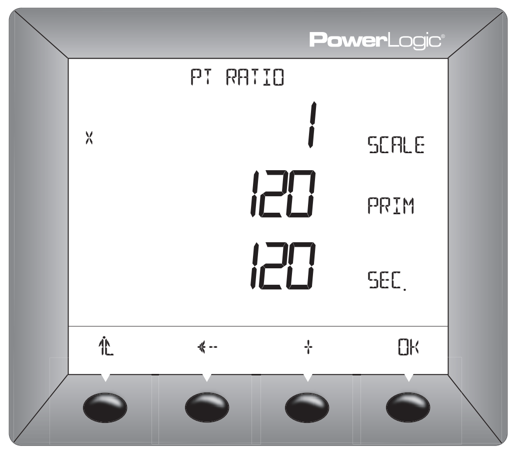


Set Up CTs



1. In SETUP mode, press ----▸ until METER is visible.
2. Press METER.
3. Press CT.
4. Enter the PRIM (primary CT) number.
5. Press OK.
6. Enter the SEC. (secondary CT) number.
7. Press OK to return to the METER SETUP screen.
8. Press ⮤ to return to the SETUP screen.

Set Up PTs



1. In SETUP mode, press ----▸ until METER is visible.
2. Press METER.
3. Press PT.
4. Enter the SCALE value: x1, x10, x100, NO PT (for direct connect).
5. Press OK.
6. Enter the PRIM (primary) value.
7. Press OK.
8. Enter the SEC. (secondary) value.
9. Press OK to return to the METER SETUP screen.
10. Press ⮤ to return to the SETUP MODE screen.

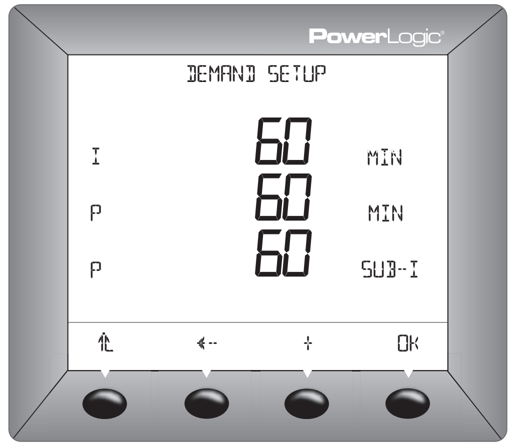
Set Up Demand Current and Power

1. In SETUP mode, press ----▸ until DMD (demand) is visible.
2. Press DMD (demand setup).
3. Enter the MIN (demand interval in minutes) for I (current): 1 to 60.
4. Press OK.
5. Enter the MIN (demand interval in minutes) for P (power): 1 to 60.
6. Press OK.
7. Enter the SUB-I (number of sub-intervals) for P: 1 to 60.
8. Press OK to return to the SETUP MODE screen.

NOTE: The calculation method used for current is Thermal.

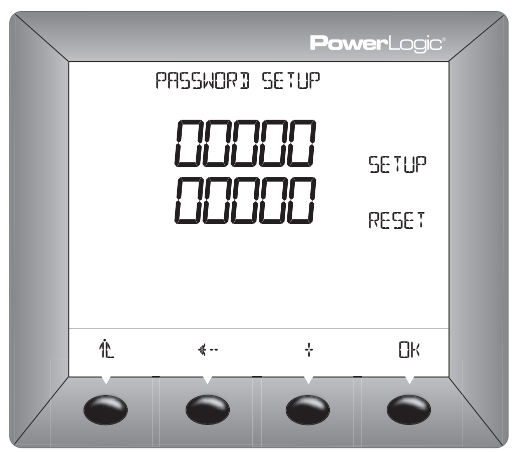
NOTE: The calculation method used for power is based on SUB-I as follows:

- 0 = sliding block
- 1= block
- >1 = rolling block (The SUB-I value must divide evenly into the MIN value. For example, if MIN is 15, SUB-I can be 3, 5, or 15. If you selected 3, you would have 3 sub-intervals at 5 minutes each.



Set Up the Passwords

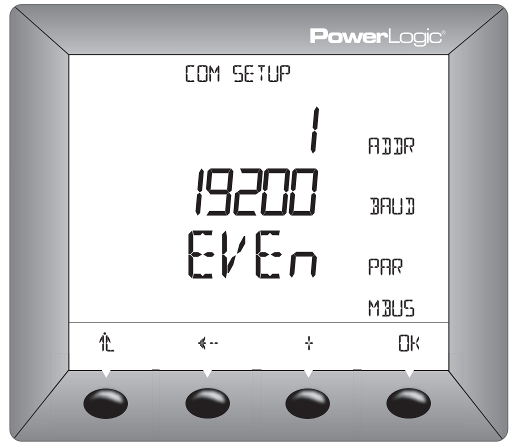
1. In SETUP mode, press ----▸ until PASSW (password) is visible.
2. Press PASSW.
3. Enter the SETUP password.
4. Press OK.
5. Enter the RESET (password to reset the power meter) password.
6. Press OK to return to the SETUP MODE screen.



Set Up Communications

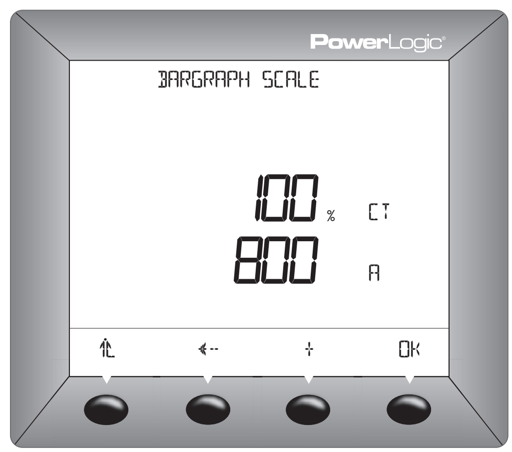
1. In SETUP mode, press ⇢ until COM is visible.
2. Press COM.
3. Enter the ADDR (meter address): 1 to 247.
4. Press OK.
5. Select the BAUD (baud rate): 2400, 4800, 9600, or 19200.
6. Press OK.
7. Select the parity: EVEN, ODD, or NONE.
8. Press OK to return to the SETUP MODE screen.

NOTE: Default values are displayed.



Set Up the Bar Graph Scale

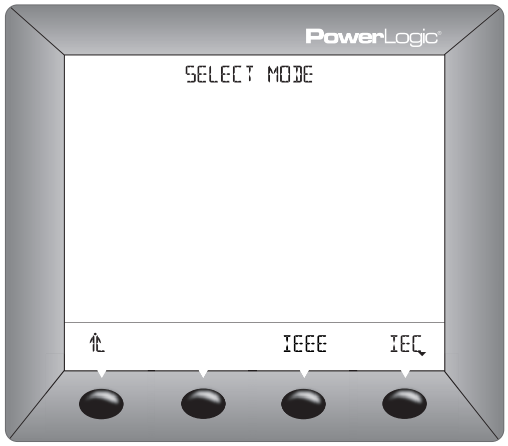
1. In SETUP mode, press ⇢ until BARG is visible.
2. Press BARG.
3. Enter the %CT (percent of CT primary to represent 100 on the bar graph).
4. Press OK to return to the SETUP MODE screen.



Set Up Meter Mode

NOTE: The meter Mode is set up using the RESET menu. Follow the "Power Meter Setup" instructions on page 7 but select RESET instead instead of SETUP. The meter mode is only a visualization mode. It does not change or affect the way the PM750 performs its calculations.

1. In RESET mode, press ----▸ until MODE is visible.
2. Press MODE.
3. Select IEEE or IEC by pressing the corresponding button below the selection. A small triangle is displayed below the current selection.
4. Press ⮤ to return to the RESET MODE screen.



Set Up I/O

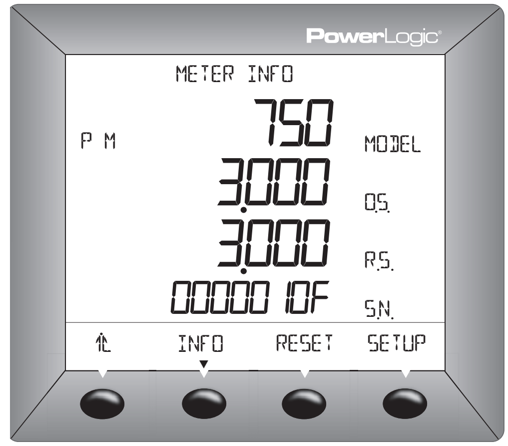
See Section 5 for information on setting up I/O.

Set Up Alarms

See Section 6 for information on setting up alarms.

VIEW THE METER INFORMATION

1. Press ----▸ until MAINT(maintenance) is visible.
2. Press MAINT.
3. Press INFO (meter info).
4. View the meter information (model number, operating system firmware version, reset system firmware version, and power meter serial number).
5. Press ⇮ to return to the MAINTENANCE screen.



RESET THE POWER METER

Meter values can be re-initialized using the Reset function.

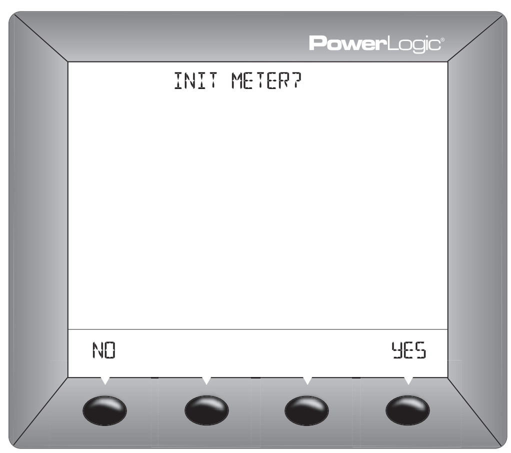
Initializing the Meter

The following values are affected by this Reset:

- Operation Timer
- Energies
- Min Max Values
- Peak Demand
- Output Counter
- Input Counters

To re-initialize the power meter, complete the following steps:

1. From the MAINTENANCE screen, press RESET.
2. Enter the RESET password (00000 is the default).
3. Press OK.
4. Press METER.
5. Press NO or YES.
6. Press ⇮ to return to the MAINTENANCE screen.

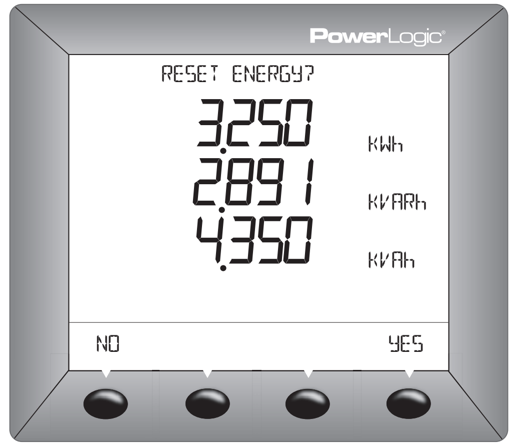


Resetting Individual Values

Individual values for Energy, Demand, Min/Max, Mode, and Timer can be reset without affecting other values. Below are instructions for resetting Energy values.

Resetting Energy Values

1. From the MAINTENANCE screen, press RESET.
2. Enter the RESET password (00000 is the default).
3. Press OK.
4. Press E.
5. Press NO or YES.
6. Press ⇑ to return to the MAINTENANCE screen.



Individual settings for Demand, Min/Max, Mode, and Timer can be reset by selecting the value and using the above procedure.

SECTION 4— METERING

POWER METER CHARACTERISTICS

The power meter measures currents and voltages and reports in real time the rms values for all three phases and neutral. In addition, the power meter calculates power factor, real power, reactive power, and more.

Table 4– 1 lists metering characteristics of the PM750.

