GE
Grid Solutions

Multilin EPM 9700

High Performance Power Quality Metering System

Instruction Manual

Software Revision: 1.0x
Manual P/N: 1601- 0715-A6

WORLDWIDE 10 YEAR WARRANTY

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REGISTERED ISO 9001 GE MULTILIN

imagination at work

Multilin EPM 9700 Instruction Manual for product revision 1.0x.

Part number: 1601-0715-A6 (September 2021)

⚠CAUTION

GENERAL SAFETY PRECAUTIONS - EPM 9700

- This equipment is intended to be permanently Installed within a metal enclosure or panel that is protective earthed, mounted such that the exposed terminals are enclosed. Voltages are measured by connections to the branch supply only
- Failure to observe and follow the instructions provided in the equipment manual(s) could cause irreversible damage to the equipment and could lead to property damage, personal injury and/or death.
- Before attempting to use the equipment, it is important that all danger and caution indicators are reviewed.
- If the equipment is used in a manner not specified by the manufacturer or functions abnormally, proceed with caution. Otherwise, the protection provided by the equipment may be impaired and can result in Impaired operation and injury.
- Caution: Hazardous voltages can cause shock, burns or death.
- Installation/service personnel must be familiar with general device test practices, electrical awareness and safety precautions must be followed.
- Before performing visual inspections, tests, or periodic maintenance on this device or associated circuits, isolate or disconnect all hazardous live circuits and sources of electric power.
- Failure to shut equipment off prior to removing the power connections could expose you to dangerous voltages causing injury or death.
- All recommended equipment that should be grounded and must have a reliable and un-compromised grounding path for safety purposes, protection against electromagnetic interference and proper device operation.
- Equipment grounds should be bonded together and connected to the facility's main ground system for primary power.
- Keep all ground leads as short as possible.
- At all times, equipment ground terminal must be grounded during device operation and service.
- In addition to the safety precautions mentioned all electrical connections made must respect the applicable local jurisdiction electrical code.
- Before working on CTs, they must be short-circuited.
- To be certified for revenue metering, power providers and utility companies must verify that the billing energy meter performs to the stated accuracy. To confirm the meter's performance and calibration, power providers use field test standards to ensure that the unit's energy measurements are correct.

This product cannot be disposed of as unsorted municipal waste in the European Union. For proper recycling return this product to your supplier or a designated collection point. For more information go to www.recyclethis.info.

Safety words and definitions

The following symbols used in this document indicate the following conditions

DANGER **Indicates a hazardous situation which, if not avoided, will result in death or serious injury.**

WARNING **Indicates a hazardous situation which, if not avoided, could result in death or serious injury.**

CAUTION **Indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.**

NOTICE Indicates practices not related to personal injury.

NOTE **Indicates general information and practices, including operational information, that are not related to personal injury.**

For further assistance

For current manuals and software go to:

Website: https://www.gegridsolutions.com/multilin/catalog/epm9700.htm

For product support, contact the information and call center as follows:

GE Grid Solutions
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Europe e-mail: multilin.tech.euro@ge.com
Website: https://www.gegridsolutions.com/multilin

Warranty

GE warrants most of its GE manufactured products for 10 years. For warranty details including any limitations and disclaimers, see our Terms and Conditions at

https://www.gegridsolutions.com/multilin/warranty.htm

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Multilin EPM 9700

Chapter 1: Overview and Specifications

1.1 The EPM 9700 Meter

The GE EPM 9700 meter is the ideal upgrade retrofit to the EPM 9450 and EPM 9650 Series power meters. The system is a metering transducer with optional displays and I/O modules. At its core, the metering system utilizes a highly stable and advanced metrology named Multi Gain technology. This new method of measurement uses a dual sensor measurement circuit that enables the meter to hold accuracy from very low currents to the full 20 A secondary range. Stable components insure accuracy over temperature and time. GE's new metrology allows for highly accurate Grid-level electrical measurements that can be sent to SCADA systems. The meter meets the ANSI C12.20 0.1 Accuracy Class standard. It supports both 50/60 Hz and Wide Band frequencies, which means that it can be used for very low (25 Hz) and very high (400 Hz) frequencies to support multiple metering applications.

The meter is equipped with extensive communication ports that allow it to speak with many different SCADA or other communication systems simultaneously. The meter has 6 communication ports as a standard offering. These ports include 4 serial ports and 2 Ethernet-based communication ports. The Ethernet port includes an ST-terminated fiber optic port and an RJ45 port. Both ports use separate IP addresses, so that they can run on simultaneous redundant networks. Both Ethernet ports support email on alarm and port control, which enables/disables multiple sever and protocol functions. The meter's RS485 Port 4 can also be configured as either an RTU Master, capable of polling up to 128 registers from Modbus slave devices.

The EPM 9700 meter also provides advanced capabilities for storing measured values over time, for trending and analysis. The meter is preconfigured to store core measurements, which include over 140 different values, at demand interval or every demand interval, and EN 50160 measurements (which include over 170 values) every 10 minutes, without any user intervention. Additionally, a user is able to configure historical logs, with user defined values and time intervals.

Properly measuring power quality is integral to improving the reliability of a power system. Whether you are a utility provider or a large electricity customer, knowing the quality of the electricity flowing through the line is important. Poor power quality can result in losses of power and productivity and can produce many other undesirable effects. The EPM 9700 meter is designed to the highest standards for power quality, including IEC 61000-4-7, IEC 61000-4-15, and IEC 61000-4-30 Class A, Edition 3. The metering system can record voltage surges and sags, harmonics, and flicker. It will measure and record almost every aspect of power quality, so that a comprehensive picture of system reliability can be assessed. Note that when the meter is functioning in Wide Band Auto Frequency, Flicker measurements and IEC 61000-4-30/EN 50160 reporting are not supported, and the harmonic magnitude levels available are restricted, going up only to the 25th order.

The meter is equipped with an internal clock crystal which can be synchronized with IRIG-B, line frequency, SNTP, DNP3 or Modbus protocol.

The EPM 9700 meter utilizes a unique HTML 5-based web server. This new web server acts as an energy dashboard, allowing a user to view real time data, as well as to analyze stored history logs, alarms, and waveform records. Using the metering system's web pages allows a user to gain the benefits of an online energy dashboard without having to invest in 3rd party software, such as a web-based energy dashboard. Moreover, the web server is built on a responsive architecture, so that it will work properly with hand held browser-based devices.

The meter works with P40N^{PLUS} external LED displays or P70N external touchscreen LCD displays (see Chapter 5: Using the External Displays, on page 5-1, for details). The EPM 9700 meter has eight digital inputs as well as two solid-state KYZ pulse outputs for additional capability. GE Communicator software allows a user to poll and gather data from multiple EPM meters installed at local or remote locations (see the *GE Communicator Instruction Manual* for details).

NOTE ON CORRECT METER FUNCTION:

The EPM 9700 meter has a Heartbeat LED, located on the top, right side of the meter face. When the meter is functioning correctly, the green LED pulse toggles on and off (blinks) 5 times per second after initial Boot stage (during Boot stage, the heartbeat LED pulses at a faster rate).

EPM 9700 Energy Metering

- Delivers laboratory-grade 0.06% watt-hour accuracy (at unity power factor) in a field-mounted device.
- Meets all ANSI C12.20 Class 0.1 and IEC 62053-22 Class 0.2S accuracy specifications.
- Adjusts for transformer and line losses, using user-defined compensation factors.
- Automatically logs Time of Use (TOU) for up to eight programmable tariff registers.
- Counts pulses and aggregates different loads.
- Provides programmable demand and max demand profiles.
- Provides password protection and a sealing (reset) switch for added security.
- Offers extended frequency range (from 20 Hz to 500 Hz) with the Wide Band Auto Frequency option, in addition to 50/60 Hz.

EPM 9700 Power Quality Monitoring *

- Records up to 1024 samples per cycle on an event.
- Measures and records Harmonics to the 127th order (for 50/60 Hz).

- Offers inputs for neutral-to-earth ground voltage measurements for ground fault measurements.
- Offers IEC 61000-4-7 Harmonics measurement, IEC 61000-4-15 Flicker measurement, and IEC 6100-4-30 Class A Edition 3 power quality measurement.
- See Chapter 8: IEC 61000-4-30/EN 50160 Reporting, on page 8-1, for a detailed explanation of the Power Quality Compliance functions.
- Time synchronization through IRIG-B, line frequency, SNTP, DNP3, or Modbus protocol.
- Offers email on alarm.

