Instruction Leaflet for Modbus Power Monitoring/ Metering Module (PM3) for FD, JG, and KD/LG Circuit Breakers and Motor Circuit Protectors

Contents

Powering Business Worldwide

1. Installation and Specifications

⚠ CAUTION

DO NOT ATTEMPT TO INSTALL OR PERFORM MAINTENANCE ON EQUIPMENT WHILE IT IS ENERGIZED. DEATH OR SEVERE PERSONAL INJURY CAN RESULT FROM CONTACT WITH ENERGIZED EQUIPMENT. ALWAYS VERIFY THAT NO VOLTAGE IS PRESENT BEFORE PROCEEDING.

1. Attach endcap.

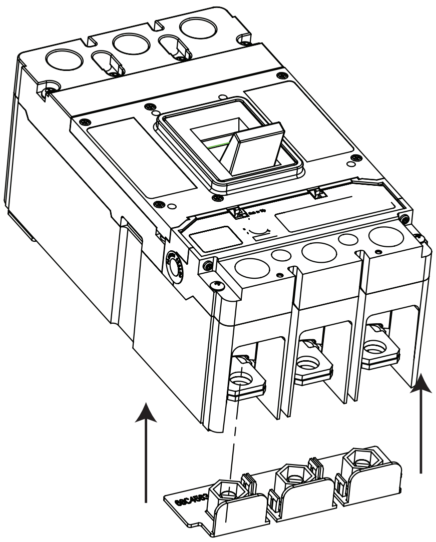


Figure 1. Attaching the Endcap.

Table 1. End Cap Kits.

Breaker Frame	End Cap Kit Cat #	End Cap Kit Style #
FD	KPEKM1	6606C63G04
FD	KPEK1	67B9101G03
JG	FJ3RTWK	68C2837G09
JG	FJ3RTDK	68C2837G07
KD	KPEKM3	5102A14G02
KD	KPEK3	5102A14G01
LG	L3RTWK	66A4562G05

2. Insert unit into breaker.

Breaker must be in OFF or TRIPPED position for assembly.

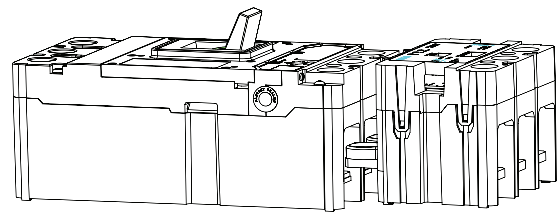


Figure 2. Inserting the Unit into the Breaker.

3. Push down.

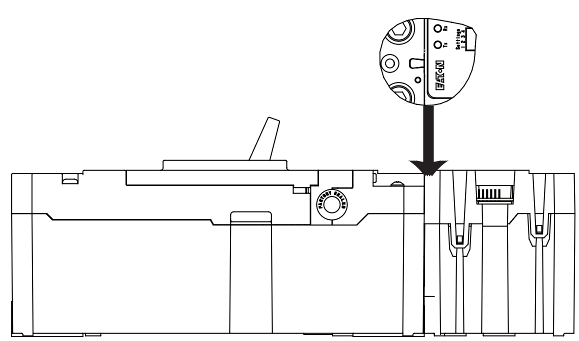


Figure 3. Locking the Unit in Place.

4. Insert screws in retainers.

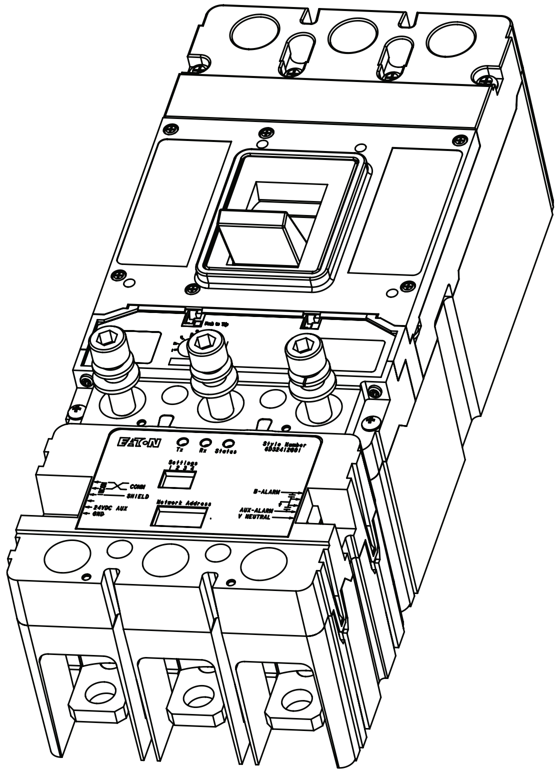
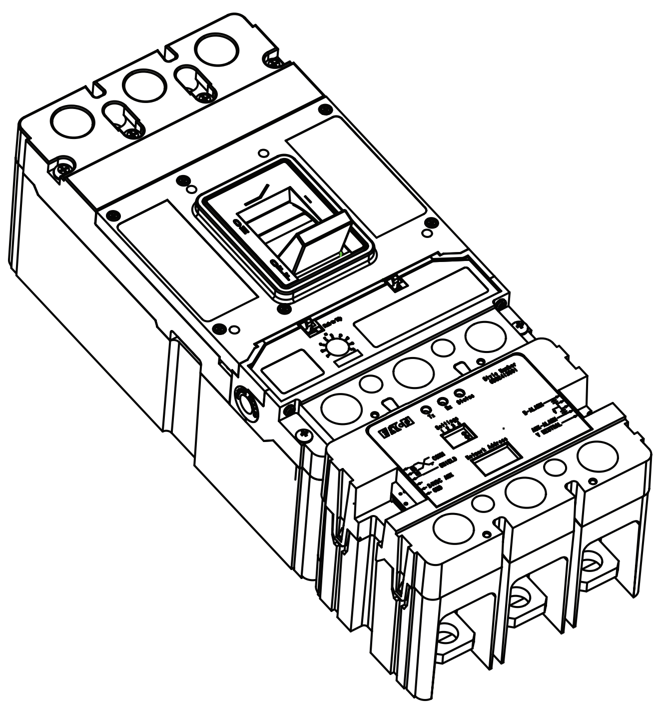


Figure 4. Inserting the Screws into the Retainers.

5. Tighten mounting screws to provided torque specifications.



Torque Chart for Connecting PM3 to Breaker

Breaker Frame	Head Size	Torque
FD	Slotted screw	34-38 in-lb 4-4.4 N•m
JG	Hex .236"	120-144 in-lb 14-16 N•m
KD	Hex .236"	120-144 in-lb 14-16 N•m
LG	Hex .315"	275 in-lb 31 N•m

Figure 5. Torquing the Mounting Screws.

Table 2. FD, JG, KD, LG Terminal Information.

Frame Type	Wire Type	Wire Size AWG	Wire Size mm²	Terminal Materials	Catalog Number	Torque Lb.In.	Torque Nm
LG-Frame	Cu/Al	500-750(1)	240-380(1)	Aluminum	TA631L*2	550	62
LG-Frame	Cu/Al	2-500(2)	35-240(2)	Aluminum	TA632L*1*2	375	42
LG-Frame	Cu/Al	2-500(1)	35-240(1)	Aluminum	TA350L	375	42
KD-Frame*3	Cu/Al	2-500(2)	35-240(2)	Aluminum	TA632L*1*2	375	42
KD-Frame*3	Cu/Al	2-500(1)	35-240(1)	Aluminum	TA350L	375	42
JG-Frame	Cu/Al	#4-350(1)	25-185	Aluminum	TA250FJ	250	28.2
FD-Frame	Cu/Al	4-40	25-95	Aluminum	3TA225FD	120	13.5

*1 Standard collars mounted on line and load end.