Table 4– 1: Power Meter Characteristics

Instantaneous rms Values	
Current	Per phase, neutral, average of 3 phases
Voltage	Average of 3 phases, L-L and L-N
Frequency	45 to 65 Hz
Active power	Total and per phase (signed)*
Reactive power	Total and per phase (signed)*
Apparent power	Total and per phase
Power factor	Total 0.000 to 1 (signed)
Energy Values	
Active energy (total)	0 to 1.84 x 10^{18} Wh (signed)*
Reactive energy (total)	0 to 1.84 x 10^{18} VARh (signed)*
Apparent energy (total)	0 to 1.84 x 10^{18} VAh
Operating times	Up to 32,767 hours and 59 minutes
Demand Values	
Current	Per phase (Thermal)
Active, reactive, apparent power	Total (sliding block, rolling block, or block)
Maximum Demand Values	
Maximum current	Phase
Maximum active power	Total
Maximum reactive power	Total
Maximum apparent power	Total
Power-quality Values	
Total harmonic distortion (THD)	Current and voltage (L-L and L-N)
Reset (password protected)	
Maximum demand current and power	
Energy values and operating time	
Minimum and maximum values	
Operational timer	
I/O Counters (only upon meter reset)	
Visualization Modes (password protected)	
IEC and IEEE	Display (All calculations are the same under both visualization modes.)
Minimum and Maximum Values (unsigned)	
Total real power	
Total apparent power	
Total reactive power	
Total PF (power factor)	
Current per phase	
Voltage (L-L and L-N)	
THD current per phase	
THD voltage (L-L and L-N)	

*NOTE: * kW, kVAR, kWh, kVARh are signed and net consumption values.*

Table 4– 1: Power Meter Characteristics *(continued)*

Local or Remote Setup	
Type of distribution system	3-phase 3- or 4-wire with 1, 2, or 3 CTs, two- or single-phase
Rating of current transformers	Primary 5 to 32,767 A Secondary 5 or 1 A
Voltage	Primary 3,276,700 V max Secondary 100, 110, 115, 120
Calculation interval for demand currents	1 to 60 minutes
Calculation interval for demand power	1 to 60 minutes

MODBUS RS485

Functions	
RS485 link	2-wire
Communication protocol	MODBUS RTU
Settings	
Communication address	1 to 247
Baud rate (communication speed)	2400, 4800, 9600, 19200 baud
Parity	none, even, odd

Pulse Output

Pulse Output	
Three Modes: External Control, Alarm Mode, Active Energy Pulse	Solid state relay

Digital Inputs

Digital Inputs	
Two Modes: Normal, Demand Sync	2 digital outputs

MIN/MAX VALUES FOR REAL-TIME READINGS

When certain readings reach their highest or lowest value, the Power Meter saves the values in its nonvolatile memory. These values are called the minimum and maximum (min/max) values. The min/max values stored since the last min/max reset can be viewed using the Power Meter display. See Table 4– 1 for a list of the minimum and maximum values stored in the PM750. The min/max value for power is based on the unsigned value of power.

POWER FACTOR MIN/MAX CONVENTIONS

The min/max value for power factor is based on the unsigned value of power factor. See “How Signed Power Factor is Stored in the Register” on page 48 for more information on power factor.

DEMAND READINGS

The power meter provides a variety of demand readings. Table 4– 2 lists the available demand readings and their reportable ranges.

Table 4– 2: Demand Readings

Demand Readings	Reportable Range
Demand Current, Per-Phase	
Last Complete Interval	0 to 32,767 A
Peak	0 to 32,767 A
Demand Real Power, 3Ø Total	
Last Complete Interval	0 to 3276.70 MW
Peak	0 to 3276.70 MW

Table 4– 2: Demand Readings *(continued)*

Demand Reactive Power, 3Ø Total	
Last Complete Interval	0 to 3276.70 MVAR
Peak	0 to 3276.70 MVAR
Demand Apparent Power, 3Ø Total	
Last Complete Interval	0 to 3276.70 MVA
Peak	0 to 3276.70 MVA

Demand Power Calculation Methods

Demand power is the energy accumulated during a specified period divided by the length of that period. How the power meter performs this calculation depends on the method you select. To be compatible with electric utility billing practices, the power meter provides the following types of demand power calculations:

- Block Interval Demand
- Synchronized Demand
- Thermal Demand

The default demand calculation is set to sliding block with a 15 minute interval. (You can set up the other demand power calculation methods only through communications.)

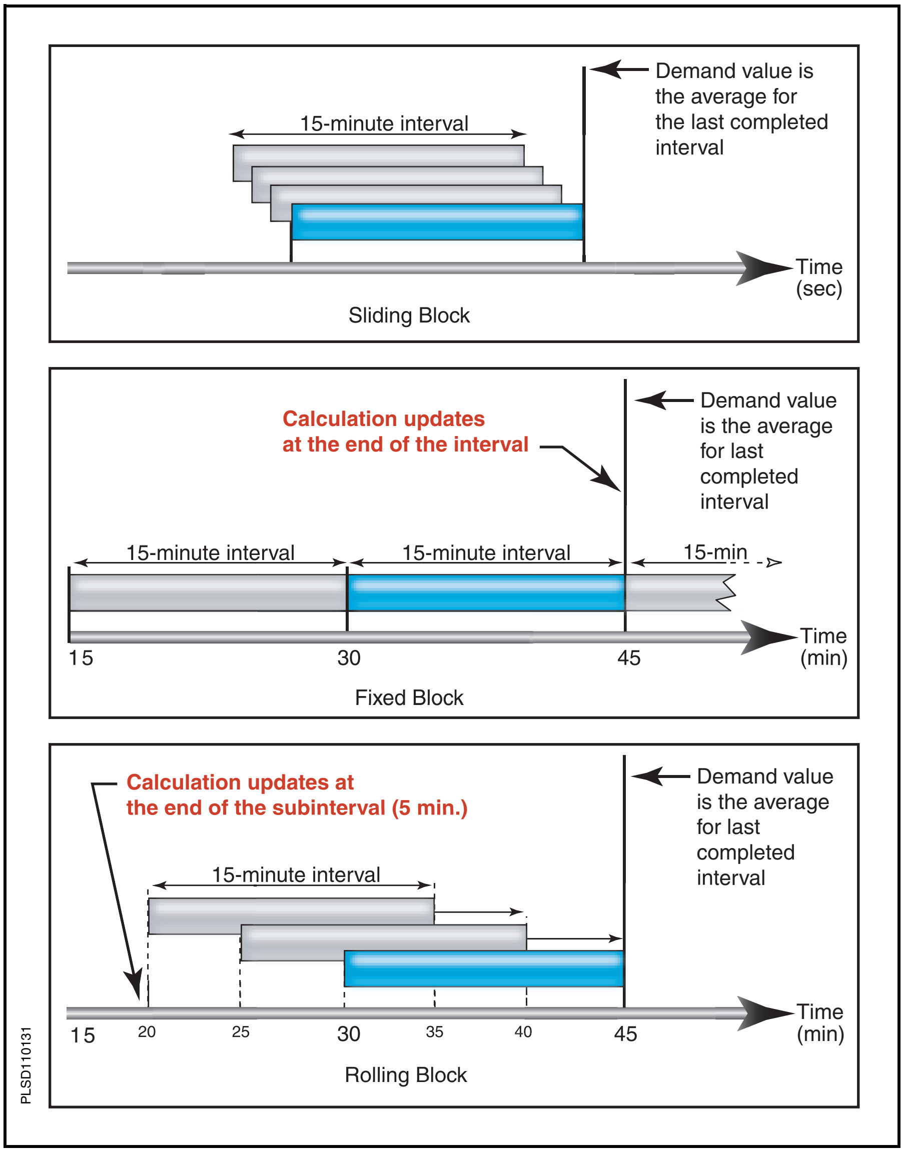
Block Interval Demand

In the block interval demand method, you select a “block” of time that the power meter uses for the demand calculation. You choose how the power meter handles that block of time (interval). Three different modes are possible:

- **Sliding Block**. In the sliding block interval, you select an interval from 1 to 60 minutes (in 1-minute increments). The power meter displays the demand value for the last completed interval.
- **Fixed Block**. In the fixed block interval, you select an interval from 1 to 60 minutes (in 1-minute increments). The power meter calculates and updates the demand at the end of each interval.
- **Rolling Block**. In the rolling block interval, you select an interval and a subinterval. The subinterval must divide evenly into the interval. For example, you might set three 5-minute subintervals for a 15-minute interval. Demand is *updated at each subinterval*. The power meter displays the demand value for the last completed interval.

Figure 4– 1 illustrates the three ways to calculate demand power using the block method. For illustration purposes, the interval is set to 15 minutes.

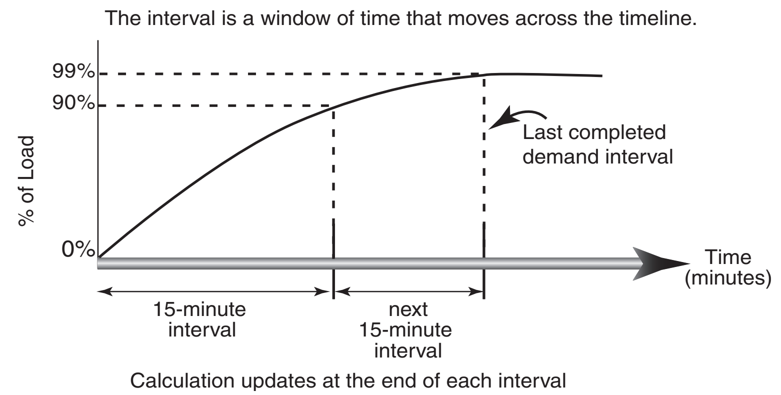
Figure 4– 1: Block Interval Demand Examples



Thermal Demand

The thermal demand method calculates the demand based on a thermal response, which mimics thermal demand meters. The demand calculation updates at the end of each interval. You select the demand interval from 1 to 60 minutes (in 1-minute increments). In Figure 4– 2 the interval is set to 15 minutes for illustration purposes.

Figure 4– 2: Thermal Demand Example



Demand Current

The power meter calculates demand current using the thermal demand method. The default interval is 15 minutes, but you can set the demand current interval between 1 and 60 minutes in 1-minute increments.

Peak Demand

In nonvolatile memory, the power meter maintains a running maximum for power demand values, called “peak demand.” The peak is the highest average for each of these readings: kWD, kVARD, and kVAD since the last reset. Table 4– 2 on page 16 lists the available peak demand readings from the power meter.

You can reset peak demand values from the power meter display. From the Main Menu, select MAINT > RESET > DMD.

You should reset peak demand after changes to basic meter setup, such as CT ratio or system type.

ENERGY READINGS

The power meter calculates and stores accumulated energy values for real, reactive, and apparent energy.

You can view accumulated energy from the display. The resolution of the energy value will automatically change through the range of 000.000 kWh to 000,000 MWh (000.000 kVAh to 000,000 MVARh).

Energy values can be reported over communications in two formats: scaled long integer and floating point. The units are always kWh, KVARh, or kVAh. The long integer values are limited to 2,147,483,647 x the scale factor. The floating point values are limited to 1.84×10^{18}.

POWER ANALYSIS VALUES

The power meter provides power analysis values for Total Harmonic Distortion (THD). THD is a quick measure of the total distortion present in a waveform and is the ratio of harmonic content to the fundamental. It provides a general indication of the “quality” of a waveform. THD is calculated for both voltage and current. The power meter uses the following equation to calculate THD where H is the harmonic distortion:

$$THD = \frac{\sqrt{H_2^2 + H_3^2 + H_4^2 + \cdots}}{H_1} \times 100\%$$

SECTION 5— INPUT/OUTPUT CAPABILITIES

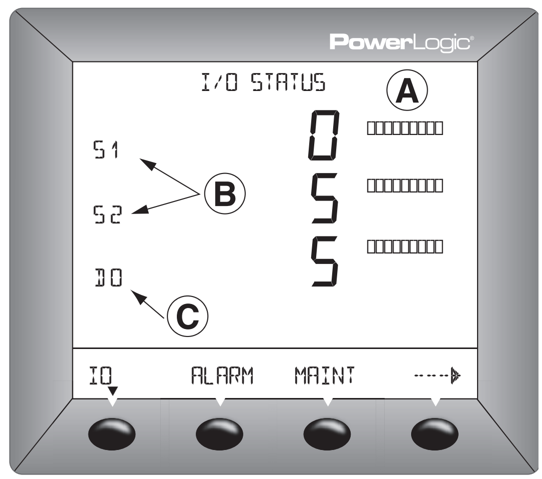
DIGITAL INPUTS

The power meter can accept two digital inputs designated as S1 and S2. A digital input is used to detect digital signals. For example, the digital input can be used to determine circuit breaker status, count pulses, or count motor starts.

The power meter counts OFF-to-ON transitions for each input, and you can reset this value using the command interface or by performing a METER reset under MAINT. Figure 5– 1 shows the status of the I/O function for the PM750.

Figure 5– 1:I/O Status Screen

A. Lit bar graph indicates that the input or output is ON.
B. S1 and S2 represent the two digital inputs.
C. DO represents the digital output.



The digital input has two operating modes:

- **Normal**—Use the normal mode for simple ON/OFF digital inputs.
- **Demand Interval Synch Pulse**—Use this mode to configure a digital input to accept a demand synch pulse from a utility demand meter.