* For meters operating in Wide Range Auto frequency, IEC 61000-15 and IEC 61000-4-30 are not supported, and the harmonic magnitude ranges are restricted - going up only to the 25th order.

EPM 9700 Memory, Communication and Control

- Up to 4 gigabytes of memory, of which 1 gigabyte is used for logging.
- CORE™ storage technology automatically stores up to 142 data values for automated data collection.
- 4 high speed Serial Communication ports.
- 2 Ethernet ports with port control and email on alarm functionality.
- Standard Modbus ASCII/RTU/TCP protocol.
- DNP3 Protocol.
- High speed updates for Control applications, available as programmable updates of between two and 20 cycles, or single cycle RMS updates.
- Two built-in KYZ solid state pulse outputs configurable to provide Wh and VARh pulses.

1.2 Measurements and Calculations

The EPM 9700 Meter measures many different power parameters.

Following is a list of the formulas used to perform calculations with samples for Wye and Delta services.

Samples for Wye: va, vb, vc, ia, ib, ic, in

Samples for Delta: vab, vbc, vca, ia, ib, ic

Root Mean Square (RMS) of Phase Voltages: N = number of samples

For Wye: x = a, b, c

$$V_{RMS_x} = \sqrt{\frac{\sum_{t=1}^{N} v_{x(t)}^2}{N}}$$

Root Mean Square (RMS) of Line Currents: N = number of samples

For Wye: x =a, b, c, n

For Delta: x = a, b, c

$$I_{RMS_x} = \sqrt{\frac{\sum_{t=1}^{N} i_{x(t)}^2}{N}}$$

Root Mean Square (RMS) of Line Voltages: N = number of samples

For Wye: x, y= a,b or b,c or c,a

$$V_{RMS_{xy}} = \sqrt{\frac{\sum_{t=1}^{N} (v_{x_{(t)}} - v_{y_{(t)}})^2}{N}}$$

For Delta: xy = ab, bc, ca

$$V_{RMS_{xy}} = \sqrt{\frac{\sum_{t=1}^{N} v_{xy(t)}^2}{N}}$$

Power (Watts) per phase: N = number of samples

For Wye: x = a, b, c

$$W_X = \frac{\sum_{t=1}^{N} v_{x(t)} \bullet i_{x(t)}}{N}$$

Apparent Power (VA) per phase:

For Wye: x = a, b, c

$$VA_x = V_{RMS_X} \bullet I_{RMS_X}$$

Reactive Power (VAR) per phase:

For Wye: x = a, b, c

$$VAR_x = \sqrt{VA_x^2 - W_x^2}$$

Active Power (W) Total: N = number of samples

For Wye:

$$W_T = W_a + W_b + W_c$$

For Delta:

$$W_T = \frac{\sum_{t=1}^{N} (v_{ab(t)} \bullet i_{a(t)} - v_{bc(t)} \bullet i_{c(t)})}{N}$$

Reactive Power (VAR) Total: N = number of samples

For Wye:

$$VAR_T = \sqrt{(VA_T \bullet VA_T) - (W_T \bullet W_T)}$$

For Delta:

$$VAR_T = \sqrt{\left(V_{RMS_{ab}} \bullet I_{RMS_a}\right)^2 - \left[\frac{\sum_{t=1}^{N} v_{ab(t)} \bullet i_{a(t)}}{N}\right]^2} + \sqrt{\left(V_{RMS_{bc}} \bullet I_{RMS_c}\right)^2 - \left[\frac{\sum_{t=1}^{N} v_{bc(t)} \bullet i_{c(t)}}{N}\right]^2}$$

Apparent Power (VA) Total:

For Wye:

Either Arithmetic Sum Method:

$$VA_T = VA_a + VA_b + VA_c$$

Or Vector Sum Method:

$$VA_T = \sqrt{W_T^2 + VAR_T^2}$$

Power Factor (PF):

For Wye: x = a,b,c,T

For Delta: x = T

$$PF_x = \frac{W_x}{VA_x}$$

Phase Angles:

x = a, b, c

$$\angle_x = \cos^{-1}\left(PF_x\right)$$

% Total Harmonic Distortion (%THD):

For Wye: x = va, vb, vc, ia, ib, ic

For Delta: x = ia, ib, ic, vab, vbc, vca

$$THD = \frac{\sqrt{\sum_{h=2}^{127}\left(RMS_{x_h}\right)^2}}{RMS_{x_1}}$$

K Factor: x = ia, ib, ic

$$KFactor = \frac{\sum_{h=1}^{127} (h \bullet RMS_{x_h})^2}{\sum_{h=1}^{127} (RMS_{x_h})^2}$$

Watt hour (Wh): N = number of samples

$$Wh = \sum_{t=1}^{N} \frac{W_{(t)}}{3600_{sec/hr}}$$

VAR hour (VARh): N = number of samples

$$VARh = \sum_{t=1}^{N} \frac{VAR_{(t)}}{3600_{sec/hr}}$$

1.3 Demand Integrators

Power utilities take into account both energy consumption and peak demand when billing customers. Peak demand, expressed in kilowatts (kW), is the highest level of demand recorded during a set period of time, called the interval. The EPM 9700 supports the following conventions for averaging demand and peak demand: Block Window Demand and Rolling Window Demand. You can program demand using the GE Communicator software (see the *GE Communicator Instruction Manual)*.

Block (Fixed) Window Demand:

This convention records the average (arithmetic mean) demand for consecutive time intervals (usually 15 minutes).

Example: A typical setting of 15 minutes produces an average value every 15 minutes (at 12:00, 12:15. 12:30. etc.) for power reading over the previous fifteen minute interval (11:45-12:00, 12:00-12:15, 12:15-12:30, etc.).

Rolling Window Demand:

Rolling Window Demand functions like multiple overlapping Block Window Demands. The programmable settings provided are the number and length of demand subintervals. At every subinterval, an average (arithmetic mean) of power readings over the subinterval is internally calculated. This new subinterval average is then averaged (arithmetic mean), with as many previous subinterval averages as programmed, to produce the Rolling Window Demand.

Example: With settings of 3 five-minute subintervals, subinterval averages are computed every 5 minutes (12:00, 12:05, 12:15, etc.) for power readings over the previous five-minute interval (11:55-12:00, 12:00-12:05, 12:05-12:10, 12:10-12:15, etc.). In addition, every 5 minutes the subinterval averages are averaged in groups of 3 (12:00. 12:05, 12:10, 12:15. etc.) to produce a fifteen (5x3) minute average every 5 minutes (rolling (sliding) every 5 minutes) (11:55-12:10, 12:00-12:15, etc.).

1.4 Specifications

POWER SUPPLY

Input Voltage Range:.................. High Voltage Option: (96 to 276) V AC or V DC @50/60 Hz; (20 to 500) Hz V AC.
Low Voltage DC Option: (18 to 60) V DC.
Startup/Dropout Voltage: .... AC option 96/87 V AC
DC Option 18/17 V DC
Protection .... Short-circuit protection and auto-restart when failure is removed.
Surge Withstand .... See Compliance section for details.
Frequency Range......................... (20 to 500) Hz.
Ride-through Characteristics at Maximum Power Consumption:
2 cycles - 120 V AC, 60 Hz
1 cycle - 120 V AC, 50 Hz.
Power Consumption:.................. 20 VA/12.5 W without optional I/O modules or display.
40 VA Max with I/O modules and display.
Typical: 12 VA/7.8 W at 120 V AC.
Connection Screw Torque: .... (6 to 9) in-lb. max or (0.68 to 1) Nm max.

VOLTAGE INPUTS

UL Measurement Category:..... Category III
Range (absolute maximum rating, between any voltage inputs) .... (20 to 720) V AC.
Measurement Modes:................ 2, 2.5, 3 element measurements
Services to Monitor: .... Single or polyphase, Wye, 3 or 4 wire Delta
Current hookup with CT only
Input Impedance.......................... 10 MOhms per voltage input.
Pickup Voltage .... 5 VAC.
Connection..................................... (6 to 9) in-lb. max or (0.68 to 1) Nm max.
AWG #12-24, solid or stranded.
Voltage Input Maximum Continuous Rating:
720 V AC between any two voltage inputs.
Voltage Input Withstand Capability:
Meets ANSI C37.90.1 surge withstand capability.
Reading .... Programmable Full Scale to any PT ratio.