*2 Terminal Shield required.

*3 When using PM3 on KD breakers, LG terminals are required on load end of PM3.

⚠ CAUTION

TERMINAL SHIELDS MUST BE USED AS PER ORIGINAL CIRCUIT BREAKER INSTALLATION INSTRUCTIONS.

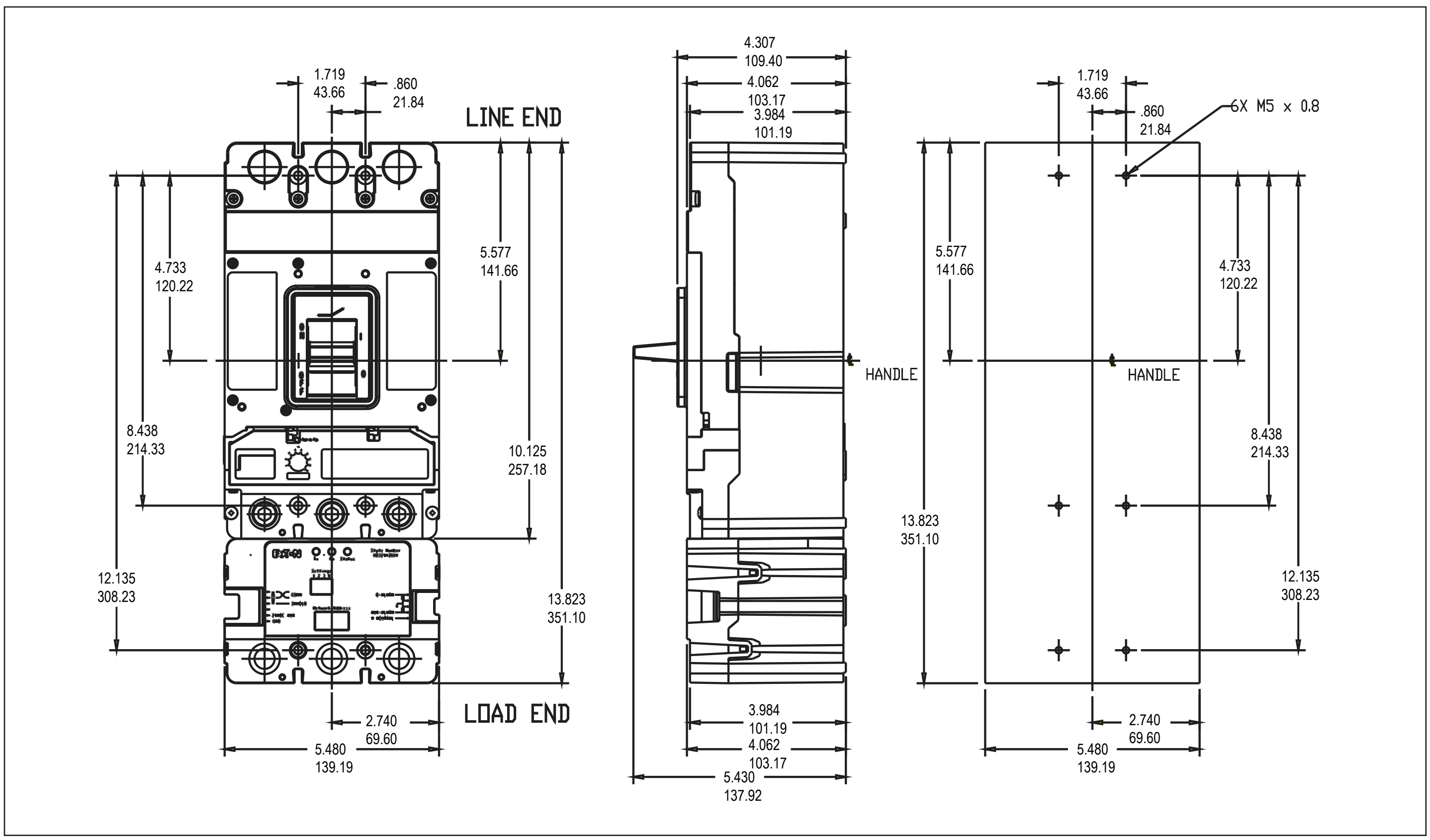


Figure 6. Layout of LG 3 Pole with PM3.

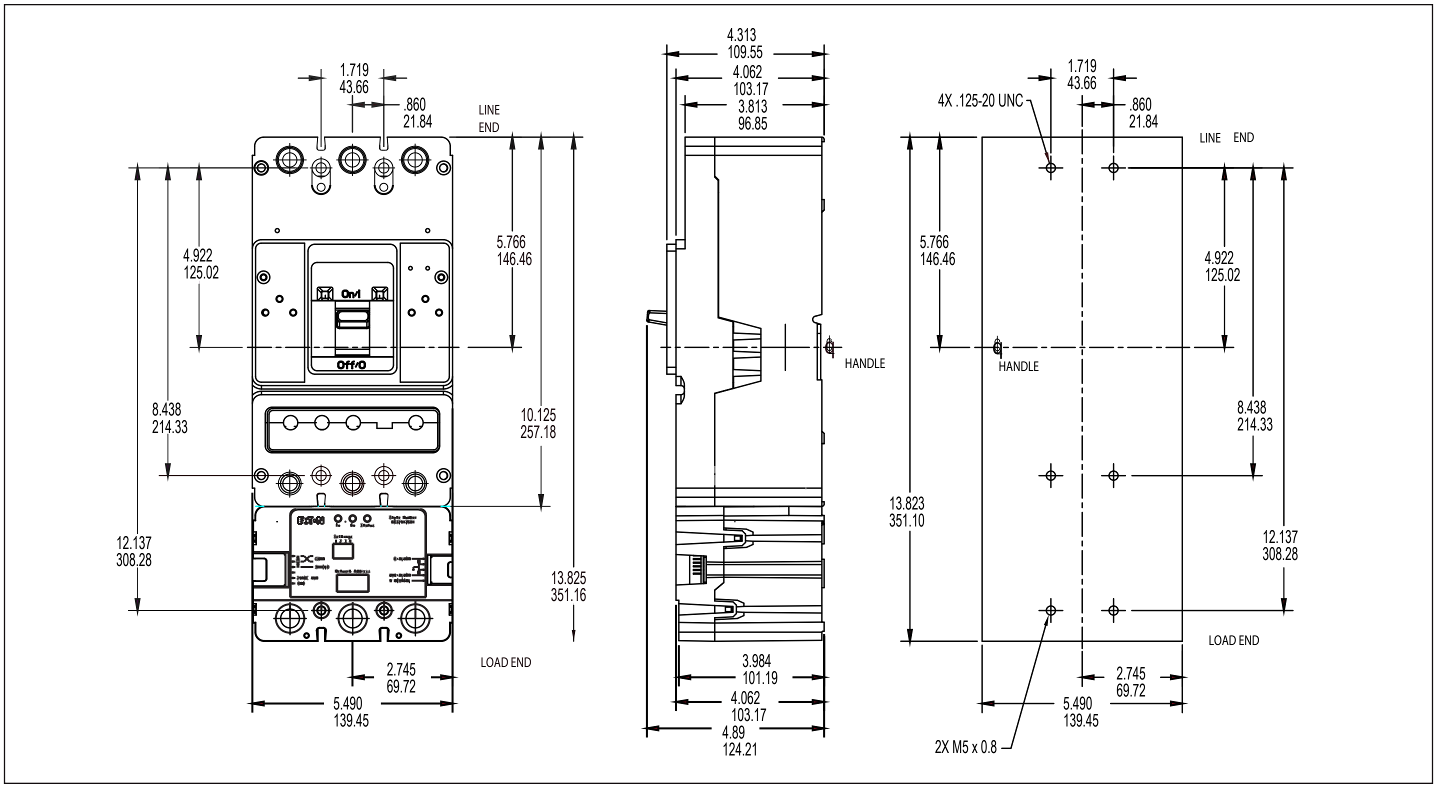


Figure 7. Layout of KD 3 Pole with PM3.