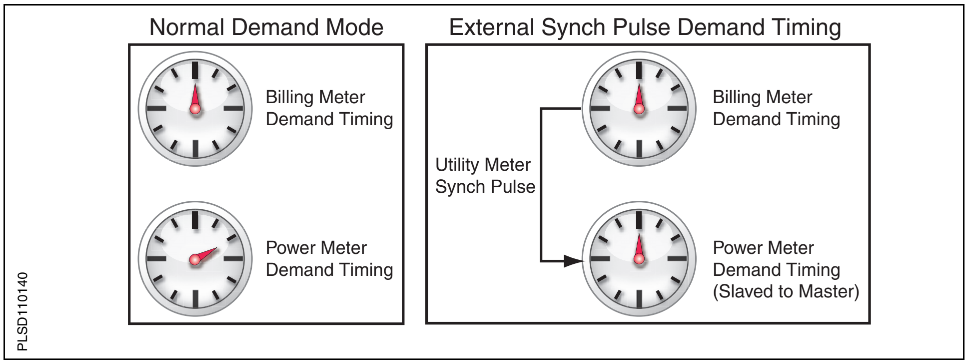
The digital inputs can also be configured to activate an alarm when changing status; for example, from OFF to ON. See Alarms on page 27.

Demand Synch Pulse Input

You can configure the power meter to accept a demand synch pulse from an external source such as another demand meter. By accepting demand synch pulses through a digital input, the power meter can make its power demand interval “window” match the other meter’s demand interval “window.” The power meter does this by “watching” the digital input for a pulse from the other demand meter. When it sees a pulse (an off-to-on transition of the digital input), it starts a new demand interval and calculates the demand for the preceding interval. The power meter then uses the same time interval as the other meter for each demand calculation. Figure 5– 2 illustrates this point.

When in demand synch pulse operating mode, the power meter will not end a demand interval without a pulse. Either digital input can be set to accept a demand synch pulse. However, only one of them should be configured that way at a time.

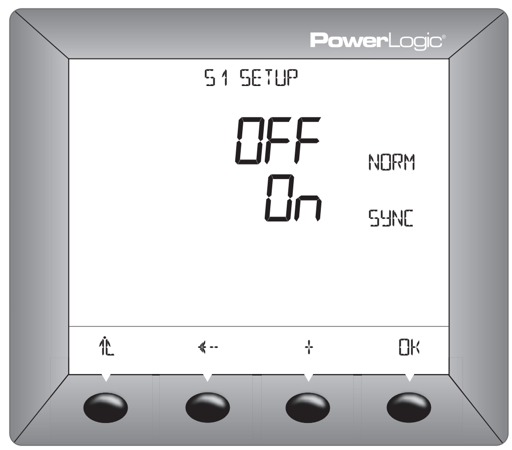
Figure 5– 2:Demand synch pulse timing



Setting Up the Digital Inputs

Use this procedure to set up the digital inputs.

1. In SETUP mode, press ----▸ until D IN (digital inputs) is visible.
2. Press D IN.
3. Select S1 or S2.
4. Select OFF or ON for NORM (normal mode).
5. The value for SYNC (demand sync mode) automatically changes depending on the value selected for NORM.
6. Press OK to return to the SETUP MODE screen.



DIGITAL OUTPUT

The PM750 has one digital output.The digital output has three operating modes:

- External—This is the default setting. The output can be controlled by a command sent over the communications link. To de-energize the digital output, write the value 3320 to register 4126. To energize the digital output, write 3321 to register 4126.
- Alarm—The output is controlled by the power meter in response to a set-point controlled alarm condition. When the alarm is active, the output will be ON. Multiple alarms can be associated with the same output simultaneously.
- kWh Pulse—In this mode, the meter generates a fixed-duration pulse output that can be associated with the kWh consumption.

Solid-state KY Pulse Output

The power meter is equipped with one solid-state digital output that can be used as a KY pulse output. The solid-state relay provides the extremely long life—billions of operations—required for pulse initiator applications.

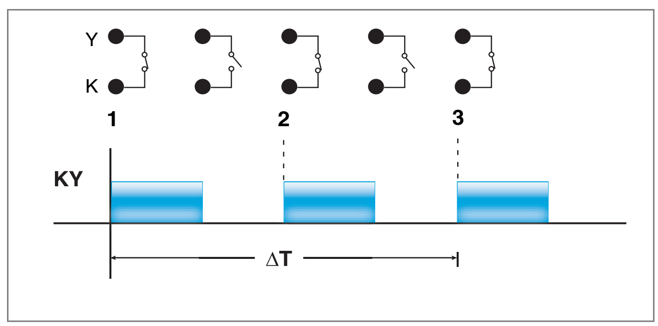
The output is a Form-A contact with a maximum rating of 100 mA. Because most pulse initiator applications feed solid-state receivers with low burdens, this 100 mA rating is adequate for most applications.

When setting the kWh/pulse value, set the value based on a 2-wire pulse output. For instructions on calculating the correct value, see “Calculating the Kilowatt-hour- Per-Pulse Value” on page 24 in this chapter.

2-wire Pulse Initiator

Figure 5– 3 shows a pulse train from a 2-wire pulse initiator application.

Figure 5– 3: Two-wire pulse train



In Figure 5– 3, the off-to-on transitions of the output are marked as 1, 2, and 3. Each time the output transitions from off-to-on, the receiver counts a pulse. The power meter can deliver up to 8 pulses per second.

Calculating the Kilowatt-hour- Per-Pulse Value

This section shows an example of how to calculate kilowatt-hours per pulse. To calculate this value, first determine the highest kW value you can expect and the required pulse rate. In this example, the following assumptions are made:

- The metered load should not exceed 1600 kW.
- About two KY pulses per second should occur at full scale.

Step 1: Convert 1600 kW load into kWh/second.

$$(1600 \text{ kW})(1 \text{ Hr}) = 1600 \text{ KWh}$$

$$\frac{(1600 \text{ kWh})}{1 \text{ hour}} = \frac{X \text{ kWh}}{1 \text{ second}}$$

$$\frac{(1600 \text{ kWh})}{3600 \text{ seconds}} = \frac{X \text{ kWh}}{1 \text{ second}}$$

$$X = 1600/3600 = 0.444 \text{ kWh/second}$$

Step 2: Calculate the kWh required per pulse.

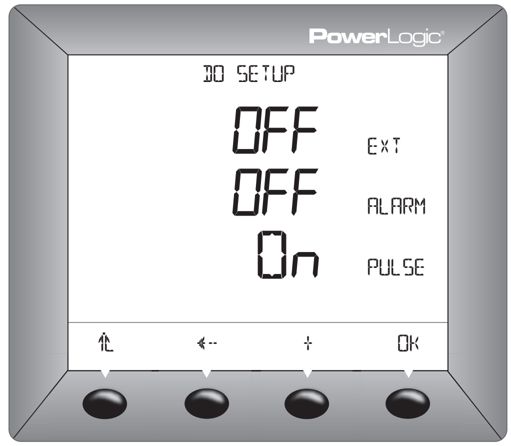
$$\frac{0.444 \text{ kWh/second}}{2 \text{ pulses/second}} = 0.2222 \text{ kWh/pulse}$$

Step 3: Round to the next option (0.01, 0.1, 1, 10, 100, 1000, 10,000).

$$Ke = 1 \text{ kWh/pulse}$$

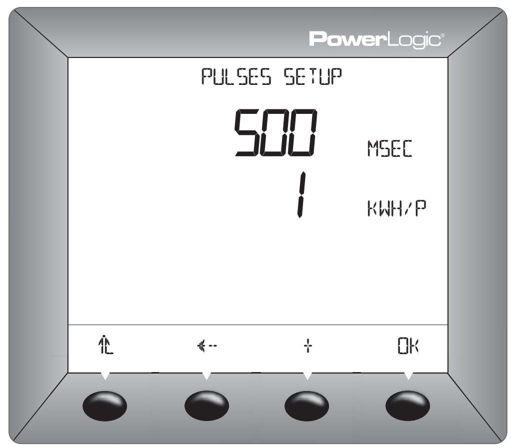
Setting Up the Digital Output

1. In SETUP mode, press ---▸ until D OUT is visible.
2. Press D OUT.
3. Select OFF or ON for the desired output mode by pressing ✢. Depending on which mode is set to ON, the other values change automatically.
4. Select ON for EXT to choose external mode. For setting up pulse or alarm output mode, see below.
5. Press OK when output mode is complete



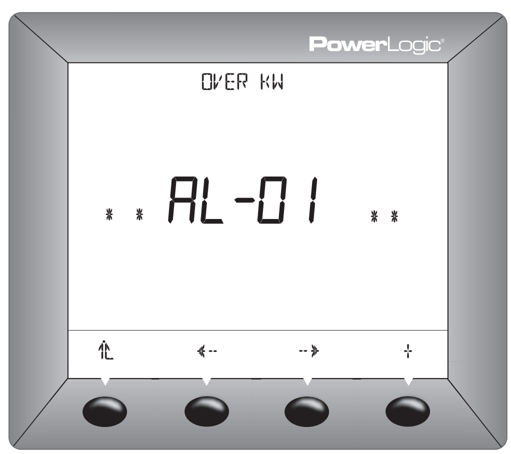
Set Up Output for Pulse

1. On the DO SETUP screen, select ON for PULSE.
2. Select the pulse duration option. Values available are: 10, 50,100, 300, 500, or 1000 MSEC (milliseconds).
3. Select the pulse weight option. Values available are: 0.01, 0.1, 1, 10, 100, 1000, or 10000 for kWH/P.
4. Press OK when output setup is complete to return to the SETUP MODE screen.



Set Up Output for Alarms

1. On the DO SETUP screen, select ON for ALARM.
2. Using the ◂--- and ---▸ buttons, scroll through the alarms until you reach the alarm(s) you want to set.
3. Press ✢ to “mark” the selected alarm(s). When the alarm is selected, asterisks will appear on either side of the alarm name.
4. Press ⮬ return to the DO SETUP screen.
5. Press OK to return to the SETUP MODE screen.



SECTION 6— ALARMS

ABOUT ALARMS

The PM750 can detect 15 pre-configured alarms. A complete list of alarm configurations is described in Table 6– 1. All alarms can be configured with the following values when using the display except that digital alarms have a fixed pickup and dropout magnitude:

- Enable—disable (default) or enable.
- Pickup Magnitude—For digital alarms off-to-on (1), on-to-off (0)
- Pickup Time Delay (0-32767 seconds)
- Dropout Magnitude—For digital alarms off-to-on (0), on-to-off (1)
- Dropout Time Delay (0-32767 seconds)

Values that can also be configured over communications are:

- Alarm Type
- Test Register (reading)
- Alarm Label

The ⚠ icon appears in the upper-right corner of the power meter display when an alarm is active.

ALARM CONDITIONS AND ALARM NUMBERS

Table 6– 1 lists the pre-configured alarms by alarm number. For each alarm condition, the following information is provided.

- Alarm No.—a position number indicating where an alarm falls in the list.
- Alarm Description—a brief description of the alarm condition
- Abbreviated Display Name—an abbreviated name that describes the alarm condition, but is limited to 16 characters that fit in the window of the power meter's display.
- Test Register—the register number that contains the value that is used as the basis for a comparison to alarm pickup and dropout settings. This value is an integer, and the evaluation produces an absolute value.

Table 6– 1: List of Default Alarms by Alarm Number

Alarm Number	Alarm Description	Abbreviated Display Name	Test Register
Standard Speed Alarms (1 Second)			
01	Over Kilowatt	OVER KW	4006
02	Over Kilovolt-Ampere	OVER KVA	4007
03	Over Kilovolt-Ampere-Reactive	OVER KVAR	4008
04	Under Power Factor	UNDER POWER FAC	4009
05	Over Voltage L-L	OVER U	4010
06	Over Voltage L-N	OVER V	4011
07	Under Voltage L-L	UNDER U	4010
08	Under Voltage L-N	UNDER V	4011
09	Over Current	OVER CURRENT	4012
10	Over Frequency	OVER FREQUENCY	4013
11	Under Frequency	UNDER FREQUENCY	4013
12	Over THD Current	OVER THD CURRENT	4045
13	Over THD Voltage	OVER THD VOLTAGE	4052

Table 6– 1: List of Default Alarms by Alarm Number *(continued)*

Alarm Number	Alarm Description	Abbreviated Display Name	Test Register
Digital			
14	Digital Input OFF/ON	DIGITAL INPUT S1	4115
15	Digital Input OFF/ON	DIGITAL INPUT S2	4116

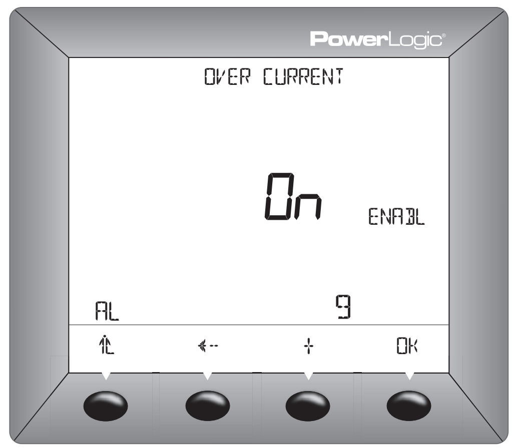
ALARM SETUP

When making alarm setup changes using the display, evaluation of all alarms is temporarily suspended while alarm setup screens are displayed. Evaluation resumes immediately upon exit from the alarm setup screens.