CURRENT INPUTS

Class 2 and Class 20:.................. 1 or 5 A nominal, 20 A maximum.
Pickup Current.............................. Begins reading at 0.001 A (1 mA), 0.5% accuracy on watt readings at pickup current.
Current Input Maximum Continuous Rating: 30 A AC maximum continuous rating.
Current Input Withstand Capability: 100 A for 10 s, 300 A for 3 s, 500 A for 1 s.
Maximum voltage from current inputs to Earth Ground: 40 V AC.
Current Input terminals: .... 8-32 threaded stud. The current inputs are transformer rated and only to be connected to external CTs.
Reading: .... The current inputs are transformer rated and only to be connected to external CTs.
Burden: .... 0.028 VA @ 20 A input/phase.

FREQUENCY

Line Frequency Range:.............. Wideband Auto Frequency option (20-500) Hz or (42.5 - 69.5) Hz.

ISOLATION

Between human accessible I/O connections and power, voltage current inputs: 2500 V AC.
Between power and voltage and current inputs: 2500 V AC.
Between human accessible I/O connections: 500 V AC.
Isolation is Hi-Pot test verified in factory.

MEASUREMENT METHODS

Sensing Method:........................... RMS

UPDATE RATE

High accuracy readings: ....1 second, 1 cycle readings
High-speed readings: ....Programmable between 2 and 20 cycles.

MISCELLANEOUS

Memory for Storage: ....Up to 1200 MB (dependent on Software Option).
Auxiliary Output Power:..............18 V DC.
IRIG-B Port Impedance: ....8 mA@5 V.

COMMUNICATION

1 x RS232/RS485:...........................Selectable with switch.
3 x RS485:..With 18 V DC power output for a display and I/O modules.
1 x Ethernet over Copper:..........RJ45 connector 10/100BaseT.
1 x Ethernet over Fiber:...............ST connector, 1300 nm for 2 km multimode fiber.
Protocols:..Modbus (RTU, ASCII, TCP/IP), EGD, DNP3, SMTP, SNTP.
Device Serial Address Range: ..1-247/1-65520 (DNP ONLY).

ENVIRONMENTAL RATING

Operating Temperature: ....(-25 to +70) °C/(-32 to +158) °F.
Storage Temperature:.................(-40 to +70) °C/(-40 to +158) °F.
Protection Class: ....IP30.
Altitude: ....2000 m maximum
Relative Humidity: ....5 to 95% non-condensing

MECHANICAL PARAMETERS

Dimensions: see *Chapter 2 Mechanical Installation*.
Shipping Box Dimensions: ....14 in. x 10 in. x 6 in.
Meter and Shipping Weight:.....Approximately 5 lbs.
Connection Screw Torque: ....(6 to 9) in-lb max. or (0.68 to 1) Nm max.

1.5 External Display Specifications

P40N^{PLUS} LED EXTERNAL DISPLAYS

Maximum Input Voltage.............30 V DC
Minimum Input Voltage ....12 V DC
Maximum Power Consump. ..... 5 W
Nominal Power Consump.......... Approximately 3 W
Operating Temp. Range ....(-20 to +70) °C/(-4 to +158) °F
Overall Dimensions.......................(H x W x D) (5.25 x 5.25 x 1.79) inches/(13.34 x 13.34 x 4.54) cm

P70N LCD TOUCHSCREEN EXTERNAL DISPLAYS

Maximum Input Voltage.............24 V DC
Minimum Input Voltage ....12 V DC
Power Consumption (power not supplied to USB device)
3.6 W or less
Power Consumption (power supplied to USB device)
7.7 W or less
Storage Temperature Range ...(-20 to +60) °C/(-4 to +140) °F
Overall Dimensions (H x W).......(3.05 x 4.59) inches/(7.75 x 11.65) cm

1.6 Software Option Technology

The EPM 9700 meter is equipped with Software Option technology, a virtual firmware-based switch that allows you to enable meter features through software communication. Software Option technology allows the unit to be upgraded after installation without removing it from service.

1.6.1 Available Software Option Upgrades

Available Software Option upgrades

- Software Option A (Standard) - 512MB memory, 128 samples/cycle, and IEC 61000-4-30 Class A.
- Software Option B - 1.2GB memory and 1024 samples/cycle, and IEC 61000-4-30 Class A.

1.6.2 Upgrading the Meter's Software Option

To upgrade your meter to a higher Software Option (e.g., B), follow these steps:

1. To obtain a higher Software Option upgrade, contact Grid Solutions sales team. You will be asked for the following information:
   - Serial number(s) of the meter you are upgrading.
   - Desired Software Option upgrade.
   - Purchase Order.
2. Grid Solutions will issue you the Software Option upgrade key. To enable the key, follow these steps:
   - Open GE Communicator software.
   - Power up your EPM 9700 meter.
   - Connect to the meter via GE Communicator. (See the *GE Communicator Instruction Manual* for detailed instructions: you can open the manual online by clicking **Help > Contents** from the GE Communicator Main screen).
   - Click **Tools > Change Software Option** from the Title Bar of the Main screen. A screen opens, requesting the encrypted key.
   - Enter the upgrade key provided by Grid Solutions.

1.7 Accuracy

For 23 °C +/- 5 °C, 3 Phase balanced Wye or Delta load, at 50 Hz or 60 Hz (as per order code), accuracy as follows:

Parameter	1 Second Update	1 Cycle Update	Accuracy Input Range
Voltage L-N *	0.04% of reading	0.20% of reading	(45 to 480) V AC
Voltage L-L *	0.04% of reading	0.20% of reading	(80 to 720) V AC
Current *	0.04% of reading	0.20% of reading	(0.025 to 20) A AC
Neutral Current *	0.04%	0.20% of reading	(0.025 to 20) A AC
Frequency **	0.001 Hz	0.025 Hz	V: 20 V AC minimum
Active Power Total [W] ***	0.06% of reading	0.20% of reading	I: (0.025 to 20) A AC V: (45 to 480) V PF: 1.0
	0.1% of reading	0.35% of reading	I: (0.05 to 10) A AC V: (45 to 480) V PF: +/-(0.5 to 1) lag/lead
	0.15% of reading	0.50% of reading	I: (10 to 20) A AC V: (45 to 480) V PF: +/-(0.5 to 1) lag/lead
Active Energy Total [Wh]	0.06% of reading	N/A	I: (0.025 to 20) A AC V: (45 to 480) V PF: 1.0
	0.1% of reading	N/A	I: (0.05 to 10) A AC V: (45 to 480) V PF: +/-(0.5 to 1) lag/lead
	0.15% of reading	N/A	I: (10 to 20) A AC V: (45 to 480) V PF: +/-(0.5 to 1) lag/lead
Reactive Power Total [VAR] ***	0.15% of reading	0.50% of reading	I: (0.025 to 20) A AC V: (45 to 480) V PF: +/-(0.0 to 0.8) lag/lead
Reactive Energy Total [VARh]	0.15% of reading	N/A	I: (0.025 to 20) A AC V: (45 to 480) V PF: +/-(0.0 to 0.8) lag/lead
Apparent Power Total [VA] ***	0.06% of reading	0.20% of reading	I: (0.025 to 20) A AC V: (45 to 480) V PF: 1.0
	0.1% of reading	0.35% of reading	I: (0.05 to 20) A AC V: (45 to 480) V PF: +/-(0.5 to 1) lag/lead
Apparent Energy Total [VAh]	0.06% of reading	N/A	I: (0.025 to 20) A AC V: (45 to 480) V PF: 1.0
	0.1% of reading	N/A	I: (0.05 to 20) A AC V: (45 to 480) V PF: +/-(0.5 to 1) lag/lead
Power Factor ***	0.15% of reading	0.35% of reading	(45 to 65) Hz, PF: +/-(0.5 to 1) lag/lead
THD	2.5% of reading	N/A	I: (0.1 to 10) A AC V: (45 to 480) V
Flicker	5.0% of reading	N/A	Pst: 0.2 to 10
Unbalance	0.15% of reading	N/A	0.5% to 5% as measurement range
Mains Signaling	5% of reading	N/A	3% to 15% as measurement range