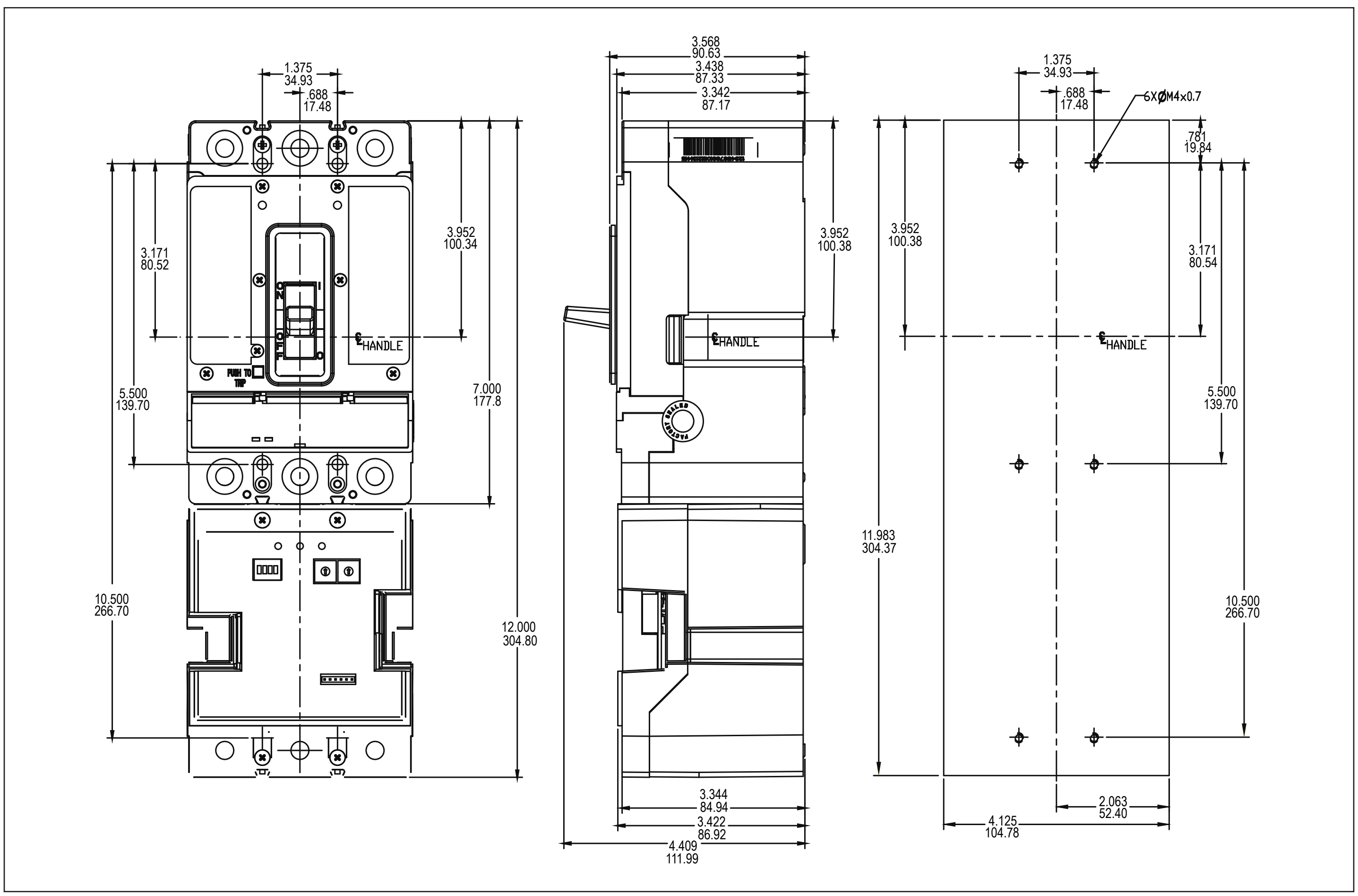


Figure 8. Layout of JG with PM3.

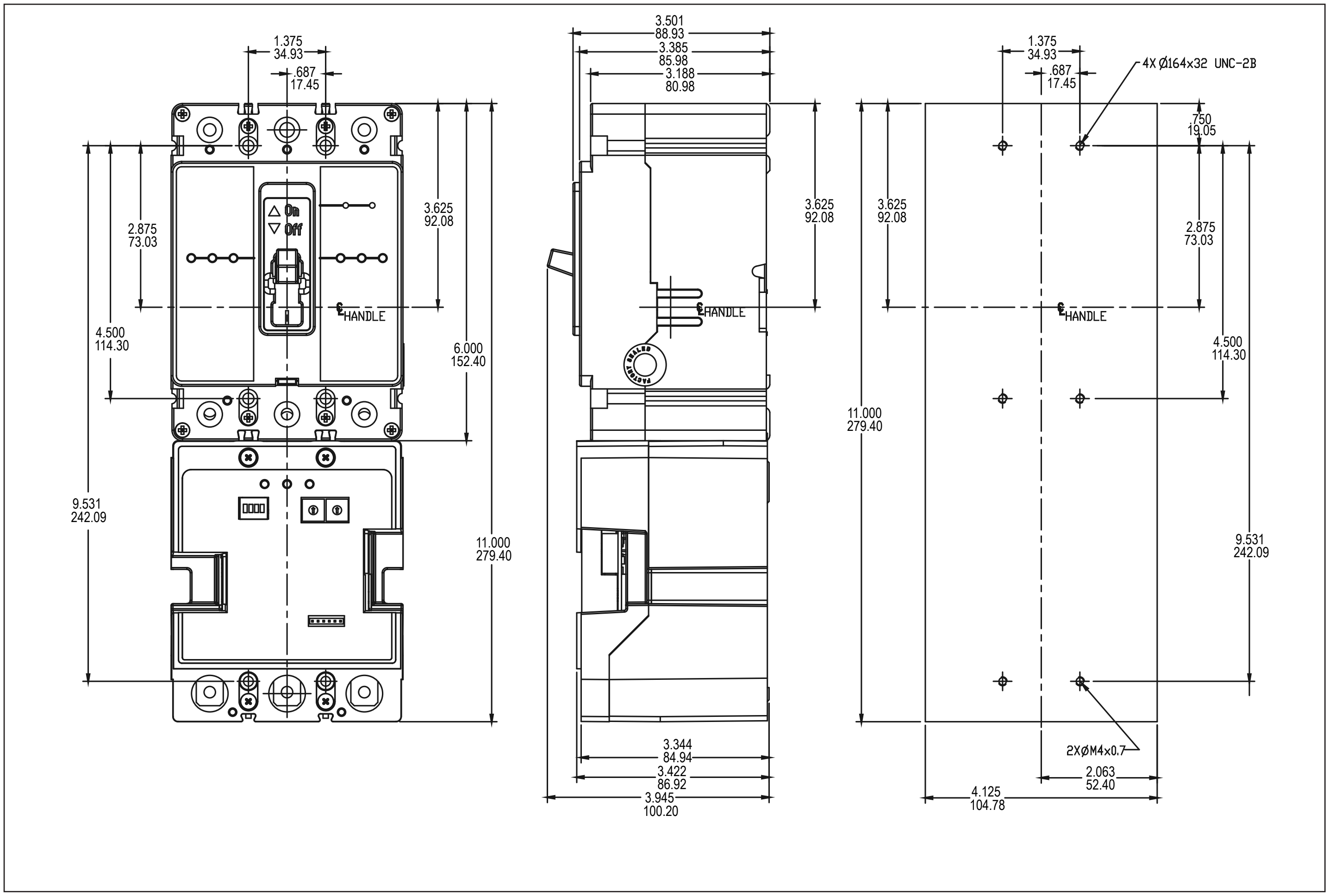


Figure 9. Layout of FD with PM3.