Setting Up Alarms

The following sequence may be used to set up an alarm:

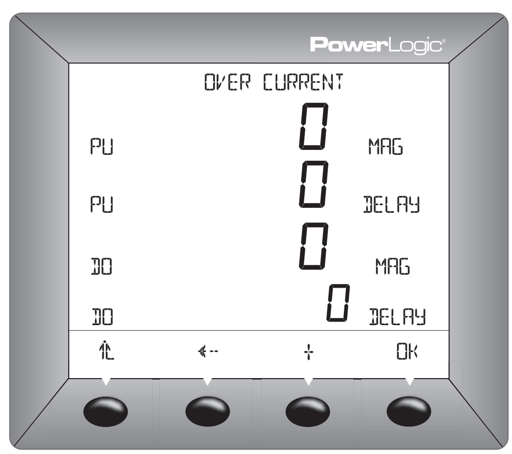
1. In SETUP mode, press → until ALARM is visible.
2. Press ALARM.
3. Using the ← and → buttons, scroll through the alarms until you reach the alarm(s) you want to set.
4. Press EDIT to change the ENABL value. The value will start to blink.
5. Press ± to toggle the On/Off setting. Press OK to select. To set up magnitude and delay values, see below.
6. Press ⮤ return to the SETUP MODE screen.



Setting Up Magnitudes and Delays

After changing an alarm's status, a screen for changing the pickup and dropout magnitudes and delay values is displayed.

1. Enter the PU MAG value (pickup magnitude). Press OK.
2. Enter the PU DELAY value (pickup delay in seconds). Press OK.
3. Enter the DO MAG value (dropout magnitude). Press OK.
4. Enter the DO DELAY value (dropout delay in seconds). Press OK.
5. Press ⮤ return to the SETUP MODE screen.



SECTION 7— MAINTENANCE AND TROUBLESHOOTING

INTRODUCTION

The power meter does not contain any user-serviceable parts. If the power meter requires service, contact your local sales representative. Do not open the power meter. Opening the power meter voids the warranty.

Getting Technical Support

Please refer to the *Technical Support Contacts* provided in the power meter shipping carton for a list of support phone numbers by country or go to www.powerlogic.com, select your country > tech support for phone numbers by country.

Troubleshooting

The information in Table 7– 1 describes potential problems and their possible causes. It also describes checks you can perform or possible solutions for each. After referring to this table, if you cannot resolve the problem, contact the your local Square D/Schneider Electric sales representative for assistance.

⚠ DANGER

HAZARD OF ELECTRIC SHOCK, EXPLOSION, OR ARC FLASH

- Apply appropriate personal protective equipment (PPE) and follow safe electrical work practices. See NFPA 70E.
- This equipment must be installed and serviced only by qualified electrical personnel.
- Turn off all power supplying this equipment before working on or inside.
- Always use a properly rated voltage sensing device to confirm that all power is off.
- Carefully inspect the work area for tools and objects that may have been left inside the equipment.
- Use caution while removing or installing panels so that they do not extend into the energized bus; avoid handling the panels, which could cause personal injury.

Failure to follow this instruction will result in death or serious injury

Table 7– 1: Troubleshooting

Potential Problem	Possible Cause	Possible Solution
The maintenance icon is illuminated on the power meter display.	When the maintenance icon is illuminated, it indicates the metered signals are clipping or the frequency is out of range.	• Verify voltage and current inputs range. The Voltage input metering range is 10-480 L-L VAC (direct) or 10-277 L-N VAC (direct) or up to 1.6 MV (with external VT). The Current input metering range is: 5 mA - 6 A. In addition, verify that the current and voltage inputs are free of noise. • Call Technical Support or contact your local sales representative for assistance.
The display is blank after applying control power to the power meter.	The power meter may not be receiving the necessary power.	• Verify that the power meter line (L) and neutral (N) terminals are receiving the necessary power. • Verify that the heartbeat LED is blinking. • Check the fuse.

Table 7– 1: Troubleshooting *(continued)*

The data being displayed is inaccurate or not what you expect.	Incorrect setup values.	Check that the correct values have been entered for power meter setup parameters (CT and PT ratings, System Type, Nominal Frequency, and so on).
	Incorrect voltage inputs.	Check power meter voltage input terminals to verify that adequate voltage is present.
	Power meter is wired improperly. See **Appendix C—Instrument Transformer Wiring: Troubleshooting Guide** on page 51 for more information on troubleshooting wiring problems.	Check that all CTs and PTs are connected correctly (proper polarity is observed) and that they are energized. Check shorting terminals.
Cannot communicate with power meter from a remote personal computer.	Power meter address is incorrect.	Check to see that the power meter is correctly addressed.
	Power meter baud rate (parity, stop bit) is incorrect.	Verify that the baud rate of the power meter matches the baud rate of all other devices on its communications link.
	Communications lines are improperly connected.	Verify the power meter communications connections.
	Communications lines are improperly terminated.	Check to see that a multipoint communications terminator is properly installed.

APPENDIX A—SPECIFICATIONS

POWER METER SPECIFICATIONS

Table A– 1: Specifications

Electrical Characteristics		
Type of measurement		True rms up to the 15th harmonic on three-phase AC system (3P, 3P + N) 32 samples per cycle
Measurement Accuracy	Current	0.4% from 1A to 6A
	Voltage	0.3% from 50 V to 277 V
	Power Factor	0.5% from 1A to 6A
	Power	0.5%
	Frequency	±0.02% from 45 to 65 Hz
	Real Energy	IEC 62053-22 Class 0.5S
	Reactive Energy	IEC 62053-23 Class 2
Data update rate		1 s
Input-voltage	Measured voltage	10 to 480 V AC (direct L-L) 10 to 277 V AC (direct L-N) Up to 1.6 MV AC (with external VT). The starting of the measuring voltage depends on the PT ratio.
	Metering over-range	1.2 Un
	Impedance	2 MΩ (L-L) / 1 MΩ (L-N)
	Frequency range	45 to 65 Hz
Input-current	CT ratings Primary	Adjustable from 5A to 32767 A
	CT ratings Secondary	5 A or 1A
	Measurement input range	5 mA to 6 A
	Permissible overload	10 A continuous 50 A for 10 seconds per hour 120 A for 1 second per hour
	Impedance	< 0.1 Ω
	Load	< 0.15 VA
Control Power	AC	100 to 415 ±10% V AC, 5 VA; 50 to 60 Hz
	DC	125 to 250 ±20% V DC, 3W
	Ride-through time	100 ms at 120 V AC
Digital Output	Pulse output	8–36 V DC max range, 24 V DC nominal. @ 25 °C, 3.0 kV rms isolation, 28 Ω on-resistance @ 100 mA
Status Digital Inputs	Voltage ratings	12–36 V DC max range, 24 V DC nominal
	Input impedance	12k Ω
	Maximum frequency	25 Hz
	Response time	10 milliseconds
	Isolation	2.5 kV rms
Mechanical Characteristics		
Weight		0.37 kg
IP degree of protection (IEC 60529)		Designed to IP52 front display, IP30 meter body
Dimensions		96 x 96 x 88 mm (meter with display) 96 x 96 x 50 mm (behind mounting surface)
Environmental Characteristics		
Operating temperature	Meter	-5 °C to +60 °C
	Display	-10 °C to +55 °C
Storage temperature	Meter + display	-40 °C to +85 °C
Humidity rating		5 to 95% RH at 50 °C (non-condensing)
Pollution degree		2

Table A– 1: Specifications *(continued)*

Metering category (voltage inputs and control power)	CAT III, for distribution systems up to 277 V L-N / 480 V AC L-L
Dielectric withstand	As per IEC61010, UL508 Double insulated front panel display
Altitude	3000 m
Electromagnetic Compatibility	
Electrostatic discharge	Level III (IEC 61000-4-2)
Immunity to radiated fields	Level III (IEC 61000-4-3)
Immunity to fast transients	Level III (IEC 61000-4-4)
Immunity to impulse waves	Level III (IEC 61000-4-5)
Conducted immunity	Level III (IEC 61000-4-6)
Immunity to magnetic fields	Level III (IEC 61000-4-8)
Immunity to voltage dips	Level III (IEC 61000-4-11)
Conducted and radiated emissions	CE commercial environment/FCC part 15 class B EN55011
Harmonics	IEC 61000-3-2
Flicker emissions	IEC 61000-3-3
Safety	
Europe	CE, as per IEC 61010-1
U.S. and Canada	UL508
Communications	
RS485 port	2-wire, 2400, 4800, 9600, or 19200 baud; Parity—Even, Odd, None; 1 stop bit; Modbus RTU
Firmware update	Update via the communication port
Display Characteristics	
Dimensions 73 x 69 mm	Back-lit green LCD (6 lines total, 4 concurrent values)

APPENDIX B—REGISTER LIST

REGISTER LIST

Table B– 1: Register Listing—Setup and Status

Setup & Status									
Reg	**Name**	**Size**	**Type**	**Access**	**NV**	**Scale**	**Units**	**Range**	**Notes**
1090	Reserved	2	Float	RO	N	-	-	-	Reserved
1120	Reserved	2	Float	RO	Y	-	Amp	-	Current, N, Minimum
1140	Reserved	2	Float	RO	Y	-	%	-	Current, N, THD Minimum
1170	Reserved	2	Float	RO	Y	-	Amp	-	Current, N, Maximum
1190	Reserved	2	Float	RO	Y	-	%	-	Current, N, THD Maximum
1204	Usage Hours	2	Float	RO	Y	-	Hours	>= 0.0	This combination timer counts the total time for which the absolute current on at least one phase is > 0.1Amp.
1206	Usage Minutes	2	Float	RO	Y	-	Minutes	0.0-59.0	This combination timer counts the total time for which the absolute current on at least one phase is > 0.1Amp.
4063	Reserved	1	Integer	RO	Y	I	Amp	-	Current, N, Minimum
4073	Reserved	1	Integer	RO	Y	0.1	%	-	Current, N, THD Minimum
4088	Reserved	1	Integer	RO	Y	I	Amp	-	Current, N, Maximum
4098	Reserved	1	Integer	RO	Y	0.1	%	-	Current, N, THD Maximum
4105	Scale Factor I (current)	1	Integer	RO	N	-	-	-	Power of 10
4106	Scale Factor V (voltage)	1	Integer	RO	N	-	-	-	Power of 10
4107	Scale Factor W (power)	1	Integer	RO	N	-	-	-	Power of 10
4108	Scale Factor E (energy)	1	Integer	RO	N	-	-	-	Power of 10
4109	Reserved	1	Integer	RO	Y	-	-	-	Feature Bitmap
4110	Usage Hours	1	Integer	RO	Y	-	Hours	0-32767	
4111	Usage Minutes	1	Integer	RO	Y	-	Minutes	0-59	
RO = Read Only R/W = Read/Write NV = Nonvolatile.									

Table B– 1: Register Listing—Setup and Status *(continued)*

Setup & Status									
Reg	**Name**	**Size**	**Type**	**Access**	**NV**	**Scale**	**Units**	**Range**	**Notes**
4112	Error Bitmap	1	Integer	RO	N	-	-	-	bit0: VA Clipping bit1: VB Clipping bit2: VC Clipping bit3: IA Clipping bit4: IB Clipping bit5: IC Clipping bit6: Freq Invalid
4117	Thermal Demand Interval	1	Integer	R/W	Y	-	Minutes	1-60	Current Demand Only
4118	Power Block Demand Interval	1	Integer	R/W	Y	-	Minutes	1-60	Duration in minutes
4119	Power Block Demand Number of Sub-Intervals	1	Integer	R/W	Y	-	Seconds	1-60	0: Sliding Block Calculation If Reg[4118] <= 15 Minutes the Sub-interval is 15 Seconds if Reg[4118] > 15 Minutes the Sub-interval is 60 Seconds 1: Fixed Block else: Rolling Block
4120	CT Ratio - Primary	1	Integer	R/W	Y	-	-	1-32767	
4121	CT Ratio - Secondary	1	Integer	R/W	Y	-	-	1 or 5	
4122	PT Ratio - Primary	1	Integer	R/W	Y	-	-	1-32767	
4123	PT Ratio - Scale (0 = No PT)	1	Integer	R/W	Y	-	-	0, 1, 10, 100	
4124	PT Ratio - Secondary	1	Integer	R/W	Y	-	-	100, 110, 115, 120	
4125	Service Frequency	1	Integer	R/W	Y	-	Hz	50 or 60	
4126	Reset Commands	1	Integer	R/W	N	-	-	N/A	Always return a 0. A list of commands is shown in Table B– 7.
4127	System Type	1	Integer	R/W	Y	-	-	10,11,12,30,31,32,40,42,44	
4128	Display Mode	1	Integer	R/W	Y	-	-	0,1	0 = IEC Units 1 = IEEE Units
4138	Reserved	1	Integer	RO	N	-	-	-	Always returns 0
RO = Read Only R/W = Read/Write NV = Nonvolatile.									