Accuracy for meters operating in Wide Band Auto Frequency:

* 1 second voltage, current RMS 0.2%

** 1 second frequency, 0.01%

*** 1 second, reactive power, apparent power, and power factor at unity PF, 0.5%
1 second, reactive power, apparent power, and power factor at 1/2 PF, 1%

1.8 Compliance

Test	Reference Standard	Level/Class
Low voltage Directive	2014/35/EU	
EMC Directive	2014/30/EU	
RoHS 2 Directive	EU Directive 2011/65/EC	
REACH Regulation	(EC) No 1907/2006	
Electromagnetic compatibility (EMC). Testing and measurement techniques. Electrostatic discharge immunity test	IEC 61000-4-2	Level 3
Electromagnetic compatibility (EMC). Radiated, radio-frequency, electromagnetic field immunity test	IEC 61000-4-3	80Mhz -1Ghz & 1.4-2.7 GHz Level 2, 2-2.7Ghz Level 1
Electrical fast transient/burst immunity test	IEC 61000-4-4	
Surge immunity test	IEC 61000-4-5	Level 3
Immunity to conducted disturbances, induced by radio-frequency fields	IEC 61000-4-6	Level 3
Limits for harmonic current emissions	EN/IEC 61000-3-2	Class A
Flicker	EN/IEC 61000-3-3	all parameters
Power quality measurement methods	IEC 61000-4-30	Class A Edition 3
Voltage Dips and Interruptions	IEC 61000-4-11	Level 3
Radiated and Conducted Emissions	CISPR 11	Class A
Measuring, Testing and Signal Equipment (Product Safety)	UL61010-1 3rd edition 2012-05-11 CAN/CSA-C22-2 No.61010-1 3rd edition,2012-05	UL Listed to PICQ,PICQ7
Power Magnetic Immunity	IEC 61000-4-8	Level 4
Voltage Dips and Interrupts (DC)	IEC 61000-4-29	per report

1.9 Ordering

1.9.1 Order Codes

Table 1–1: EPM 9700 Order Codes

	PL9900P	X	*	*	*	*	*	*	Description
Base Unit	**PL9700**	|	|	|	|	|	|	|	EPM 9700 Multi-function metering system
		X							Reserved for future use
Frequency			0	|	|	|	|	|	60 Hz AC frequency system
			1	|	|	|	|	|	50 Hz AC frequency system
Control Power				0	|	|	|	|	Universal (100-240) VAC @50/60 Hz or (100-240) VDC
				1	|	|	|	|	18 to 60 VDC
Software					A	|	|	|	Standard: 512MB Memory, 512 Samples/Cycle
					B	|	|	|	Advanced: 1.2GB Memory, 1024 Samples/Cycle
						X	X	X	Reserved for future use

1.9.2 EPM Accessories

This section describes accessories for the EPM 9700 which are available separately for the meter.

NOTE: External modules and accessories must be ordered separately from base meters.

External Displays

The following external displays are available:

External Displays:

PL9000	*	*	*	*	*	*	*	0	0	
	P	4	0	N	P	L	U	S	0	P40N PLUS three-line LED display with 6 ft (1.8 m) cable
	P	7	0	N	0	0	0	0	0	P70N color touchscreen LCD display with 6 ft (1.8 m) cable

External Input/Output (I/O) Modules

The following external (I/O) modules are available:

Analog output modules:

PL9000	*	*	*	*	*	*	*	0	0	
	1	M	A	O	N	4	0	0	0	Four channel 0 to 1 mA analog outputs
	1	M	A	O	N	8	0	0	0	Eight channel 0 to 1 mA analog outputs
	2	O	M	A	O	N	4	0	0	Four channel 4 to 20 mA analog outputs
	2	O	M	A	O	N	8	0	0	Eight channel 4 to 20 mA analog outputs

Analog input modules:

PL9000	*	*	*	*	*	*	*	0	0	
	8	A	I	1	0	0	0	0	0	Eight channel 0 to 1 mA analog inputs
	8	A	I	2	0	0	0	0	0	Eight channel 4 to 20 mA analog inputs
	8	A	I	3	0	0	0	0	0	Eight channel 0 to 5 V DC analog inputs
	8	A	I	4	0	0	0	0	0	Eight channel 0 to 10 V DC analog inputs

Digital dry contact relay/solid state pulse outputs:

PL9000	– *	– *	– *	– *	– 0	– 0	– 0	– 0	– 0	
	4	R	0	1	0	0	0	0	0	Four relay outputs, 5A, 250VAC/30 VDC, form C latching
	4	P	0	1	0	0	0	0	0	Four solid state pulse outputs, form A or C KYZ pulses, 20 pulses/sec. max.

Auxiliary output power supply and mounting:

PL9000	– *	– *	– I	– O	– 0	– 0	– *	– *	– *	
	M	B	I	O	0	0	0	0	0	Mounting bracket (required for external modules)
	P	S	I	O	0	0	0	0	0	Auxiliary power supply (required for external modules)
	A	C	C	D	I	N	-	-	-	EPM 9700 DIN Rail Mount Kit

Software Upgrade Options

The following table describes the option available for upgrading software for the EPM 9700.

Table 1–2: Upgrade Software

Part Number	Description
PL9900P-ACC-SAB	Upgrade Software option A to B: Advanced: 1.2GB Memory, 1024 Samples/Cycle

1.10 Approvals

	Applicable Council Directive	According to:
CE compliance	Low voltage directive	EN/IEC 61010-1
	EMC Directive	EN61000-6-2
		EN61000-6-4
North America cULus Listed	Measurement Category III, Pollution Degree 2.	UL61010-1 (PICQ)
		C22.2.No 61010-1 (PICQ7)
		File E200431
ISO	Manufactured under a registered quality program	ISO9001

Multilin EPM 9700

Chapter 2: Mechanical Installation

This chapter explains how to install the EPM 9700 meter, including optional I/O modules and the optional display.

2.1 Panel Mounting the EPM 9700 Meter

⚠CAUTION

This equipment is intended to be permanently installed within a metal enclosure or panel that is protective earthed, mounted such that the exposed terminals are enclosed. Voltages are measured by connections to the branch supply only.

The EPM 9700 Meter is designed to mount against any firm, flat surface. Use a #10 screw in each of the four slots on the flange to ensure that the unit is installed securely. For safety reasons, mount the meter in an enclosed and protected environment, such as in a switchgear cabinet. Install a switch or circuit breaker nearby; label it clearly as the meter's disconnecting mechanism.

Maintain the following conditions:

- Operating Temperature: -25 °C to +70 °C / -32 °F to +158 °F
- Storage Temperature: -40 °C to +70 °C / -40 °F to +158 °F
- Relative Humidity: 5 to 95% non-condensing