Table 3. PM3 Power Monitoring and Communications Module Specifications.

Current Input	
Pick up current	0.3A rms
Max reported current	
FD / JG	250A rms
KD / LD	630A rms
Accuracy	0.5% of reading

Voltage Inputs	
Range	
Line-to-neutral	30 - 366 Vac
Line-to-line	52 - 635 Vac
Supported Systems	3 element wye, 3 element wye + neutral 2 element delta, 4-wire delta systems
Input Impedance	996 kilo ohm/phase
Burden per phase	0.36 VA/phase max. at 600 V; 0.014 VA at 120 Volts"
Phase Voltage Connections	Internal via screw terminal to busbar
Neutral Connection	For wye system, a Neutral is required to be connected to the PM3 on the right Phoenix connector.
	If Neutral is not available, the meter will calculate a virtual Neutral based on the phase to phase RMS voltage. The system voltage must be balanced for this to be accurate.

Frequency	
Frequency	50 / 60 Hz
Accuracy	± 0.1 Hz
Resolution	0.1 Hz

Power and Energy	
Accuracy	1% of reading (ANSI C12.1)

Isolation
All inputs and outputs are galvanically isolated to 2500 volts.

Environmental Ratings	
Operating temperature	-20° to +50°C (-4 to 122°F)
Storage temperature	-20° to +50°C (-4 to 122°F)
Operating humidity	To 95% RH non-condensing

Sensing Method	
Voltage, current	True RMS
Sampling Rate	13.02 K samples per second

Update Rate	
Watts, Var and VA	1.03 sec at 60 Hz
All other parameters	1.07 second at 60 Hz

Power Supply	
DC voltage	18 – 30 Vdc
Max Current	30.0 mA @ 24 Vdc
Burden	0.72 Watts

Standard Communication Format		
Connection type	3 Wire RS-485 (A,B,Common)	
Com port baud rate	9600 or 19,200 bauds	Default: 19,200
Modbus address range	01 – 247	
Data format	Selectable (8,N,1 | 8,N,2 | 8,Even,1 | 8,Odd, 1)	Default: 8,N,2
Protocols	Modbus RTU	
Internal Termination Resistor selectable On or Off	Via DIP switch	Default: Enabled

Dimensions and Shipping		
Weight (lbs)	FD	1.26 (0.57 kg)
	JG	1.6 (0.73 kg)
	KD / LG	2.25 (1.02 kg)
Basic unit (in)	FD	4.13 W X 5.00 L X 3.39 H (104.90 x 127.00 x 86.11 mm)
	JG	4.13 W X 5.00 L X 3.39 H (104.90 x 127.00 x 86.11 mm)
	KD / LG	5.48 W X 3.70 L X 4.062 H (139.19 x 93.98 x 103.17 mm)
Shipping container dimensions (in)	FD/JG	8.0 X 5.13 x 5.5 (203.20 x 130.30 x 139.70 mm)
	KD/LG	6.25 X 8.25 X 7.00 (158.75 x 209.55 x 177.80 mm)

Compliance
UL489, Annex J
IEC 61000-4-2 - ESD
IEC 61000-4-4 - EFT
IEC 61000-4-5 - SURGE
IEC 61000-4-6 - EMC
ANSI C12.1 (1% accuracy)
UL®/cUL®/CE

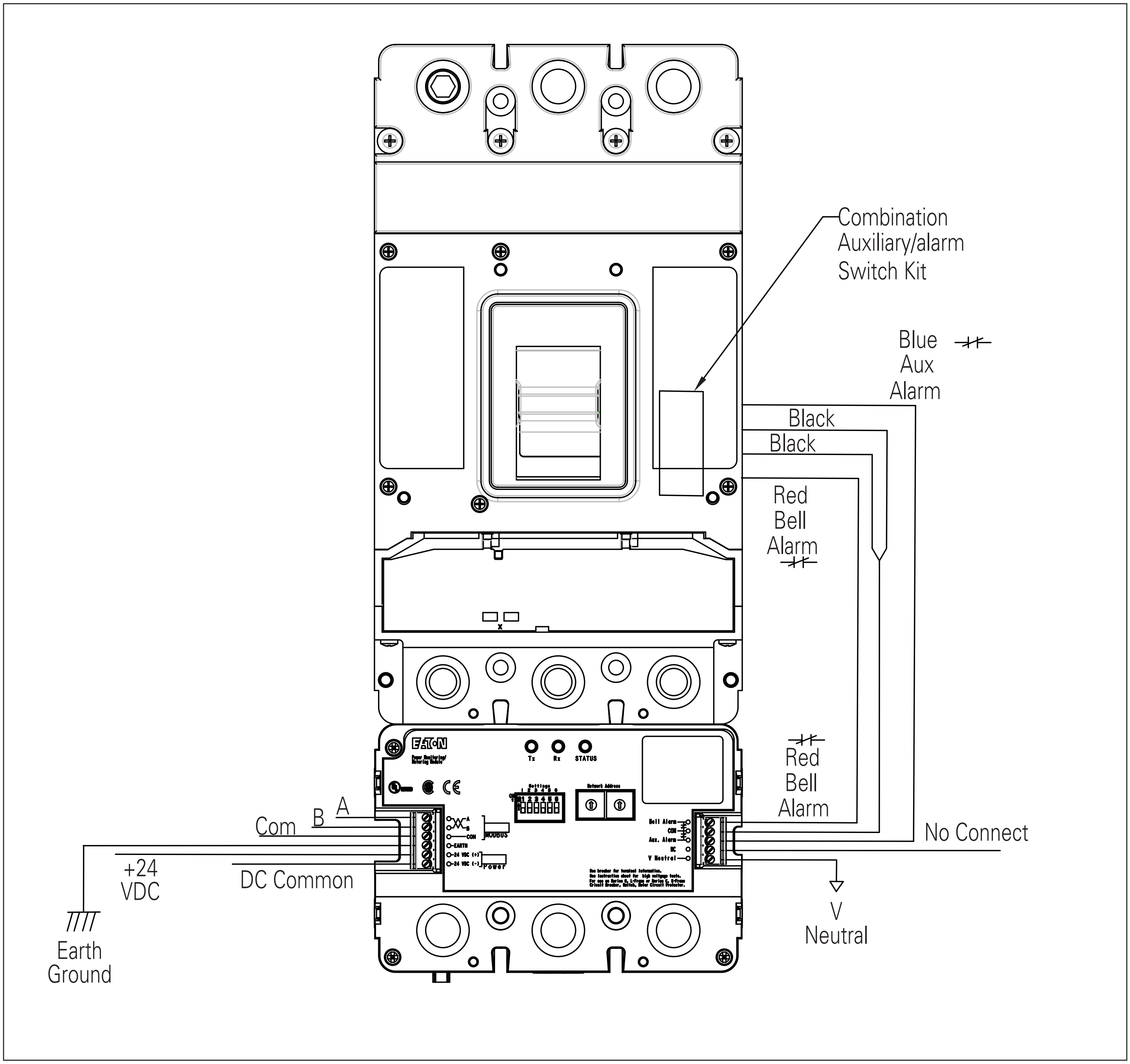


Figure 10. PM3 Breaker Status Wiring Diagram (KD/LG PM3).

Breaker Status:

Breaker status is brought to the unit through a 5-pin Phoenix RA-series connector, part number 1844249. Figure 10 shows the pin assignments for this connector.