The PM750 includes registers in two different formats: integer and floating point. For example, Real Power A is included in Register 1066 and 1067 (floating point) and register 4036 (integer).

Table B– 2: Register Listing—Metered Data

Metered Data									
Reg	**Name**	**Size**	**Type**	**Access**	**NV**	**Scale**	**Units**	**Range**	**Notes**
1000	Real Energy, Total	2	Float	RO	Y	-	kWh	-	Signed Net Consumption
1002	Apparent Energy, Total	2	Float	RO	Y	-	kVAh	-	
1004	Reactive Energy, Total	2	Float	RO	Y	-	kVARh	-	Signed Net Consumption
1006	Real Power, Total	2	Float	RO	N	-	kW	-	Signed Net Power
1008	Apparent Power, Total	2	Float	RO	N	-	kVA	-	
1010	Reactive Power, Total	2	Float	RO	N	-	kVAR	-	Signed Net Power
1012	Power Factor, Total	2	Float	RO	N	-	-	0.0 - 1.0	
1014	Voltage, L-L, 3P Average	2	Float	RO	N	-	Volt	-	
1016	Voltage, L-N, 3P Average	2	Float	RO	N	-	Volt	-	
1018	Current, 3P Average	2	Float	RO	N	-	Amp	-	
1020	Frequency	2	Float	RO	N	-	Hz	45.0 - 65.0	Derived from Phase A
1034	Current, A	2	Float	RO	N	-	Amp	-	
1036	Current, B	2	Float	RO	N	-	Amp	-	
1038	Current, C	2	Float	RO	N	-	Amp	-	
1040	Current, N	2	Float	RO	N	-	Amp	-	
1054	Voltage, A-B	2	Float	RO	N	-	Volt	-	
1056	Voltage, B-C	2	Float	RO	N	-	Volt	-	
1058	Voltage, C-A	2	Float	RO	N	-	Volt	-	
1060	Voltage, A-N	2	Float	RO	N	-	Volt	-	
1062	Voltage, B-N	2	Float	RO	N	-	Volt	-	
1064	Voltage, C-N	2	Float	RO	N	-	Volt	-	
1066	Real Power, A	2	Float	RO	N	-	kW	-	Signed Net Power
1068	Real Power, B	2	Float	RO	N	-	kW	-	Signed Net Power
RO = Read Only R/W = Read/Write NV = Nonvolatile.									

Table B– 2: Register Listing—Metered Data *(continued)*

Reg	Name	Size	Type	Access	NV	Scale	Units	Range	Notes
Metered Data									
1070	Real Power, C	2	Float	RO	N	-	kW	-	Signed Net Power
1072	Apparent Power, A	2	Float	RO	N	-	kVA	-	
1074	Apparent Power, B	2	Float	RO	N	-	kVA	-	
1076	Apparent Power, C	2	Float	RO	N	-	kVA	-	
1078	Reactive Power, A	2	Float	RO	N	-	kVAR	-	Signed Net Power
1080	Reactive Power, B	2	Float	RO	N	-	kVAR	-	Signed Net Power
1082	Reactive Power, C	2	Float	RO	N	-	kVAR	-	Signed Net Power
1084	Current, A, THD	2	Float	RO	N	-	%	0.0-1000.0	
1086	Current, B, THD	2	Float	RO	N	-	%	0.0-1000.0	
1088	Current, C, THD	2	Float	RO	N	-	%	0.0-1000.0	
1092	Voltage, A-N, THD	2	Float	RO	N	-	%	0.0-1000.0	
1094	Voltage, B-N, THD	2	Float	RO	N	-	%	0.0-1000.0	
1096	Voltage, C-N, THD	2	Float	RO	N	-	%	0.0-1000.0	
1098	Voltage, A-B, THD	2	Float	RO	N	-	%	0.0-1000.0	
1100	Voltage, B-C, THD	2	Float	RO	N	-	%	0.0-1000.0	
1102	Voltage, C-A, THD	2	Float	RO	N	-	%	0.0-1000.0	
4000	Real Energy, Total	2	Long	RO	Y	E	kWh/Scale	0-0xFFFFFFFF	Signed Net Consumption
4002	Apparent Energy, Total	2	Long	RO	Y	E	kVAh/Scale	0-0xFFFFFFFF	
4004	Reactive Energy, Total	2	Long	RO	Y	E	kVARh/Scale	0-0xFFFFFFFF	Signed Net Consumption
4006	Real Power, Total	1	Integer	RO	N	W	kW/Scale	0-32767	Signed Net Power
4007	Apparent Power, Total	1	Integer	RO	N	W	kVA/Scale	0-32767	
4008	Reactive Power, Total	1	Integer	RO	N	W	kVAR/Scale	0-32767	Signed Net Power
4009	Power Factor, Total	1	Integer	RO	N	0.0001	-	0-1	
4010	Voltage, L-L, 3P Average	1	Integer	RO	N	V	Volt/Scale	0-32767	

RO = Read Only
R/W = Read/Write
NV = Nonvolatile.

Table B– 2: Register Listing—Metered Data *(continued)*

Reg	Name	Size	Type	Access	NV	Scale	Units	Range	Notes
Metered Data									
4011	Voltage, L-N, 3P Average	1	Integer	RO	N	V	Volt/Scale	0-32767	
4012	Current, 3P Average	1	Integer	RO	N	I	Amp/Scale	0-32767	
4013	Frequency	1	Integer	RO	N	0.01	Hz	4500-6500	Derived from Phase A
4020	Current, A	1	Integer	RO	N	I	Amp/Scale	0-32767	
4021	Current, B	1	Integer	RO	N	I	Amp/Scale	0-32767	
4022	Current, C	1	Integer	RO	N	I	Amp/Scale	0-32767	
4023	Current, N	1	Integer	RO	N	I	Amp/Scale	0-32767	
4030	Voltage, A-B	1	Integer	RO	N	V	Volt/Scale	0-32767	
4031	Voltage, B-C	1	Integer	RO	N	V	Volt/Scale	0-32767	
4032	Voltage, C-A	1	Integer	RO	N	V	Volt/Scale	0-32767	
4033	Voltage, A-N	1	Integer	RO	N	V	Volt/Scale	0-32767	
4034	Voltage, B-N	1	Integer	RO	N	V	Volt/Scale	0-32767	
4035	Voltage, C-N	1	Integer	RO	N	V	Volt/Scale	0-32767	
4036	Real Power, A	1	Integer	RO	N	W	kW/Scale	0-32767	Signed Net Consumption
4037	Real Power, B	1	Integer	RO	N	W	kW/Scale	0-32767	Signed Net Consumption
4038	Real Power, C	1	Integer	RO	N	W	kW/Scale	0-32767	Signed Net Consumption
4039	Apparent Power, A	1	Integer	RO	N	W	kVA/Scale	0-32767	
4040	Apparent Power, B	1	Integer	RO	N	W	kVA/Scale	0-32767	
4041	Apparent Power, C	1	Integer	RO	N	W	kVA/Scale	0-32767	
4042	Reactive Power, A	1	Integer	RO	N	W	kVAR/Scale	0-32767	Signed Net Consumption
4043	Reactive Power, B	1	Integer	RO	N	W	kVAR/Scale	0-32767	Signed Net Consumption
4044	Reactive Power, C	1	Integer	RO	N	W	kVAR/Scale	0-32767	Signed Net Consumption
4045	Current, A, THD	1	Integer	RO	N	0.1	%	0-10000	
4046	Current, B, THD	1	Integer	RO	N	0.1	%	0-10000	

RO = Read Only
R/W = Read/Write
NV = Nonvolatile.

Table B– 2: Register Listing—Metered Data *(continued)*

Metered Data									
Reg	**Name**	**Size**	**Type**	**Access**	**NV**	**Scale**	**Units**	**Range**	**Notes**
4047	Current, C, THD	1	Integer	RO	N	0.1	%	0-10000	
4048	Power Factor, Total Signed	1	Integer	RO	N	0.0001	-	0 - 1	"-" sign indicates lag
4049	Voltage, A-N, THD	1	Integer	RO	N	0.1	%	0-10000	
4050	Voltage, B-N, THD	1	Integer	RO	N	0.1	%	0-10000	
4051	Voltage, C-N, THD	1	Integer	RO	N	0.1	%	0-10000	
4052	Voltage, A-B, THD	1	Integer	RO	N	0.1	%	0-10000	
4053	Voltage, B-C, THD	1	Integer	RO	N	0.1	%	0-10000	
4054	Voltage, C-A, THD	1	Integer	RO	N	0.1	%	0-10000	
RO = Read Only R/W = Read/Write NV = Nonvolatile.									

Table B– 3: Register Listing—Demand Values

Demand Values									
Reg	**Name**	**Size**	**Type**	**Access**	**NV**	**Scale**	**Units**	**Range**	**Notes**
1022	Real Power, Total Demand Present	2	Float	RO	N	-	kW	-	
1024	Apparent Power, Total Demand Present	2	Float	RO	N	-	kVA	-	
1026	Reactive Power, Total Demand Present	2	Float	RO	N	-	kVAR	-	
1028	Real Power, Total Demand Peak	2	Float	RO	Y	-	kW	-	
1030	Apparent Power, Total Demand Peak	2	Float	RO	Y	-	kVA	-	
1032	Reactive Power, Total Demand Peak	2	Float	RO	Y	-	kVAR	-	
1042	Current, A, Demand Present	2	Float	RO	N	-	Amp	-	
1044	Current, B, Demand Present	2	Float	RO	N	-	Amp	-	
1046	Current, C, Demand Present	2	Float	RO	N	-	Amp	-	
RO = Read Only R/W = Read/Write NV = Nonvolatile.									

Table B– 3: Register Listing—Demand Values *(continued)*

Demand Values									
Reg	**Name**	**Size**	**Type**	**Access**	**NV**	**Scale**	**Units**	**Range**	**Notes**
1048	Current, A, Demand Peak	2	Float	RO	Y	-	Amp	-	
1050	Current, B, Demand Peak	2	Float	RO	Y	-	Amp	-	
1052	Current, C, Demand Peak	2	Float	RO	Y	-	Amp	-	
4014	Real Power, Total Demand Present	1	Integer	RO	N	W	kW/Scale	0-32767	
4015	Apparent Power, Total Demand Present	1	Integer	RO	N	W	kVA/Scale	0-32767	
4016	Reactive Power, Total Demand Present	1	Integer	RO	N	W	kVAR/Scale	0-32767	
4017	Real Power, Total Demand Peak	1	Integer	RO	Y	W	kW/Scale	0-32767	
4018	Apparent Power, Total Demand Peak	1	Integer	RO	Y	W	kVA/Scale	0-32767	
4019	Reactive Power, Total Demand Peak	1	Integer	RO	Y	W	kVAR/Scale	0-32767	
4024	Current, A, Demand Present	1	Integer	RO	N	I	Amp/Scale	0-32767	
4025	Current, B, Demand Present	1	Integer	RO	N	I	Amp/Scale	0-32767	
4026	Current, C, Demand Present	1	Integer	RO	N	I	Amp/Scale	0-32767	
4027	Current, A, Demand Peak	1	Integer	RO	Y	I	Amp/Scale	0-32767	
4028	Current, B, Demand Peak	1	Integer	RO	Y	I	Amp/Scale	0-32767	
4029	Current, C, Demand Peak	1	Integer	RO	Y	I	Amp/Scale	0-32767	
RO = Read Only R/W = Read/Write NV = Nonvolatile.									

Table B– 4: Register Listing—Min Max Values

Min Max values									
Reg	**Name**	**Size**	**Type**	**Access**	**NV**	**Scale**	**Units**	**Range**	**Notes**
1104	Real Power, Total Minimum	2	Float	RO	Y	-	kW	-	
1106	Apparent Power, Total Minimum	2	Float	RO	Y	-	kVA	-	
RO = Read Only R/W = Read/Write NV = Nonvolatile.									