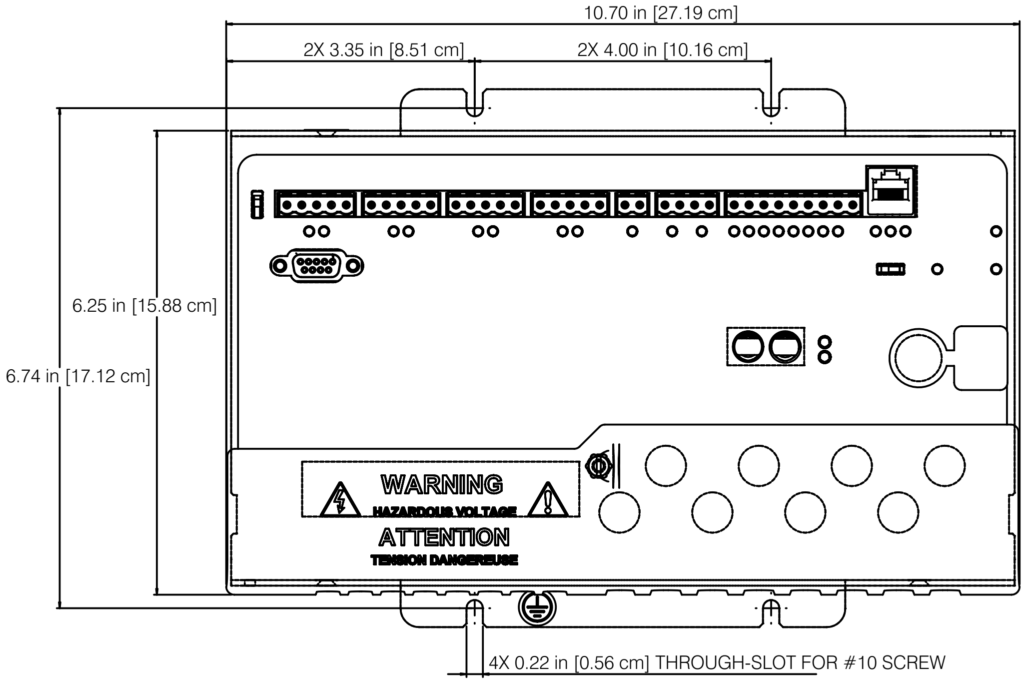


Figure 2-1: EPM 9700 Mounting Diagram Top View

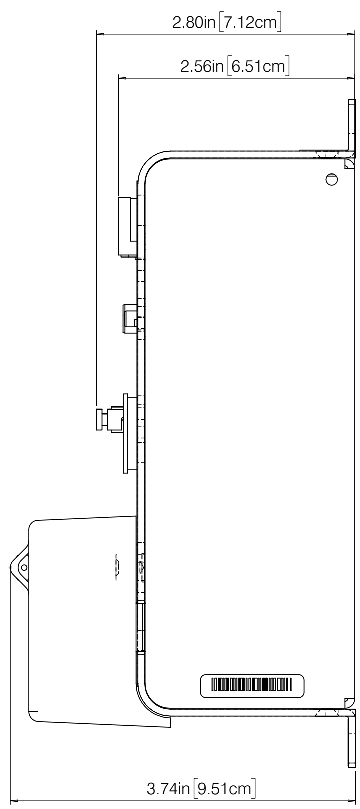
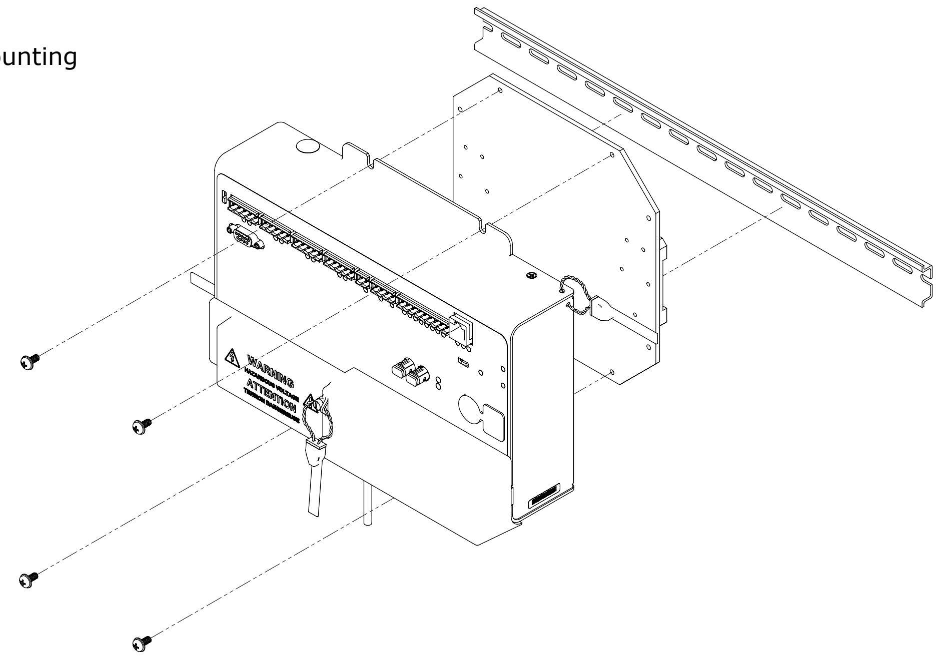


Figure 2-2: EPM 9700 Mounting Diagram Side View

2.2 DIN Rail Mounting

The EPM 9700 meter can also be mounted, either horizontally or vertically (for space saving), on a DIN Rail. If you have ordered this optional accessory, the meter came with a DIN Rail mounting kit (order code PL9000ACCDIN).

Horizontal Mounting



Vertical Mounting

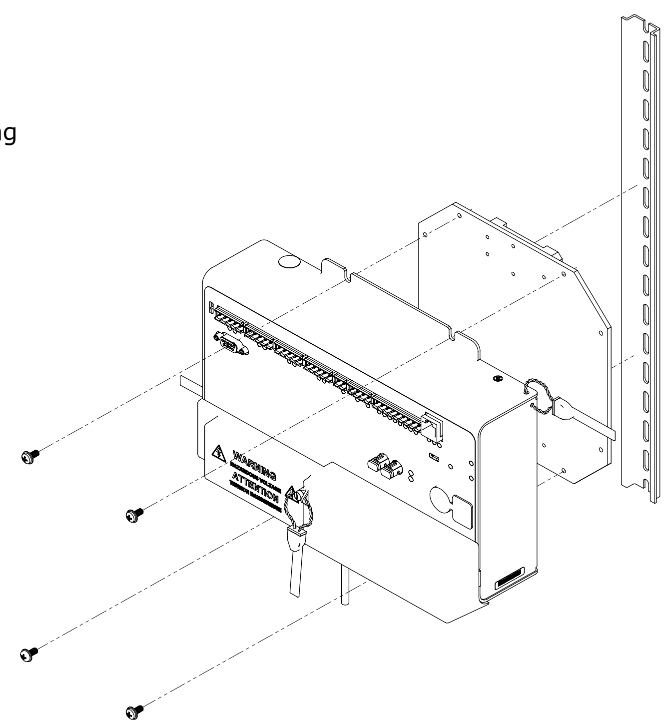
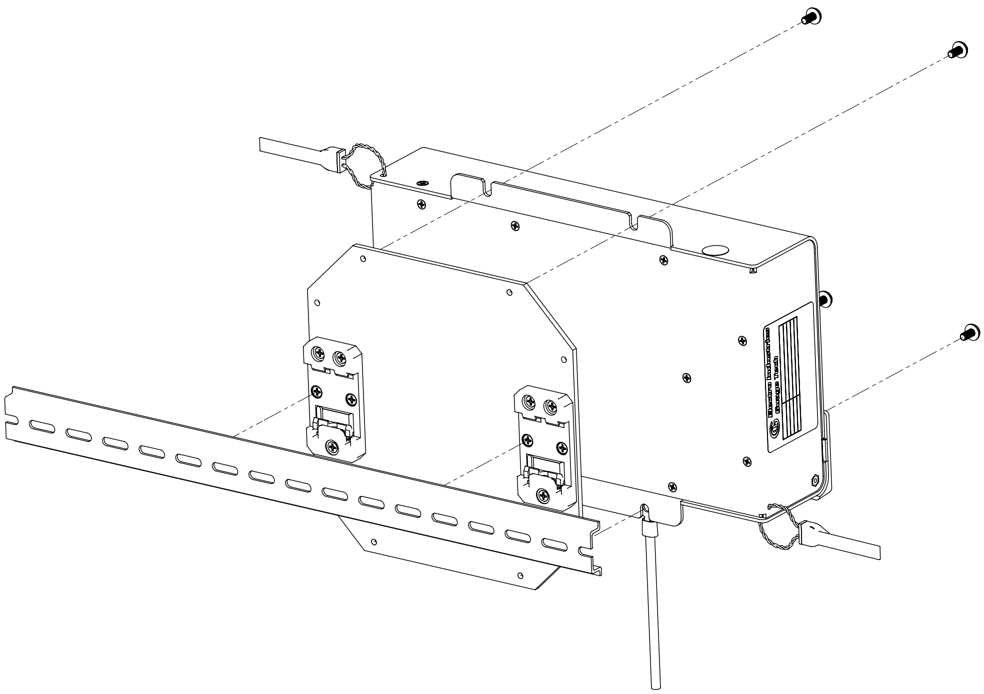