⚠ CAUTION

FOR WYE SYSTEM, A NEUTRAL IS REQUIRED TO BE CONNECTED TO THE PM3 ON THE RIGHT PHOENIX CONNECTOR. IF NEUTRAL IS NOT AVAILABLE, THE METER WILL CALCULATE A VIRTUAL NEUTRAL BASED ON THE PHASE-TO-PHASE RMS VOLTAGE. THE SYSTEM MUST BE BALANCED FOR THIS TO BE ACCURATE.

2. Indicators

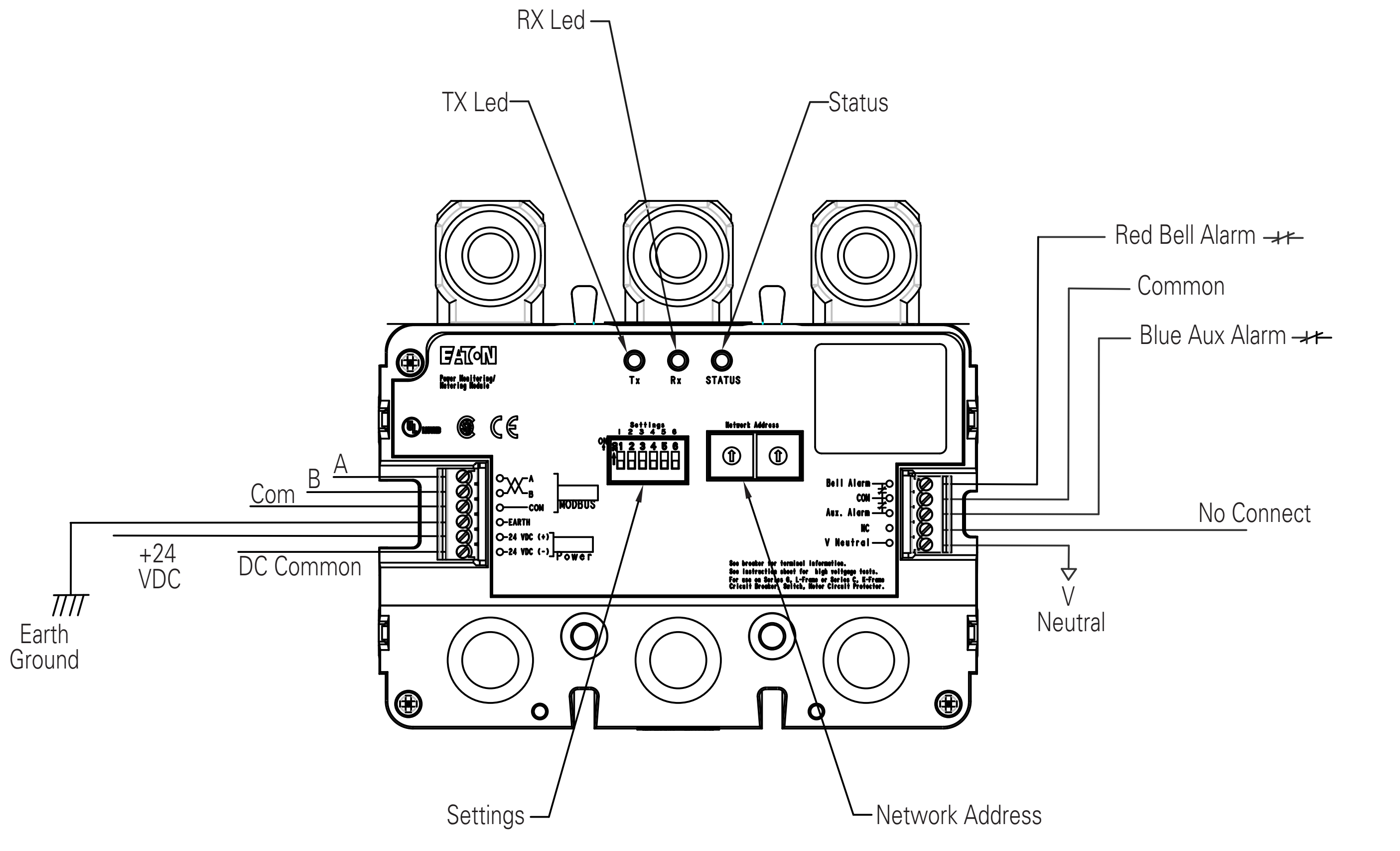


Figure 11. Status Indicators (KD/LG PM3).

2.1. Status Indicator

A single green LED is used to indicate the status of the Measurement Board. The indicator has three states:

1. OFF

No light emission indicates internal DC power is not available, or the Measurement Board has malfunctioned.

2. ON

Continuous light emission indicates power is applied, but the Measurement Board is executing a power-on self test.

3. Slow Flash

Repetitive one second on, one second off indicates the Measurement Board is operating normally.

Fast Flash

0.5 second on, 0.5 second off indicates one of three failures:

- Unit not calibrated;
- Unit has not been assembled properly; or
- Unit memory has been damaged.

2.2. Modbus Status Indicator

Modbus Rx Indicator

When illuminated, this green LED indicates the Communications Board is receiving messages on the Modbus network.

Note: This LED will typically be a solid green. That is, it will not flash as the transmit LED does.

Modbus Tx Indicator

When illuminated, this green LED indicates the Communications Board is transmitting a message on the Modbus network.

Note: This LED typically flashes as the Communications Board transmits messages over the Modbus network.

3. Modbus RTU Communications

Modbus is a popular application-layer messaging protocol. The protocol takes place at the data link layer of the Open Systems Interconnection (OSI) model. Modbus serial line (Modbus RTU) is a Master-Slave protocol. A Modbus transaction consists of two messages: a request from the master, and a reply from the slave.

The Modbus Add-on Module is a Modbus slave. The Modbus physical layer transmitter and receiver conforms to the RS485 standard.

A Modbus serial line message frame, or Protocol Data Unit, contains:

- An Address Field;
- A Function Code;
- Data; and
- CRC.

Valid addresses are 1 – 247 decimal.

The function code indicates what kind of action to perform. Examples are:

- 01 – Read Coils;
- 04 – Read Input Registers;
- 06 – Write Single Register;

Messages consist of 11-bit characters. Characters consist of:

- 1 Start Bit;
- 8 Data Bits (least significant bit first);
- 1 Parity Bit (even parity is the default; other modes may be supported); or
- 1 Stop Bit (2 stop bits if no parity is used).

The least significant bit is transmitted first (see Table 4).

- Modbus Slave, line terminator selectable by dip switch
- Baud rate (9600, 19.2k) selectable by dip switch
- Parity (even, odd, none) selectable by dip switches

3.1. Modbus RS485 Network

The following simplified rules apply to a given system consisting of a cable link between master and slave devices. For more complex configurations please refer to standard Modbus RTU wiring specification rules for the RS485 network

The recommended Modbus cable has twisted-pair wires (24 AWG stranded 7x32 conductors with PVC insulation) having an aluminum/mylar foil shield with drain wire.

- The maximum system capacity is 4,000 feet of communications cable and 247 devices on the Modbus RTU network.
- Make sure that there is twisted-pair wire that is recommended for Modbus RTU network use. Use shielded twisted-pair wire to connect each slave to the Modbus RTU network, daisy-chain style. The polarity of the twisted pair is critically important.

3.2. Modbus Address Switches

Two rotary hexadecimal switches are used to set the Modbus Slave Address for the unit. Valid addresses are from 0x01 to 0xF7 (1 to 247).

3.3. Exception Codes

Under certain circumstances, the PM3 will return an exception code.

If the function in the query is not supported by the PM3, exception code 01 is returned in the response.

If the data (object) register is illegal, exception code 02 is returned in the response.

If the data value in the query is illegal, exception code 03 is returned.

In certain circumstances, an exception code 05 (ACK) is returned.

If the PM3 cannot perform the requested function, exception code 07 (NAK) is returned.