Table B– 4: Register Listing—Min Max Values *(continued)*

Min Max values									
Reg	**Name**	**Size**	**Type**	**Access**	**NV**	**Scale**	**Units**	**Range**	**Notes**
1108	Reactive Power, Total Minimum	2	Float	RO	Y	-	kVAR	-	
1110	Power Factor, Total Minimum	2	Float	RO	Y	-	-	0.0-1.0	
1112	Frequency Minimum	2	Float	RO	Y	-	Hz	45.0-65.0	derived from Phase A
1114	Current, A, Minimum	2	Float	RO	Y	-	Amp	-	
1116	Current, B, Minimum	2	Float	RO	Y	-	Amp	-	
1118	Current, C, Minimum	2	Float	RO	Y	-	Amp	-	
1122	Voltage, A-N, Minimum	2	Float	RO	Y	-	Volt	-	
1124	Voltage, B-N, Minimum	2	Float	RO	Y	-	Volt	-	
1126	Voltage, C-N, Minimum	2	Float	RO	Y	-	Volt	-	
1128	Voltage, A-B, Minimum	2	Float	RO	Y	-	Volt	-	
1130	Voltage, B-C, Minimum	2	Float	RO	Y	-	Volt	-	
1132	Voltage, C-A, Minimum	2	Float	RO	Y	-	Volt	-	
1134	Current, A, THD Minimum	2	Float	RO	Y	-	%	0.0-1000.0	
1136	Current, B, THD Minimum	2	Float	RO	Y	-	%	0.0-1000.0	
1138	Current, C, THD Minimum	2	Float	RO	Y	-	%	0.0-1000.0	
1142	Voltage, A-N, THD Minimum	2	Float	RO	Y	-	%	0.0-1000.0	
1144	Voltage, B-N, THD Minimum	2	Float	RO	Y	-	%	0.0-1000.0	
1146	Voltage, C-N, THD Minimum	2	Float	RO	Y	-	%	0.0-1000.0	
1148	Voltage, A-B, THD Minimum	2	Float	RO	Y	-	%	0.0-1000.0	
1150	Voltage, B-C, THD Minimum	2	Float	RO	Y	-	%	0.0-1000.0	
1152	Voltage, C-A, THD Minimum	2	Float	RO	Y	-	%	0.0-1000.0	
1154	Real Power, Total Maximum	2	Float	RO	Y	-	kW	-	
1156	Apparent Power, Total Maximum	2	Float	RO	Y	-	kVA	-	
1158	Reactive Power, Total Maximum	2	Float	RO	Y	-	kVAR	-	
RO = Read Only R/W = Read/Write NV = Nonvolatile.									

Table B– 4: Register Listing—Min Max Values *(continued)*

Min Max values									
Reg	**Name**	**Size**	**Type**	**Access**	**NV**	**Scale**	**Units**	**Range**	**Notes**
1160	Power Factor, Total Maximum	2	Float	RO	Y	-	-	0.0-1.0	
1162	Frequency Maximum	2	Float	RO	Y	-	Hz	45.0-65.0	derived from Phase A
1164	Current, A, Maximum	2	Float	RO	Y	-	Amp	-	
1166	Current, B, Maximum	2	Float	RO	Y	-	Amp	-	
1168	Current, C, Maximum	2	Float	RO	Y	-	Amp	-	
1172	Voltage, A-N, Maximum	2	Float	RO	Y	-	Volt	-	
1174	Voltage, B-N, Maximum	2	Float	RO	Y	-	Volt	-	
1176	Voltage, C-N, Maximum	2	Float	RO	Y	-	Volt	-	
1178	Voltage, A-B, Maximum	2	Float	RO	Y	-	Volt	-	
1180	Voltage, B-C, Maximum	2	Float	RO	Y	-	Volt	-	
1182	Voltage, C-A, Maximum	2	Float	RO	Y	-	Volt	-	
1184	Current, A, THD Maximum	2	Float	RO	Y	-	%	0.0-1000.0	
1186	Current, B, THD Maximum	2	Float	RO	Y	-	%	0.0-1000.0	
1188	Current, C, THD Maximum	2	Float	RO	Y	-	%	0.0-1000.0	
1192	Voltage, A-N, THD Maximum	2	Float	RO	Y	-	%	0.0-1000.0	
1194	Voltage, B-N, THD Maximum	2	Float	RO	Y	-	%	0.0-1000.0	
1196	Voltage, C-N, THD Maximum	2	Float	RO	Y	-	%	0.0-1000.0	
1198	Voltage, A-B, THD Maximum	2	Float	RO	Y	-	%	0.0-1000.0	
1200	Voltage, B-C, THD Maximum	2	Float	RO	Y	-	%	0.0-1000.0	
1202	Voltage, C-A, THD Maximum	2	Float	RO	Y	-	%	0.0-1000.0	
4055	Real Power, Total Minimum	1	Integer	RO	Y	W	kW	0-32767	
4056	Apparent Power, Total Minimum	1	Integer	RO	Y	W	kVA	0-32767	
4057	Reactive Power, Total Minimum	1	Integer	RO	Y	W	kVAR	0-32767	
4058	Power Factor, Total Minimum	1	Integer	RO	Y	0.0001	-	0-10000	
RO = Read Only R/W = Read/Write NV = Nonvolatile.									

Table B– 4: Register Listing—Min Max Values *(continued)*

Min Max values									
Reg	**Name**	**Size**	**Type**	**Access**	**NV**	**Scale**	**Units**	**Range**	**Notes**
4059	Frequency Minimum	1	Integer	RO	Y	0.01	Hz	4500-6500	derived from Phase A
4060	Current, A, Minimum	1	Integer	RO	Y	I	Amp	0-32767	
4061	Current, B, Minimum	1	Integer	RO	Y	I	Amp	0-32767	
4062	Current, C, Minimum	1	Integer	RO	Y	I	Amp	0-32767	
4064	Voltage, A-N, Minimum	1	Integer	RO	Y	V	Volt	0-32767	
4065	Voltage, B-N, Minimum	1	Integer	RO	Y	V	Volt	0-32767	
4066	Voltage, C-N, Minimum	1	Integer	RO	Y	V	Volt	0-32767	
4067	Voltage, A-B, Minimum	1	Integer	RO	Y	V	Volt	0-32767	
4068	Voltage, B-C, Minimum	1	Integer	RO	Y	V	Volt	0-32767	
4069	Voltage, C-A, Minimum	1	Integer	RO	Y	V	Volt	0-32767	
4070	Current, A, THD Minimum	1	Integer	RO	Y	0.1	%	0-10000	
4071	Current, B, THD Minimum	1	Integer	RO	Y	0.1	%	0-10000	
4072	Current, C, THD Minimum	1	Integer	RO	Y	0.1	%	0-10000	
4074	Voltage, A-N, THD Minimum	1	Integer	RO	Y	0.1	%	0-10000	
4075	Voltage, B-N, THD Minimum	1	Integer	RO	Y	0.1	%	0-10000	
4076	Voltage, C-N, THD Minimum	1	Integer	RO	Y	0.1	%	0-10000	
4077	Voltage, A-B, THD Minimum	1	Integer	RO	Y	0.1	%	0-10000	
4078	Voltage, B-C, THD Minimum	1	Integer	RO	Y	0.1	%	0-10000	
4079	Voltage, C-A, THD Minimum	1	Integer	RO	Y	0.1	%	0-10000	
4080	Real Power, Total Maximum	1	Integer	RO	Y	W	kW	0-32767	
4081	Apparent Power, Total Maximum	1	Integer	RO	Y	W	kVA	0-32767	
4082	Reactive Power, Total Maximum	1	Integer	RO	Y	W	kVAR	0-32767	
4083	Power Factor, Total Maximum	1	Integer	RO	Y	0.0001	-	0-10000	
4084	Frequency Maximum	1	Integer	RO	Y	0.01	Hz	4500-6500	derived from Phase A
RO = Read Only R/W = Read/Write NV = Nonvolatile.									

Table B– 4: Register Listing—Min Max Values *(continued)*

Reg	Name	Size	Type	Access	NV	Scale	Units	Range	Notes
Min Max values									
4085	Current, A, Maximum	1	Integer	RO	Y	I	Amp	0-32767	
4086	Current, B, Maximum	1	Integer	RO	Y	I	Amp	0-32767	
4087	Current, C, Maximum	1	Integer	RO	Y	I	Amp	0-32767	
4089	Voltage, A-N, Maximum	1	Integer	RO	Y	V	Volt	0-32767	
4090	Voltage, B-N, Maximum	1	Integer	RO	Y	V	Volt	0-32767	
4091	Voltage, C-N, Maximum	1	Integer	RO	Y	V	Volt	0-32767	
4092	Voltage, A-B, Maximum	1	Integer	RO	Y	V	Volt	0-32767	
4093	Voltage, B-C, Maximum	1	Integer	RO	Y	V	Volt	0-32767	
4094	Voltage, C-A, Maximum	1	Integer	RO	Y	V	Volt	0-32767	
4095	Current, A, THD Maximum	1	Integer	RO	Y	0.1	%	0-10000	
4096	Current, B, THD Maximum	1	Integer	RO	Y	0.1	%	0-10000	
4097	Current, C, THD Maximum	1	Integer	RO	Y	0.1	%	0-10000	
4099	Voltage, A-N, THD Maximum	1	Integer	RO	Y	0.1	%	0-10000	
4100	Voltage, B-N, THD Maximum	1	Integer	RO	Y	0.1	%	0-10000	
4101	Voltage, C-N, THD Maximum	1	Integer	RO	Y	0.1	%	0-10000	
4102	Voltage, A-B, THD Maximum	1	Integer	RO	Y	0.1	%	0-10000	
4103	Voltage, B-C, THD Maximum	1	Integer	RO	Y	0.1	%	0-10000	
4104	Voltage, C-A, THD Maximum	1	Integer	RO	Y	0.1	%	0-10000	

RO = Read Only
R/W = Read/Write
NV = Nonvolatile.

Table B– 5: Register Listing—I/O Setup and Status

I/O Setup & Status									
Reg	**Name**	**Size**	**Type**	**Access**	**NV**	**Scale**	**Units**	**Range**	**Notes**
4114	Digital Output Status	1	Integer	RO	N	-	-	0 - 1	0 = Off 1 = On
4115	Digital Input S1 Status	1	Integer	RO	N	-	-	0 - 1	0 = Off 1 = On
4116	Digital Input S2 Status	1	Integer	RO	N	-	-	0 - 1	0 = Off 1 = On
4129	Digital Output Mode	1	Integer	R/W	Y	-	-	0 - 2	0 = External Control (default) 1 = Alarm Mode 2 = KWH Pulse Mode
4130	Digital Input S1 Mode	1	Integer	R/W	Y	-	-	0 - 1	0 = Normal (default) 1 = Demand Interval Synch
4131	Digital Input S2 Mode	1	Integer	R/W	Y	-	-	0 - 1	0 = Normal (default) 1 = Demand Interval Synch
4132	Digital Output Counter	2	Long	RO	Y	-	-	0 - 4,294,967,296	
4134	Digital Input S1 Counter	2	Long	RO	Y	-	-	0 - 4,294,967,296	
4136	Digital Input S2 Counter	2	Long	RO	Y	-	-	0 - 4,294,967,296	
RO = Read Only R/W = Read/Write NV = Nonvolatile.									

Table B– 6: Register Listing—Alarm Setup and Status

Alarm Setup & Status									
Reg	**Name**	**Size**	**Type**	**Access**	**NV**	**Scale**	**Units**	**Range**	**Notes**
4113	Alarm Status Bitmap	1	Integer	RO	N	-	-	0x0000 - 07FFF	0 = Alarm OFF 1 = Alarm ON Bit 00 = Alarm Position 1 (Default Over kW-Total) Bit 01 = Alarm Position 2 (Default Over kVA-Total) Bit 02 = Alarm Position 3 (Default Over kVAR-Total) Bit 03 = Alarm Position 4 (Default Under PF-Total) Bit 04 = Alarm Position 5 (Default Over U 3-Phase) Bit 05 = Alarm Position 6 ((Default Over V 3-Phase) Bit 06 = Alarm Position 7 (Default Under U 3-Phase) Bit 07 = Alarm Position 8 (Default Under V 3-Phase)) Bit 08 = Alarm Position 9 (Default Over Current 3-Phase) Bit 09 = Alarm Position 10 (Default Over Frequency) Bit 10 = Alarm Position 11 (Default Under Frequency) Bit 11 = Alarm Position 12 (Default Over THD Current 3-Phase) Bit 12 = Alarm Position 13 (Default Over THD Voltage 3-Phase) Bit 13 = Alarm Position 14 (Default Digital Input S1 OFF-ON) Bit 14 = Alarm Position 15 (Default Digital Input S2 OFF-ON) Bit 15 = Not Used
4139	Alarm Setup Semaphore	1	Integer	R/W	N	-	-	0 - 60	Enter the amount of time in seconds needed to write the setup of the alarms
4140	Alarm Position 1 Configuration	16	-	R/CW	Y	-	-	-	See Alarm Configuration Template
RO = Read Only R/W = Read/Write NV = Nonvolatile.									