Figure 2-3: DIN Rail Mounting Front

Horizontal Mounting



Vertical Mounting

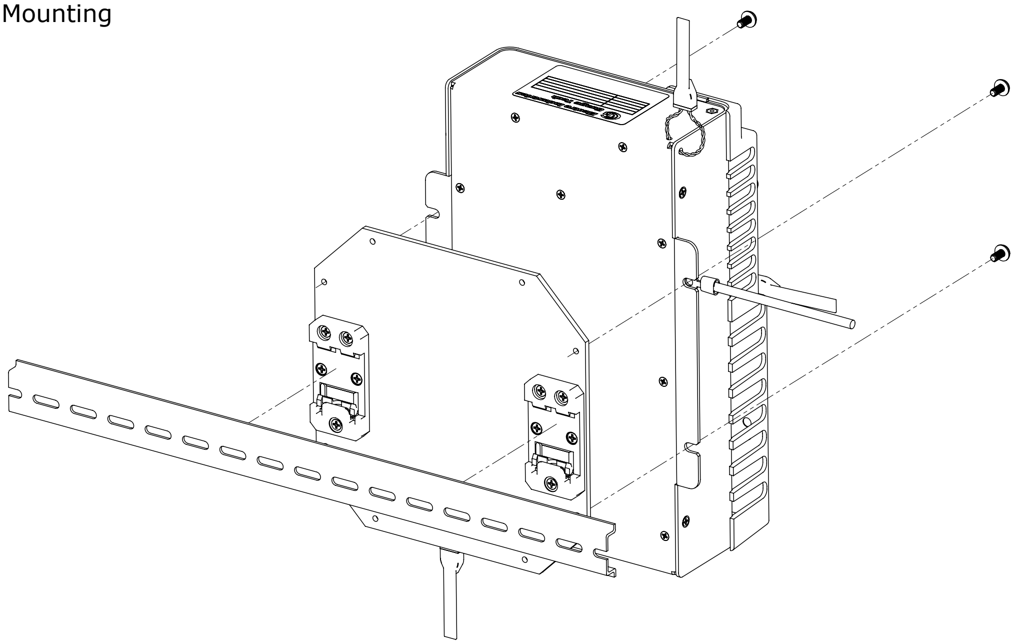


Figure 2-4: DIN Rail Horizontal Mounting Back

2.3 Mounting External Displays

This section explains how to mount the P40N^{PLUS} and P70N external displays.

2.3.1 P40N^{PLUS} LED External Displays

The P40N^{PLUS} LED display mounts using a standard ANSI C39.1 drill plan.

Secure the four mounting studs to the back of the panel with the supplied nuts.

Six feet of RS485 communication/power cable harness is supplied. Allow for at least a 1.25” (3.17 cm) diameter hole in the back for the cable harness. See Chapter 5 for communication and power supply details.

The cable harness brings power to the display from the EPM 9700 meter, which supplies (15–20) V DC. The P40N^{PLUS} can draw up to 500 mA in display test mode.

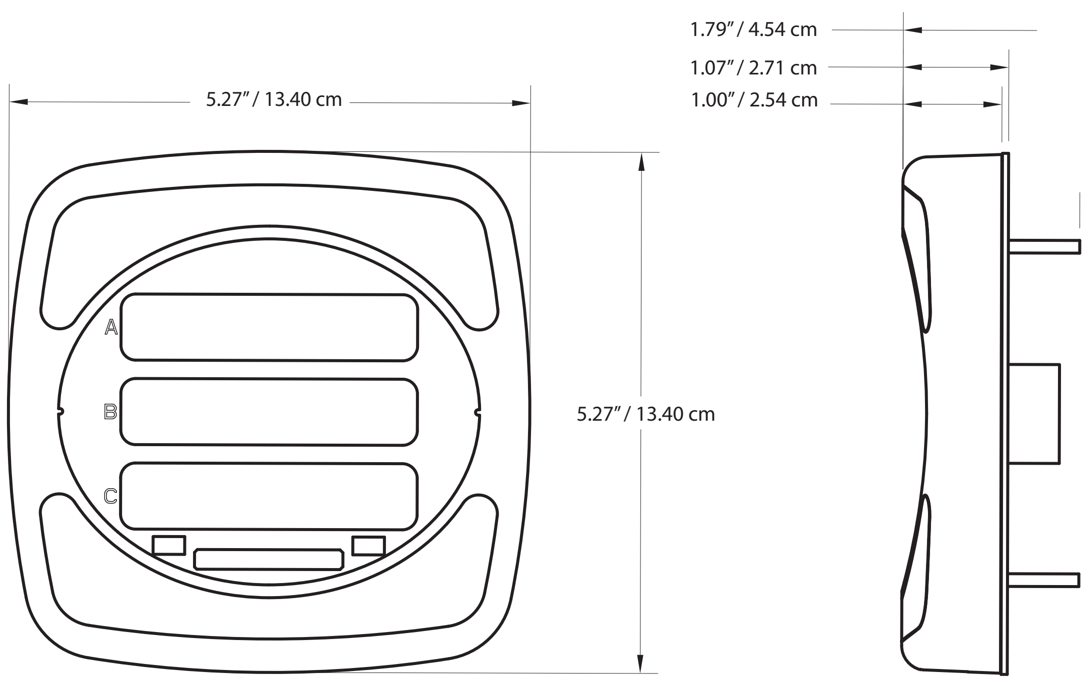


Figure 2-5: P40N^{PLUS} Front and side dimensions

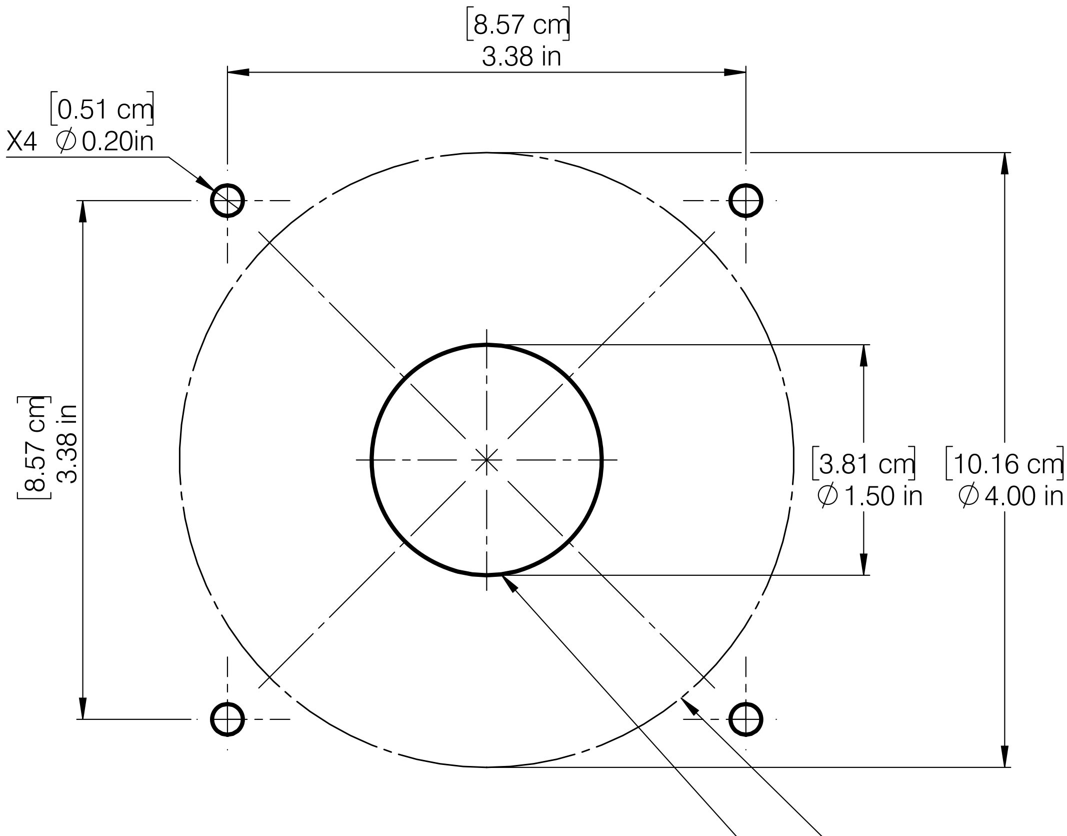


Figure 2-6: ANSI C39.1 Drill Plan for P40N^PLUS Display

2.3.2 P70N LCD Touchscreen Display Mounting and Installation

The P70N display ships with a cable for connecting the display to one of the meter's RS485 ports. There is an optional ANSI mounting kit that can be ordered for the P70N.