If only a partial register is used in the query, exception code 84 is returned.

4. Configuration and Input

4.1. User Options Dip Switch

A six-position Dip Switch is used to set user options for the unit, as follows:

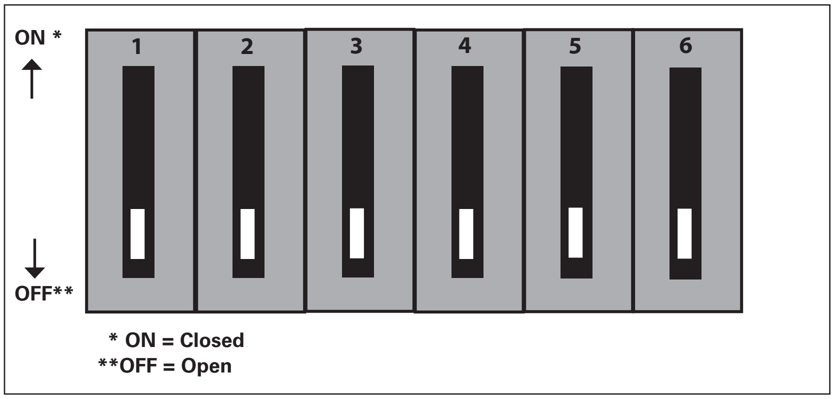


Figure 12. Six-Position Dip Switch.

Table 4. Modbus, Baud Rate and Parity Settings.

1	ON	Positive Power & Energy For Backfed Operation
	OFF	Positive Power & Energy, Normal Operation
2	ON	ABC (Left to Right Facing Unit)
	OFF	CBA (Left to Right Facing Unit)
3-4	SW3 ON & SW4 ON	No Parity, 2 Stop Bits
	SW3 OFF & SW4 ON	No Parity, 1 Stop Bit
	SW3 ON & SW4 OFF	Odd Parity, 1 Stop Bit
	SW3 OFF & SW4 OFF	Even Parity, 1 Stop Bit
5	ON	19.2 K BAUD
	OFF	9600 BAUD
6	ON	120 Ohm Termination Resistor installed
	OFF	No termination Resistor

4.2. Breaker Status

The Breaker Status is decoded from two switch inputs, Bell Alarm NC[1] and Aux Alarm NC, from the Breaker

Table 5. Bell Alarm and Aux Alarm Positions.

Bell Alarm (Red)	Aux Alarm (Blue)	Breaker Status
OFF	OFF	Unknown ①
OFF	ON	Tripped
ON	OFF	ON
ON	OFF	OFF

① Breaker not connected or improperly wired.

[1] NC= Normally Closed

5.Modbus Registers

Slave Actions, Supervisory, and Configuration Commands are accomplished through Function Code 16, Write Multiple Registers. The Modbus Add-on Module supports three such commands, as described in the following sections.

5.1. Add-on Module Status

Status is transmitted in two registers, as shown in Table 6.

Both registers must be accessed in one operation, using Function Code 04.

Table 6. Status Command Description.

Name	Starting Register Number (decimal)	Starting Register Address (hex)	Number of Registers	Format
Status	6145	1800	2	Encoded

Status is encoded as follows:

- Primary Status – High byte of Register Address 0x1800;
- Secondary Status – Low byte of Register Address 0x1800; and
- Cause of Status – Register Address 0x1801.

Status encoding is shown in Tables 7 thru 9.

Table 7. Primary Status Codes Table.

Status Code	Short Description
4	ALARM
9	OPERATIONAL

Table 8. Secondary Status Codes Table.

Status Code	Short Description
1	NOT APPLICABLE

Table 9. Cause of Status Codes Table.

Status Code	Short Description
1	Normal
40	DIAGNOSTIC FAILURE #1 (see Note 1 below)
43	DIAGNOSTIC WARNING #2 (see Note 2 below)
44	DIAGNOSTIC WARNING #3 (see Note 3 below)
54	DIAGNOSTIC FAILURE #4 (see Note 4 below)
113	Not Calibrated

Note 1: Measurement Board Communications Failure
Note 2: FRAM Energy Buffer Error
Note 3: FRAM Calibration Constants Error
Note 4: FRAM Communication Error

5.2. Breaker Status

Breaker Status is transmitted in two discrete (bit) inputs, at addresses 100110 and 100210. Both bits may be read in one operation, or either bit may be read individually, using Function Code 02. The Function Code 02 format is shown below for a Slave Address of 0x74.

Table 10. Request From Master.

Field Name	
Slave Address	0x74
Function Code	0x02
Starting Address High Byte	0x03
Starting Address Low Byte	0xE8
Number of Inputs High Byte	0x00
Number of Inputs Low Byte	0x02
CRC Low Byte	
CRC High Byte	

Table 11. Response From Slave.

Field Name	
Slave Address	0x74
Function Code	0x02
Byte Count	0x01
Data	0x0y (data is in bits 1..0)
CRC Low Byte	
CRC High Byte	

The Breaker Status command is summarized in Table 12. Breaker Status encoding is shown in Table 13

Table 12. Breaker Status Command Description.

Name	Starting Register Number (decimal)	Starting Register Address (hex)	Valid Number of Bits	Format
Breaker Status	1001	3E8	1 or 2	Encoded
Breaker Status	1002	3E9	1	Encoded

Table 13. Breaker Status Encoding.

Register Number (decimal)	Register Address (hex)	Encoding
1001	3E8	0 = Open 1 = Closed
1002	3E9	0 = Not Tripped 1 = Tripped

Table 13a. Combined Breaker Status Encoding

(Registers 1001 and 1002).

Status Code	Encoding
00	Open
01	Tripped
10	Closed
11	Unknown *

* Breaker not connected or improperly wired.

If the Breaker Status cannot be determined (for example, the connector is not connected), an exception (0x82) code of 0x01 is returned. The response will look like (see Table 14).

Table 14. Breaker Status Unknown.

Response From Slave

Field Name	
Slave Address	0x74
Function Code	0x82
Exception Error	0x01
CRC Low Byte	0x81
CRC High Byte	0x60

5.3. Metered Values

The PM3 Modbus Add-on Module communicates metered values via input registers (Function Code 04). Registers are referenced by register numbers and register addresses. Register numbers range from 1 to 65536. Register addresses range from 0 to 65535. Thus, a data value referenced with number N has an address of (N – 1). Each register contains two bytes.

The data field in the request from the Modbus Master contains the starting register address and the number of registers to read. A typical Request/Response transaction for reading metered values is shown in Table 15. This example shows a read of register numbers 6147 thru 6152 (IA thru IC) from a slave at address 116.

Table 15. Request From Master.

Field Name	
Slave Address	0x74
Function Code	0x04
Starting Address High Byte	0x18
Starting Address Low Byte	0x02
Number of Registers High Byte	0x00
Number of Registers Low Byte	0x06
CRC Low Byte	
CRC High Byte	

Table 16. Response From Slave.

Field Name	
Slave Address	0x74
Function Code	0x04
Byte Count	0x0C
Data From Register 0x1802 High Byte	
Data From Register 0x1802 Low Byte	
Data From Register 0x1803 High Byte	
Data From Register 0x1803 Low Byte	
Data From Register 0x1804 High Byte	
Data From Register 0x1804 Low Byte	
Data From Register 0x1805 High Byte	
Data From Register 0x1805 Low Byte	
Data From Register 0x1806 High Byte	
Data From Register 0x1806 Low Byte	
Data From Register 0x1807 High Byte	
Data From Register 0x1807 Low Byte	
CRC Low Byte	
CRC High Byte	

5.4. Standard Metered Values

Standard metered values are transmitted as 32-bit numbers. Metered values are read-only and are transmitted in two registers. Both registers must be accessed in one operation, using Function Code 04.