Table B– 6: Register Listing—Alarm Setup and Status *(continued)*

Alarm Setup & Status									
Reg	**Name**	**Size**	**Type**	**Access**	**NV**	**Scale**	**Units**	**Range**	**Notes**
4156	Alarm Position 2 Configuration	16	-	R/CW	Y	-	-	-	See Alarm Configuration Template
4172	Alarm Position 3 Configuration	16	-	R/CW	Y	-	-	-	See Alarm Configuration Template
4188	Alarm Position 4 Configuration	16	-	R/CW	Y	-	-	-	See Alarm Configuration Template
4204	Alarm Position 5 Configuration	16	-	R/CW	Y	-	-	-	See Alarm Configuration Template
4220	Alarm Position 6 Configuration	16	-	R/CW	Y	-	-	-	See Alarm Configuration Template
4236	Alarm Position 7 Configuration	16	-	R/CW	Y	-	-	-	See Alarm Configuration Template
4252	Alarm Position 8 Configuration	16	-	R/CW	Y	-	-	-	See Alarm Configuration Template
4268	Alarm Position 9 Configuration	16	-	R/CW	Y	-	-	-	See Alarm Configuration Template
4284	Alarm Position 10 Configuration	16	-	R/CW	Y	-	-	-	See Alarm Configuration Template
4300	Alarm Position 11 Configuration	16	-	R/CW	Y	-	-	-	See Alarm Configuration Template
4316	Alarm Position 12 Configuration	16	-	R/CW	Y	-	-	-	See Alarm Configuration Template
4332	Alarm Position 13 Configuration	16	-	R/CW	Y	-	-	-	See Alarm Configuration Template
4348	Alarm Position 14 Configuration	16	-	R/CW	Y	-	-	-	See Alarm Configuration Template
4364	Alarm Position 15 Configuration	16	-	R/CW	Y	-	-	-	See Alarm Configuration Template
Alarm Configuration Template									
Reg	**Name**	**Size**	**Type**	**Access**	**NV**	**Scale**	**Units**	**Range**	**Notes**
Base	Alarm Type	1	Integer	R/CW	Y	-	-		10 = Over 20 = Under 60 = Digital (OFF to ON) 61 = Digital (ON to OFF)
Base + 1	Test Register	1	Integer	R/CW	Y	-	-	4006 - 4104, 4110 - 4111, 4115 - 4116	
Base + 2	Enable	1	Integer	R/CW	Y	-	-	0 - 1	0 = Disable (default) 1 = Enable
Base + 3	Output Association	1	Integer	R/CW	Y	-	-	0 - 1	0 = Disable (default) 1 = Enable
Base + 4	Pickup Magnitude	1	Integer	R/CW	Y			0 - 32767	Will only evaluate based on Register Value, will not apply scaler
Base + 5	Dropout Magnitude	1	Integer	R/CW	Y			0 - 32767	Will only evaluate based on Register Value, will not apply scaler
RO = Read Only R/W = Read/Write NV = Nonvolatile.									

Table B– 6: Register Listing—Alarm Setup and Status *(continued)*

Alarm Setup & Status									
Reg	**Name**	**Size**	**Type**	**Access**	**NV**	**Scale**	**Units**	**Range**	**Notes**
Base + 6	Pickup Time Delay	1	Integer	R/CW	Y	-	Seconds	0 - 32767	
Base + 7	Dropout Time Delay	1	Integer	R/CW	Y	-	Seconds	0 - 32767	
Base + 8	Label	8	ASCII	R/CW	Y	-	-		
RO = Read Only R/W = Read/Write NV = Nonvolatile.									

Table B– 7: Register Listing—Reset Commands

Reset Commands—Write commands to Register 4126.			
Command	**Parameters**		**Notes**
666			Restart demand metering Does not reset Peaks
1115			Reset Meter
3211			Reset all alarms to default values
3320			De-energize digital output
3321			Energize digital output
3361			Reset digital output counter
3365			Reset digital input counters
6209	Register:	Energy value to appear in register:	Preset Energy Values
	7016	4000	
	7017	4001	
	7018	4002	
	7019	4003	
	7020	4004	
	7021	4005	
10001			Clear the Usage Timers. (Set to 0)
14255			Reset all Min/Max Values. (Sets values to defaults)
21212			Reset Peak Demand values. (Set to 0)
30078			Clear all Energy Accumulators. (Set to 0)

SUPPORTED MODBUS COMMANDS

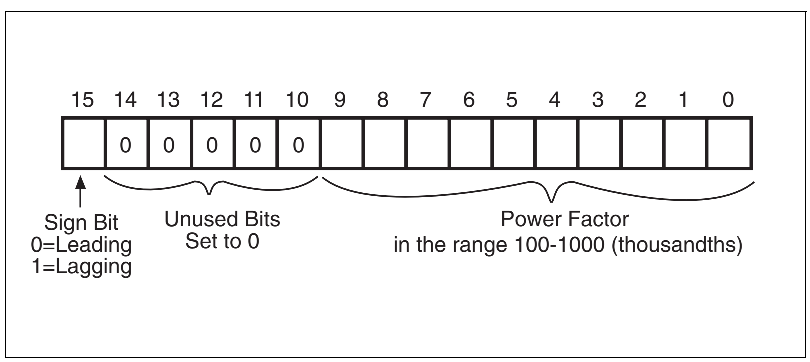
Table B– 8:

Command	Description
0x03	Read holding registers
0x04	Read input registers
0x06	Preset single registers
0x10	Preset multiple registers
0x11	Report ID Return String byte 1: 0x11 byte 2: number of bytes following without crc byte 3: ID byte = 250 byte 4: status = 0xFF bytes 5+: ID string = PM710 Power Meter last 2 bytes: CRC
0x2B	Read device identification, BASIC implementation (0x00, 0x01, 0x02 data), conformity level 1, **Object Values** 0x01: If register 4128 is 0, then “Merlin Gerin. If register 4128 is 1, then “Square D” 0x02: “PM710” 0x03: “Vxx.yyy” where xx.yyy is the OS version number. This is the reformatted version of register 7001. If the value for register 7001 is 12345, then the 0x03 data would be “V12.345”

HOW SIGNED POWER FACTOR IS STORED IN THE REGISTER

Each power factor value occupies one register. Power factor values are stored using signed magnitude notation (see Figure B–1). Bit number 15, the sign bit, indicates leading/lagging. A positive value (bit 15=0) always indicates leading. A negative value (bit 15=1) always indicates lagging. Bits 0–9 store a value in the range 0–1,000 decimal. For example, the power meter would return a leading power factor of 0.5 as 500. Divide by 1,000 to get a power factor in the range 0 to 1.000.

Figure B– 1: Power factor register format



When the power factor is lagging, the power meter returns a high negative value—for example, -31,794. This happens because bit 15=1 (for example, the binary equivalent of -31,794 is 1000001111001110). To get a value in the range 0 to 1,000, you need to mask bit 15. You do this by adding 32,768 to the value. An example will help clarify.

Assume that you read a power factor value of -31,794. Convert this to a power factor in the range 0 to 1.000, as follows:

-31,794 + 32,768 = 974

974/1,000 = .974 lagging power factor

APPENDIX C—INSTRUMENT TRANSFORMER WIRING: TROUBLESHOOTING GUIDE

Abnormal readings in an installed meter can sometimes signify improper wiring. This appendix is provided as an aid in troubleshooting potential wiring problems.

SECTION I: USING THIS GUIDE

The following sections contain “Case” tables showing a variety of symptoms and probable causes. The symptoms listed are “ideal,” and some judgment should be exercised when troubleshooting. For example, if the kW reading is 25, but you know that it should be about 300 kW, go to a table where “kW = 0” is listed as one of the symptoms.

“Section II: Common Problems for 3-Wire and 4-Wire Systems ” addresses symptoms and possible causes that occur regardless of system type. Check this section first. If the symptoms are more complicated, proceed to “Section III: 3-Wire System Troubleshooting” or “Section IV: 4-Wire System Troubleshooting” as is appropriate.

Because it is nearly impossible to address all combinations of multiple wiring mistakes or other problems that can occur (e.g., blown PT fuses, missing PT neutral ground connection, etc.), this guide generally addresses only one wiring problem at a time.

Before trying to troubleshoot wiring problems, it is imperative that all instantaneous readings be available for reference. Specifically those readings should include the following:

- line-to-line voltages
- line-to-neutral voltages
- phase currents
- power factor
- kW
- kVAR
- kVA

What is Normal?

Most power systems have a lagging (inductive) power factor. The only time a leading power factor is expected is if power factor correction capacitors are switched in or over-excited synchronous motors with enough capacitive kVARS on-line to overcorrect the power factor to leading. Some uninterruptable power supplies (UPS) also produce a leading power factor.

"Normal" lagging power system readings are as follows:

- Positive kW = $(\sqrt{3} \times V_{AB} \times I_{3\Phi Avg} \times PF_{3\Phi Avg})/1000$
- Negative kVAR = $(\sqrt{(kVA)^2 - (kW)^2})/1000$
- kVA (always positive) = $(\sqrt{3} \times V_{AB} \times I_{3\Phi Avg})/1000$
- $PF_{3\Phi Avg}$ = lagging in the range 0.70 to 1.00 (for 4-wire systems, all phase PFs are about the same)
- Phase currents approximately equal
- Phase voltages approximately equal

A quick check for proper readings consists of kW comparisons (calculated using the equation above and compared to the meter reading) and a reasonable lagging 3-phase average power factor reading. If these checks are okay, there is little reason to continue to check for wiring problems.

SECTION II: COMMON PROBLEMS FOR 3-WIRE AND 4-WIRE SYSTEMS

Table C– 1: Section II—Case A

Symptoms: 3-Wire and 4-Wire	Possible Causes
• Zero amps • Zero kW, kVAR, kVA	• CT secondaries shorted • Less than 2% load on power meter based on CT ratio Example: with 100/5 CT's, at least 2A must flow through CT window for power meter to “wake up”

Table C– 2: Section II—Case B

Symptoms: 3-Wire and 4-Wire	Possible Causes
• Negative kW of expected magnitude • Positive kVAR • Normal lagging power factor	• All three CT polarities backwards; could be CTs are physically mounted with primary polarity mark toward the load instead of toward source or secondary leads swapped • All three PT polarities backwards; again, could be on primary or secondary *NOTE: Experience shows CTs are usually the problem.*

Table C– 3: Section II—Case C

Symptoms: 3-Wire and 4-Wire	Possible Causes
• Frequency is an abnormal value; may or may not be a multiple of 60 Hz.	• PTs primary and/or secondary neutral common not grounded (values as high as 275 Hz and as low as 10 Hz have been seen) • System grounding problem at the power distribution transformer (such as utility transformer), though this is not likely

SECTION III: 3-WIRE SYSTEM TROUBLESHOOTING

Table C– 4: Section III—Case A

Symptoms: 3-Wire	Possible Causes
• Currents and voltages approximately balanced • kW = near 0 • kVAR = near 0 • PF can be any value, probably fluctuating	• CT secondary leads are swapped (A-phase lead on C-phase terminal and vice versa) • PT secondary leads are swapped (A-phase lead on C-phase terminal and vice versa)

Table C– 5: Section III—Case B

Symptoms: 3-Wire	Possible Causes
• Phase B current is $\sqrt{3}$ higher than A and C (except in System Type 31) • kVA = about half of the expected magnitude • kW and kVAR can be positive or negative, less than about half of the expected magnitude • PF can be any value, probably a low leading value	• One CT polarity is backwards

Table C– 6: Section III—Case C

Symptoms: 3-Wire	Possible Causes
• V_{CA} is $\sqrt{3}$ higher than V_{AB} and V_{BC} • kVA = about half of the expected magnitude • kW and kVAR can be positive or negative, less than about half of the expected magnitude • PF can be any value, probably a low leading value	• One PT polarity is backwards