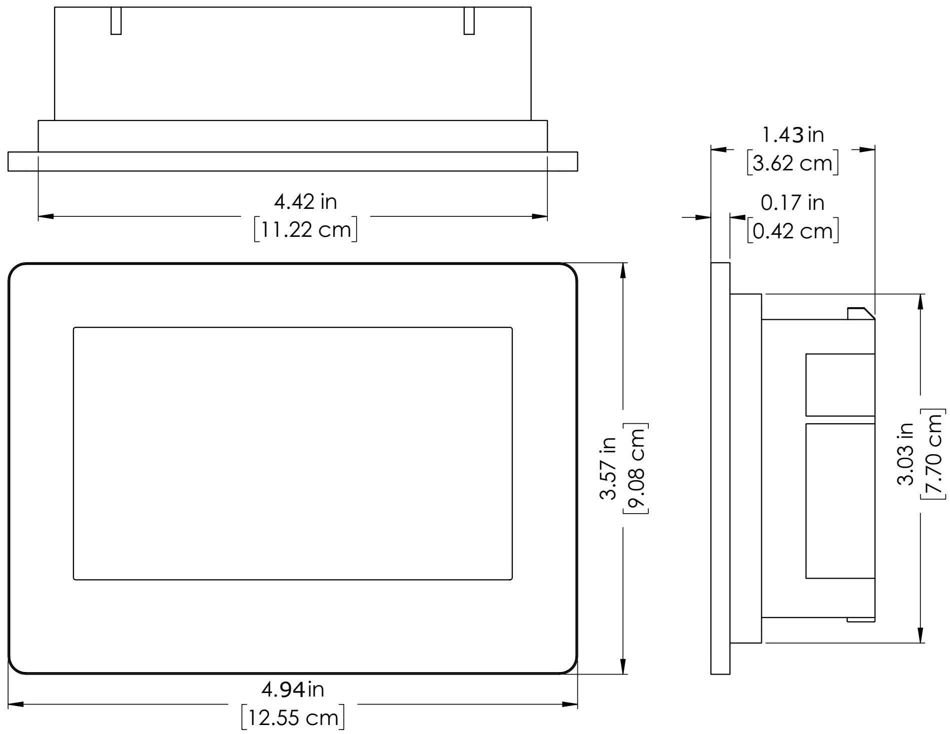


Figure 2-7: P70N Dimensions

INSTALLATION NOTES:

- For easier maintenance, operation, and improved ventilation, be sure to install the P70N at least 3.94 in. [10.01 cm] away from adjacent structures and other equipment.
- Be sure that the surrounding air temperature and the ambient humidity are within their designated ranges:
- Surrounding air temperature: 0 to 50 °C. When installing the P70N on the panel of a cabinet or enclosure, "Surrounding air temperature" indicates both the panel face and cabinet or enclosure's internal temperature.
- Ambient humidity: 10 to 90% RH
- Wet bulb temperature: 39 °C max)
- Be sure that heat from surrounding equipment does not cause the P70N to exceed its standard operating temperature (50 °C).
- When installing the P70N in a slanted panel, the panel face should not incline more than 30°.
- When installing the P70N in a slanted panel, and the panel face has to incline more than 30°, the ambient temperature must not exceed 40 °C. You may need to use forced air cooling (fan, A/C) to ensure the ambient operating temperature is 40° C or below.

- When mounting the P70N vertically, ensure that the left side of the unit faces up, i.e., the power connector and serial interface should be at the bottom.
- You can use either Mounting 1 or Mounting 2 (using the ANSI mounting kit) to mount the P70N (see the following diagrams).