Note: The arrangement of the bytes in the 4-byte standard meter register values may be configured by writing to configuration register number 2003 (register address 0x07D2).

Table 17 summarizes the Modbus commands for the standard metered values.

Table 17. Standard Metered Values Command Descriptions.

Name	Units	Register Number (decimal)	Register Address (hex)	Scale factor	Format
I_A	A	6147	1802	10	Uint32
I_B	A	6149	1804	10	Uint32
I_C	A	6151	1806	10	Uint32
V_{AB}	V	6159	180E	10	Uint32
V_{BC}	V	6161	1810	10	Uint32
V_{CA}	V	6163	1812	10	Uint32
V_{AN}	V	6167	1816	10	Uint32
V_{BN}	V	6169	1818	10	Uint32
V_{CN}	V	6171	181A	10	Uint32
Real Power – 3 Phase	W	6187	182A	1	Int32
Reactive Power – 3 phase	VAR	6189	182C	1	Uint32
Apparent Power – 3 phase	VA	6191	182E	1	Uint32
Apparent Power Factor	%	6195	1832	100	Int32
Frequency	Hz	6197	1834	10	Uint32
Phase A Real Power	W	6203	183A	1	Int32
Phase B Real Power	W	6205	183C	1	Int32
Phase C Real Power	W	6207	183E	1	Int32
Phase A Reactive Power	VAR	6209	1840	1	Int32
Phase B Reactive Power	VAR	6211	1842	1	Int32
Phase C Reactive Power	VAR	6213	1844	1	Int32
Phase A Apparent Power	VA	6215	1846	1	Int32
Phase B Apparent Power	VA	6217	1848	1	Uint32
Phase C Apparent Power	VA	6219	184A	1	Uint32
Phase A Apparent Power Factor	%	6227	1852	100	Uint32
Phase B Apparent Power Factor	%	6229	1854	100	Uint32
Phase C Apparent Power Factor	%	6231	1856	100	Uint32

5.5. Energy Values

Energy values are 32-bit numbers. Each energy value requires four Modbus registers. When reading an energy value, all four registers must be read in one operation.

Note: The arrangement of the bytes in the 4-byte energy register values may be configured by writing to configuration register number 2003 (register address 0x07D2).

Table 18 summarizes the Modbus commands for the energy values.

Table 18. Energy Values Command Descriptions.

Name	Units	Register Number (decimal)	Register Address (hex)	Format
Forward Energy	kWh	6259	1872	Uint32
Reverse Energy	kWh	6261	1874	Uint32
Total Energy	kWh	6263	1876	Int32
Leading Reactive Energy	kVARh	6265	1878	Uint32
Lagging Reactive Energy	kVARh	6267	188A	Uint32
Net Reactive Energy	kVARh	6269	187C	Int32
Apparent Energy	kVAh	6271	187E	Uint32
Saved Forward Energy	kWh	6503	1966	Uint32
Saved Reverse Energy	kWh	6505	1968	Uint32
Saved Total Energy	kWh	6507	196A	Int32
Saved Leading Reactive Energy	kVARh	6509	196C	Uint32
Saved Lagging Reactive Energy	kVARh	6511	196E	Uint32
Saved Net Reactive Energy	kVARh	6513	1970	Int32
Saved Apparent Energy	kVAh	6515	1972	Uint32

5.5.1 Product ID and Breaker Product ID

The Product ID and Breaker Product ID are transmitted in two registers, as shown in Table. Both registers must be accessed in one operation, using Function Code 04.

Table 19. Product ID Command Descriptions.

Name	Register Number (decimal)	Register Address (hex)	Format
Product ID/Breaker Product ID	6255	186E	Encoded

The Product ID is encoded as follows:

- Product ID = 3 – b15 .. b10 of Register Address 0x186F;
- Communication Version = 1 – b9 .. b6 of Register Address 0x186F; and
- Division Code = 35 – b5 b0 of Register Address 0x186F.

The Breaker Product ID is encoded as follows:

- Product ID = 1 – b15 .. b10 of Register Address 0x186E;
- Communication Version = 1 – b9 .. b6 of Register Address 0x186E; and
- Division Code = 32 – b5 b0 of Register Address 0x186E.

5.6. Snapshot Energy

The PM3 Modbus Module supports a control command to capture energy. A write to Register Numbers 2911 (Address 0x0B5E) and 2912 (Address 0x0B5F) using Function Code 16 (0x10), Write Multiple Registers, is used for this purpose. The Modbus command registers and assignments are shown in Tables 20 and 21.

Note: The effect of this command is the same as the Snapshot Energy command (see Section 5.7).

Table 20. Request From Master.

Field Name	
Slave Address	0x74
Function Code	0x10
Starting Address High Byte	0x0B
Starting Address Low Byte	0x5E
Number of Registers High Byte	0x00
Number of Registers Low Byte	0x02
Byte Count	0x04
Register 0x0B5E Data Value High Byte	0x0D
Register Address 0x0B5E Data Value Low Byte	0x00
Register Address 0x0B5F Data Value High Byte	0x00
Register Address 0x0B5F Data Value Low Byte	0x00
CRC Low Byte	
CRC High Byte	

Table 21. Response From Slave.

Field Name	
Slave Address	0x74
Function Code	0x10
Starting Address High Byte	0x0B
Starting Address Low Byte	0x5E
Number of Registers High Byte	0x00
Number of Registers Low Byte	0x02
CRC Low Byte	
CRC High Byte	

5.7. Snapshot Energy

The PM3 Modbus Module supports a control command to capture energy. A write to Register Numbers 2901 - 2903 (Address 0x0B54 through 0x0B56) using Function Code 16 (0x10), Write Multiple Registers, is used for this purpose. This command consists of a three-byte instruction, followed by the one's complement of the instruction (also three bytes). The capture energy instruction is 0x000080. The Modbus command registers and assignments are shown in Tables 22 and 23.

Table 22. Request From Master.

Field Name	
Slave Address	0x74
Function Code	0x10
Starting Address High Byte	0x0B
Starting Address Low Byte	0x54
Number of Registers High Byte	0x00
Number of Registers Low Byte	0x03
Byte Count	0x06
Register Address 0x0B54 Data Value High Byte	0x00
Register Address 0x0B54 Data Value Low Byte	0x80
Register Address 0x0B55 Data Value High Byte	0x7F
Register Address 0x0B55 Data Value Low Byte	0x00
Register Address 0x0B56 Data Value High Byte	0xFF
Register Address 0x0B56 Data Value Low Byte	0xFF
CRC Low Byte	
CRC High Byte	

Table 23. Response From Slave.

Field Name	
Slave Address	0x74
Function Code	0x10
Starting Address High Byte	0x0B
Starting Address Low Byte	0x54
Number of Registers High Byte	0x00
Number of Registers Low Byte	0x03
CRC Low Byte	
CRC High Byte	

5.8. Write Fixed-Point Data Multi-Register Configuration

Each Modbus register is defined in the Modbus protocol as a two-byte entry. Data fields requiring more than two bytes (such as 32-bit integers) must occupy consecutive register locations. Modbus protocol defines register information to be transmitted with the most-significant byte first, followed by the least-significant byte. However, the protocol does not specify the order of multi-register information.

The default adopted by most of the industry places the least-significant word in the first Modbus register (x) followed by the next higher order 16-bit word in the next Modbus register (x+1), and so forth. For example, a 32-bit data value 0x98765432 would be transmitted as shown in Table 24 (left to right).

Table 24. Default Multi-Register Fixed-Point Data Transmission Order.