Table C– 7: Section III—Case D

Symptoms: 3-Wire	Possible Causes
• kW = 0 or low, with magnitude less than kVAR • kVAR = positive or negative with magnitude of close to what is expected for kW • kVA = expected magnitude • PF = near 0 up to about 0.7 lead	• Either the two voltage leads are swapped OR the two current leads are swapped AND one instrument transformer has backwards polarity (look for $V_{CA} = \sqrt{3}$ high or phase B current = $\sqrt{3}$ high) • The power meter is metering a purely capacitive load (this is unusual); in this case kW and kVAR will be positive and PF will be near 0 lead

Table C– 8: Section III—Case E

Symptoms: 3-Wire	Possible Causes
• One phase current reads 0 • kVA = about 1/2 of the expected value • kW, kVAR, and power factor can be positive or negative of any value	• The CT on the phase that reads 0 is short-circuited • Less than 2% current (based on CT ratio) flowing through the CT on the phase that reads 0

SECTION IV: 4-WIRE SYSTEM TROUBLESHOOTING

Table C– 9: Section IV—Case A

Symptoms: 4-Wire	Possible Causes
• kW = 1/3 of the expected value • kVAR = 1/3 of the expected value • power factor = 1/3 of the expected value • All else is normal	• One CT polarity is backwards *NOTE: The only way this problem will usually be detected is by the Quick Check procedure. It is very important to always calculate kW. In this case, it is the only symptom and will go unnoticed unless the calculation is done or someone notices backwards CT on a waveform capture.*

Table C– 10: Section IV—Case B

Symptoms: 4-Wire	Possible Causes
• kW = 1/3 of the expected value • kVAR = 1/3 of the expected value • 2 of the 3 line-to-line voltages are $\sqrt{3}$ low • power factor = 1/3 of the expected value • All else is normal	• One PT polarity is backwards *NOTE: The line-to-line voltage reading that does not reference the PT with backwards polarity will be the only correct reading.* Example: $V_{AB} = 277, V_{BC} = 480, V_{CA} = 277$ In this case, the A-phase PT polarity is backwards. V_{BC} is correct because it does not reference V_A.

Table C– 11: Section IV—Case C

Symptoms: 4-Wire	Possible Causes
• One line-to-neutral voltage is zero • 2 of the 3 line-to-line voltages are $\sqrt{3}$ low • kW = 2/3 of the expected value • kVAR = 2/3 of the expected value • kVA = 2/3 of the expected value • Power factor may look abnormal	• PT metering input missing (blown fuse, open phase disconnect, etc.) on the phase that reads zero. *NOTE: The line-to-line voltage reading that does not reference the missing PT input will be the only correct reading.* Example: $V_{AB} = (277), V_{BC} = 277, V_{CA} = 480$ In this case, the B-phase PT input is missing. V_{CA} is correct because it does not reference V_B.

Table C– 12: Section IV—Case D

Symptoms: 4-Wire	Possible Causes
• 3-phase kW = 2/3 of the expected value • 3-phase kVAR = 2/3 of the expected value • 3-phase kVA = 2/3 of the expected value • One phase current reads 0 • All else is normal	• The CT on the phase that reads 0 is short-circuited • Less than 2% current (based on CT ratio) flowing through the CT on the phase that reads 0

Table C– 13: Section IV—Case E

Symptoms: 4-Wire	Possible Causes
• kW = near 0 • kVA = near 0 • 3-phase average power factor flip-flopping lead and lag • Voltages, currents, and kVA are normal	• Two CT secondary leads are swapped (A-phase on B-phase terminal, for example) • Two PT secondary leads are swapped (A-phase on B-phase terminal, for example) *NOTE: In either case, the phase input that is **not** swapped will read normal lagging power factor.*

Table C– 14: Section IV—Case F

Symptoms: 4-Wire	Possible Causes
• kW = negative and less than kVAR • KVAR = negative and close to value expected for kW • kVA = expected value • Power factor low and leading • Voltages and currents are normal	• All three PT lead connections “rotated” counterclockwise: A-phase wire on C-phase terminal, B-phase wire on A-phase terminal, C-phase wire on B-phase terminal. • All three CT lead connections “rotated” clockwise: A-phase wire on B-phase terminal, B-phase wire on C-phase terminal, C-phase wire on A-phase terminal.

Table C– 15: Section IV—Case G

Symptoms: 4-Wire	Possible Causes
• kW = negative and less than kVAR • kVAR = positive and close to the value for kW *NOTE: looks like kW and kVAR swapped places* • kVA = expected value • Power factor low and lagging • Voltages and currents are normal	• All three PT lead connections “rotated” clockwise: A-phase wire on B-phase terminal, B-phase wire on C-phase terminal, C-phase wire on A-phase terminal. • All three CT lead connections “rotated” counterclockwise: A-phase wire on C-phase terminal, B-phase wire on A-phase terminal, C-phase wire on B-phase terminal.

FIELD EXAMPLE

Readings from a 4-wire system

- $kW = 25$
- $kVAR = -15$
- $kVA = 27$
- $I_A = 904A$
- $I_B = 910A$
- $I_C = 931A$
- $I_{3\Phi Avg} = 908A$
- $V_{AB} = 495V$
- $V_{BC} = 491V$
- $V_{CA} = 491V$
- $V_{AN} = 287V$
- $V_{BN} = 287V$
- $V_{CN} = 284V$
- $PF_{3\Phi Avg} = 0.75$ lag to 0.22 lead fluctuating

Troubleshooting Diagnosis

- Power factors cannot be correct
- None of the “Section II” symptoms exist, so proceed to the 4-wire troubleshooting (“Section IV”)
- Cannot calculate kW because 3-phase power factor cannot be right, so calculate kVA instead
- Calculated kVA $= (\sqrt{3} \times V_{ab} \times I_{3\Phi Avg}) / 1000$
  $= (1.732 \times 495 \times 908) / 1000$
  $= 778 \text{ kVA}$
- Power meter reading is essentially zero compared to this value
- 4-wire Case E looks similar
- Since the PTs were connected to other power meters which were reading correctly, suspect two CT leads swapped
- Since A-phase power factor is the only one that has a normal looking lagging value, suspect B and C-phase CT leads may be swapped
- After swapping B and C-phase CT leads, all readings went to the expected values; problem solved

GLOSSARY

TERMS

accumulated energy—energy can accumulates in either signed or unsigned (absolute) mode. In signed mode, the direction of power flow is considered and the accumulated energy magnitude may increase and decrease. In absolute mode, energy accumulates as a positive regardless of the power flow direction.

active alarm—an alarm that has been set up to trigger the execution of a task or notification when certain conditions are met. An icon in the upper-right corner of the meter indicates that an alarm is active (⚠). See also *enabled alarm* and *disabled alarm.*

baud rate—specifies how fast data is transmitted across a network port.

block interval demand—power demand calculation method for a block of time and includes three ways to apply calculating to that block of time using the sliding block, fixed block, or rolling block method.

communications link—a chain of devices connected by a communications cable to a communications port.

current transformer (CT)—current transformer for current inputs.

demand—average value of a quantity, such as power, over a specified interval of time.

device address—defines where the power meter resides in the power monitoring system.

event—the occurrence of an alarm condition, such as *Undervoltage Phase A*, configured in the power meter.

firmware—operating system within the power meter

fixed block—an interval selected from 1 to 60 minutes (in 1-minute increments). The power meter calculates and updates the demand at the end of each interval.

float—a 32-bit floating point value returned by a register. The upper 16-bits are in the lowest-numbered register pair. For example, in the register 4010/11, 4010 contains the upper 16-bits while 4011 contains the lower 16-bits.

frequency—number of cycles in one second.

line-to-line voltages—measurement of the rms line-to-line voltages of the circuit.

line-to-neutral voltages—measurement of the rms line-to-neutral voltages of the circuit.

maximum demand current—highest demand current measured in amperes since the last reset of demand.

maximum demand real power—highest demand real power measured since the last reset of demand.

maximum demand voltage—highest demand voltage measured since the last reset of demand.

maximum demand—highest demand measured since the last reset of demand.

maximum value—highest value recorded of the instantaneous quantity such as Phase A Current, Phase A Voltage, etc., since the last reset of the minimums and maximums.

minimum value—lowest value recorded of the instantaneous quantity such as Phase A Current, Phase A Voltage, etc., since the last reset of the minimums and maximums.

nominal—typical or average.

parity—refers to binary numbers sent over the communications link. An extra bit is added so that the number of ones in the binary number is either even or odd, depending on your configuration). Used to detect errors in the transmission of data.

partial interval demand—calculation of energy thus far in a present interval. Equal to energy accumulated thus far in the interval divided by the length of the complete interval.

phase currents (rms)—measurement in amperes of the rms current for each of the three phases of the circuit. See also *maximum value*.

phase rotation—refers to the order in which the instantaneous values of the voltages or currents of the system reach their maximum positive values. Two phase rotations are possible: A-B-C or A-C-B.

potential transformer (PT)—also known as a voltage transformer.

power factor (PF)—true power factor is the ratio of real power to apparent power using the complete harmonic content of real and apparent power. Calculated by dividing watts by volt amperes. Power factor is the difference between the total power your utility delivers and the portion of total power that does useful work. Power factor is the degree to which voltage and current to a load are out of phase.

real power—calculation of the real power (3-phase total and per-phase real power calculated) to obtain kilowatts.

rms—root mean square. Power meters are true rms sensing devices.

rolling block—a selected interval and subinterval that the power meter uses for demand calculation. The subinterval must divide evenly into the interval. Demand is updated at each subinterval, and the power meter displays the demand value for the last completed interval.

scale factor—multipliers that the power meter uses to make values fit into the register where information is stored.

safety extra low voltage (SELV) circuit—a SELV circuit is expected to always be below a hazardous voltage level.

short integer—a signed 16-bit integer.

sliding block—an interval selected from 1 to 60 minutes (in 1-minute increments). If the interval is between 1 and 15 minutes, the demand calculation updates every 15 seconds. If the interval is between 16 and 60 minutes, the demand calculation updates every 60 seconds. The power meter displays the demand value for the last completed interval.

system type—a unique code assigned to each type of system wiring configuration of the power meter.

thermal demand—demand calculation based on thermal response.

Total Harmonic Distortion (THD or thd)—indicates the degree to which the voltage or current signal is distorted in a circuit.

total power factor—*see power factor*.

true power factor—see *power factor*.

unsigned integer—an unsigned 16-bit integer.

unsigned long integer—an unsigned 32-bit value returned by a register. The upper 16-bits are in the lowest-numbered register pair. For example, in the register pair 4010 and 4011, 4010 contains the upper 16-bits while 4011 contains the lower 16-bits.

ABBREVIATIONS

A—Ampere

ADDR—Power meter address

AMPS—Amperes

BARGR—Bargraph

COMMS—Communications

CPT—Control Power Transformer

CT—see *current transformer on* page 57

D IN—Digital Input

D OUT—Digital Output

DMD—Demand

DO—Drop Out Limit

ENABL—Enabled

F—Frequency

HZ—Hertz

I—Current

I/O—Input/Output

IMAX—Current maximum demand

kVA—Kilovolt-Ampere

kVAD—Kilovolt-Ampere demand

kVAR—Kilovolt-Ampere reactive

kVARD—Kilovolt-Ampere reactive demand

kVARH—Kilovolt-Ampere reactive hour

kW—Kilowatt

kWD—Kilowatt demand

kWH—Kilowatthours

kWH/P—Kilowatthours per pulse

kWMAX—Kilowatt maximum demand

MAG—Magnitude

MAINT—Maintenance screen

MBUS—MODBUS

MIN—Minimum

MINMX—Minimum and maximum values

MSEC—Milliseconds

MVAh—Megavolt ampere hour

MVARh—Megavolt ampere reactive hour

MWh—Megawatt hour

O.S.—Operating System (firmware version)

P—Real power

PAR—Parity

PASSW—Password

Pd—Real power demand

PF—Power factor

Ph—Real energy

PM—Power meter

PQS—Real, reactive, apparent power

PQSd—Real, reactive, apparent power demand

PR—Alarm Priority

PRIM—Primary

PT—Number of voltage connections (see *potential transformer on* page 58)

PU—Pick Up Limit

PULSE—Pulse output mode

PWR—Power

Q—Reactive power

Qd—Reactive power demand

Qh—Reactive energy

R.S.—Firmware reset system version

S—Apparent power

S.N.—Power meter serial number

SCALE—see *scale factor* on page 58

Sd—Apparent power demand

SECON—Secondary

SEC—Secondary

Sh—Apparent Energy

SUB-I—Subinterval

THD—Total Harmonic Distortion

U—Voltage line to line

V—Voltage

VAR—volt ampere reactive.

VMAX—Maximum voltage

VMIN—Minimum voltage

INDEX

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