Bits 15…8	Bits 7…0	Bits 31…24	Bits 23…16
Byte 1	Byte 0 (LS Byte)	Byte 3 (MS Byte)	Byte 2
0x54	0x32	0x98	0x76
Register x		Register x + 1	

To accommodate systems not incorporating this defacto standard, the Module may be configured to reverse this multi-register order for registers. This is accomplished by setting Register Number 2003 (Address 0x07D2) to a non-zero number. This places the most-significant word in the First Modbus register (x) followed by the next lower order 16-bit word in the next Modbus register (x+1), and so forth. For example, a 32-bit data value 0x98765432 would be transmitted as shown in Table 25 (left to right).

Table 25. Non-Default Multi-Register Fixed-Point Data Transmission Order.

Bits 31…24	Bits 23…16	Bits 15…8	Bits 7…0
Byte 3 (MS Byte)	Byte 2	Byte 1	Byte 0 (LS Byte)
0x98	0x76	0x54	0x32
Register x		Register x + 1	

5.8.1 Master Configuration Message:

Table 26. Request From Master.

Field Name	
Slave Address	0x74
Function Code	0x10
Starting Address High Byte	0x07
Starting Address Low Byte	0xD2
Number of Registers High Byte	0x00
Number of Registers Low Byte	0x01
Byte Count	0x02
Data Value High Byte	0x00 for Default (Table 43) 0xFF for Non-Default (Table 54)
Data Value Low Byte	0x00 for Default (Table 4) 0xFF for Non-Default (Table 5)
CRC Low Byte	
CRC High Byte	

5.9. Modbus Diagnostics Registers

Modbus Function Code 08 provides a series of tests for checking the communications system or for checking various internal error conditions. The function uses a two-byte sub-function field to define the type of test to be performed. The format is shown in Tables 27 and 28.

Table 27. Request From Master.

Field Name	
Slave Address	0x74
Function Code	0x08
Sub-Function Code	0x1C
Data High Byte	0x20
Data Low Byte	0x12
CRC Low Byte	
CRC High Byte	

Table 28. Request From Slave.

Field Name	
Slave Address	0x74
Function Code	0x08
Sub-Function Code	0x1C
Data High Byte	0x20
Data Low Byte	0x12
CRC Low Byte	
CRC High Byte	

The PM3 Modbus Add-on Module supports the sub-functions listed in Table 29.

Table 29. Module Supported Sub-functions.

Sub-function Code	Description	Example Transmitted Data	Example Received Data
0x0A	Clear Diagnostic Counters, echo data word	0x55AA	0x55AA
0x0B	Read Message Count Diagnostic Counter	0x0000	Message Count
0x0C	Read Communications Error Count Diagnostic Counter	0x0000	Communications Error Count
0x0D	Read Exception Error Count Diagnostic Counter	0x0000	Exception Error Count
0x0E	Read Slave Message Count Diagnostic Counter	0x0000	Slave Message Count
0x0F	Read No Response Count Diagnostic Counter	0x0000	No Response Count
0x10	Read NAK Count Diagnostic Counter	0x0000	NAK Count
0x11	Read Slave Busy Count Diagnostic Counter	0x0000	Slave Busy Count
0x12	Read Overrun Count Diagnostic Counter	0x0000	Overrun Count
0x14	Clear Diagnostic Counters, echo data word	0x55AA	0x55AA
0x1A	Read Firmware version and revision	0x0000	Data High Byte – Firmware version Data Low Byte – Firmware revision
0x1B	Read Firmware month and day	0x0000	Data High Byte – Firmware month Data Low Byte – Firmware day
0x1C	Read Firmware year	0x0000	Firmware year

Appendix A

Name	Numeric	Units	Register Number (decimal)	Register Address (decimal)	Register Address (hex)	Scale Factor	Format	Function Code
Current	I_A	A	6147-6148	6146-6147	x1802-x1803	10	Uint32	4
	I_B	A	6149-6150	6148-6149	x1804-x1805	10	Uint32	4
	I_C	A	6151-6151	6150-6151	x1806-x1807	10	Uint32	4
L-L Voltage	V_{AB}	V	6159-6160	6158-6159	x180E-x180F	10	Uint32	4
	V_{BC}	V	6161-6162	6160-6161	x1810-x1811	10	Uint32	4
	V_{CA}	V	6163-6164	6162-6163	x1812-x1813	10	Uint32	4
L-N Voltage	V_{AN}	V	6167-6168	6166-6167	x1816-x1817	10	Uint32	4
	V_{BN}	V	6169-6170	6168-6169	x1818-x1819	10	Uint32	4
	V_{CN}	V	6171-6172	6170-6171	181A-x1818	10	Uint32	4
Frequency	Freq	HZ	6197-6198	6169-6197	x1834-x1835	10	Uint32	4
Real Power	3 Phase	W	6187-6188	6186-6187	x182A-x182B	1	Int32	4
	Phase A	W	6203-6204	6202-6203	x183A-x183B	1	Int32	4
	Phase B	W	6205-6206	6204-6205	x183C-x183D	1	Int32	4
	Phase C	W	6207-6208	6206-6207	x183E-x183F	1	Int32	4
Reactive Power	3 Phase	VAR	6189-6190	6188-6189	x182C-x182D	1	Int32	4
	Phase A	VAR	6209-6210	6208-6209	x1840-x1841	1	Int32	4
	Phase B	VAR	6211-6212	6210-6211	x1842-x1843	1	Int32	4
	Phase C	VAR	6213-6214	6212-6213	x1844-x1845	1	Int32	4
Apparent Power	3 Phase	VA	6191-6192	6190-6191	x182E-x182F	1	Uint32	4
	Phase A	VA	6215-6216	6214-6215	x1846-x1847	1	Uint32	4
	Phase B	VA	6217-6218	6216-6217	x1848-x1849	1	Uint32	4
	Phase C	VA	6219-6220	6218-6219	x184A-x184B	1	Uint32	4
	Power Factor	%	6195-6196	6194-6195	x1832-x1833	100	Uint32	4
	Phase A Power Factor	%	6227-6228	6226-6227	x1852-x1853	100	Uint32	4
	Phase B Power Factor	%	6229-6230	6228-6229	x1854-x1855	100	Uint32	4
	Phase C Power Factor	%	6231-6232	6230-6231	x1856-x1857	100	Uint32	4
Energy	Forward	kWh	6259-6260	6258-6259	x1872-x1873	1	Uint32	4
	Reverse	kWh	6261-6262	6260-6261	x1874-x1875	1	Uint32	4
	Total	kWh	6263-6264	6262-6263	x1876-x1877	1	Int32	4
	Apparent	kVAh	6271-6272	6270-6271	x187E-x187F	1	Uint32	4
	Saved Forward	kWh	6503-6504	6502-6503	x1966-x1967	1	Uint32	4
	Saved Reverse	Wh	6505-6506	6504-6505	x1968-x1969	1	Uint32	4
	Saved Total	kWh	6507-6508	6506-6507	x196A-x196B	1	Int32	4
	Saved Apparent	kVAh	6515-6516	6514-6515	x1972-x1973	1	Uint32	4
Reactive Energy	Leading	kVARh	6265-6266	6264-6265	x1878-x1879	1	Uint32	4
	Lagging	kVARh	6267-6268	6266-6267	x187A-x187B	1	Uint32	4
	Net	kVARh	6269-6270	6268-6269	x187C-x187D	1	Int32	4
	Saved Leading	kVARh	6509-6510	6508-6509	x196C-x196D	1	Uint32	4
	Saved Lagging	kVARh	6511-6512	6510-6511	x196E-x196F	1	Uint32	4
	Saved Net	kVARh	6513-6514	6512-6513	x1970-x1971	1	Int32	4
Status	Module	N/A	6145-6146	6144-6145	x1800-x1801	N/A	Encoded	2
	Breaker	N/A	1001-1002	1000-1001	x03E8-x03E9	N/A	Encoded	4
ID	Product/Breaker Product	N/A	6255-6256	6254-6255	x186E-x186F	N/A	Encoded	4

Notes:

Notes:

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