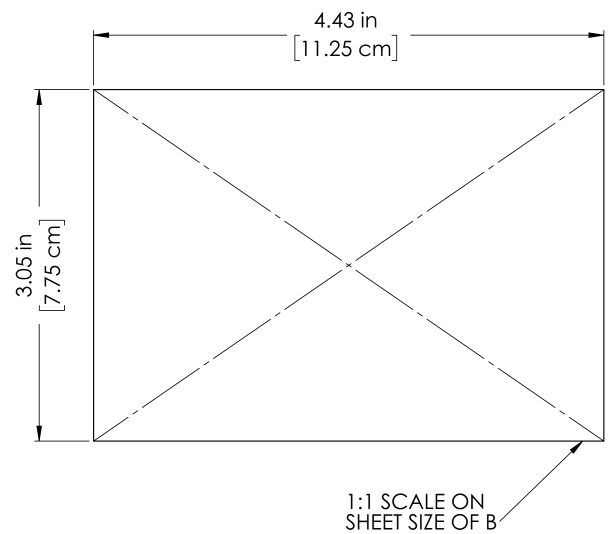


Figure 2-8: Panel Cutout Dimensions Mounting 1

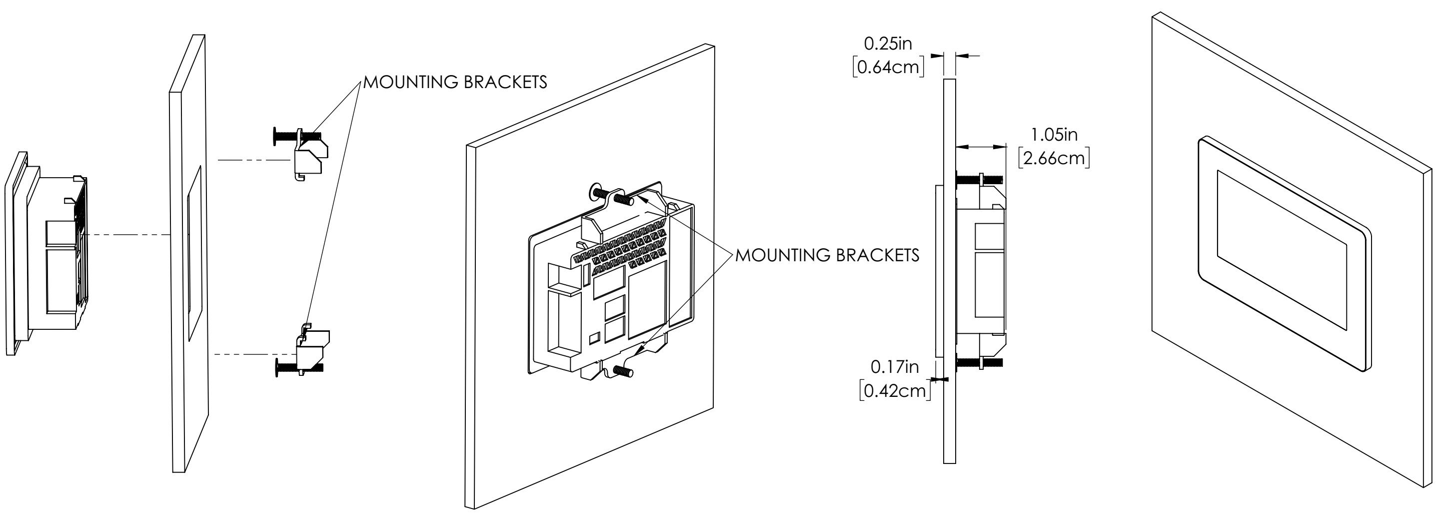


Figure 2-9: P70N Mounting 1

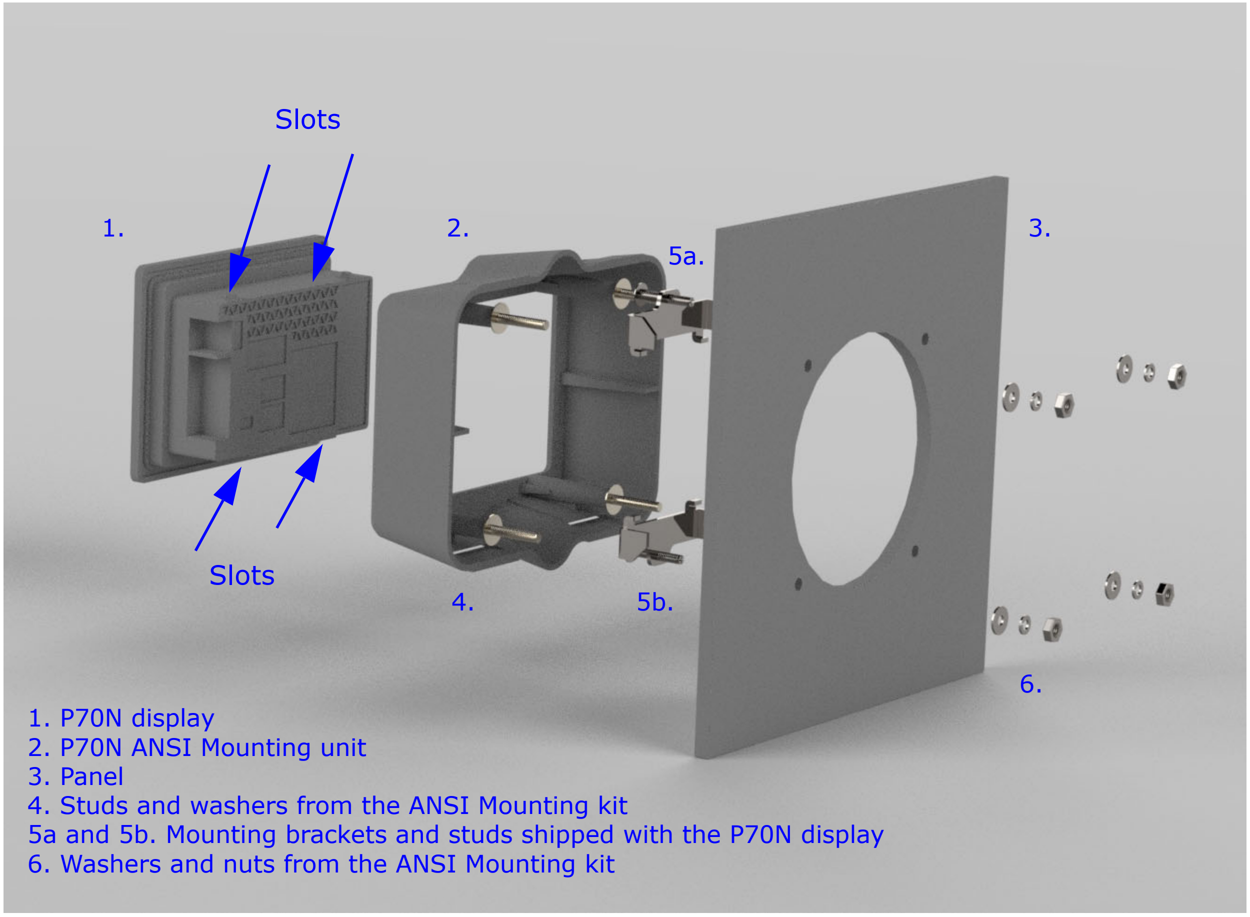


Figure 2-10: P70N Mounting 2 Using the Optional P70N ANSI Mounting Kit

The recommended order of assembly for the ANSI Mounting kit is:

1. Attach the top bracket (5a) with its stud to the top back of the P70N display (1) - the bracket has two hooks that fit into the slots on the top of the display.
2. Slide the top of the display with attached bracket under the front lip of the ANSI Mounting unit (2) and tighten stud snugly - torque is to 3.1 in-lb.
3. Attach the bottom bracket (5b) with its stud to the bottom back of the P70N display - the bracket has two hooks that fit into the slots on the bottom of the display; tighten stud snugly - torque is 3.1 in-lb.
4. Once the display is secured inside the ANSI Mounting unit, attach the studs and washers from the ANSI Mounting kit (4) to the back of the unit.
5. Use the washers and nuts from the ANSI Mounting kit (6) to attach the ANSI Mounting unit with P70N display to the panel (3) - torque is 3.5 in-lb.

2.4 Removing and Reinstalling the Sealing Switch Cover

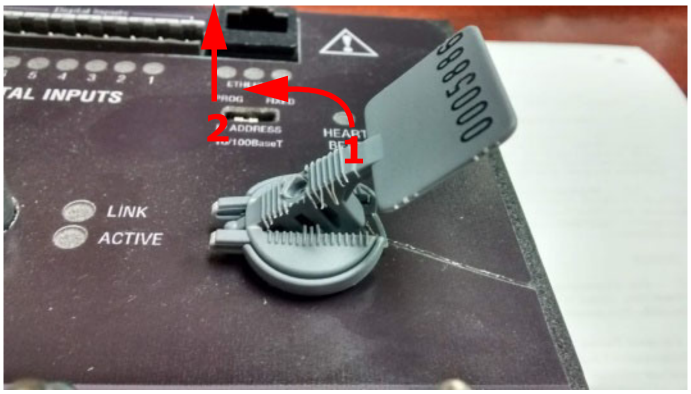
The meter's Sealing Switch feature adds an additional level of security by requiring that a button on the meter be pressed before restricted tasks can be performed. The Sealing Switch feature is enabled through GE Communicator software. Its functionality and the procedure for using it are explained fully in the *GE Communicator Instruction Manual*, available both online and in the software itself (click **About > Contents** from the software's Main screen).

The button that needs to be pressed when the Sealing Switch is enabled is the Reset button. The Reset button is covered by a seal, which needs to be broken before the button can be accessed and pressed. The seal over the Reset button can then be replaced. This section contains detailed instructions for removing and reinstalling the cover.

2.4.1 Removing the Cover

Grab the Sealing Switch cover tab (where the serial number is imprinted) with pliers and pull perpendicular to the meter face. The Seal Switch Cover will tear on either side of the tab.

Continue pulling and the Sealing Switch cover will easily come out of its mounting hole, exposing the Reset switch.



2.4.2 Re-installing the Cover

Install the Sealing Switch cover by first hooking one side of the bottom into the hole in the meter.

Continue to push down on the cover until both sides are in the hole on top of the meter.

Fold over the top portion of the cover, with the middle tab lining up with the middle slot, as shown below.

Continue to press down on the top until the tab is fully in place - it will "click" into place.

Check that the Sealing Switch cover is correctly oriented, as shown below.

Multilin EPM 9700

Chapter 3: Electrical Installation

This chapter provides electrical installation information for theEPM 9700 meter.

3.1 Safety Considerations When Installing Meters

CAUTION

- Installation of the EPM 9700 meter must be performed only by qualified personnel who follow standard safety precautions during all procedures. Those personnel should have appropriate training and experience with high voltage devices. Appropriate safety gloves, safety glasses and protective clothing are recommended.
- During normal operation of the EPM 9700 meter, dangerous voltages flow through many parts of the meter, including: Terminals and any connected CTs (Current Transformers) and PTs (Potential Transformers), all I/O (Inputs and Outputs) and their circuits. All Primary and Secondary circuits can, at times, produce lethal voltages and currents. Avoid contact with any current-carrying surfaces.
- **Do not use the meter or any I/O device for primary protection or in an energy-limiting capacity. The meter can only be used as secondary protection.**
- Do not use the meter for applications where failure of the meter may cause harm or death.
- Do not use the meter for any application where there may be a risk of fire.
- All meter terminals should be inaccessible after installation.
- Do not apply more than the maximum voltage that the meter or any attached device can withstand. Refer to meter and/or device labels and to the Specifications for all devices before applying voltages.
- Do not HIPOT/Dielectric test any Outputs, Inputs or Communications terminals.
- To prevent hazardous voltage conditions, the use of fuse branch circuit protection for voltage leads and the power supply are required.
- To prevent CT damage and potential injuries, shorting blocks for CT circuits are required if the meter needs to be removed from service. One side of the CT must be grounded.

NOTE

The current inputs are only to be connected to external current transformers provided by the installer. The CTs shall be Approved or Certified and rated for the current of the meter used.

To comply with UL standards, the meter case must be connected to a reliable protective earth available within the installation area. For this connection use minimum #14 AWG wire crimped to a ring terminal(3) with a dedicated tool. Fasten the ring terminal(3) to the lower left slot of the meter case with minimum #6 metal screw(1) and star washer(2), as is shown in Figure 3.1.

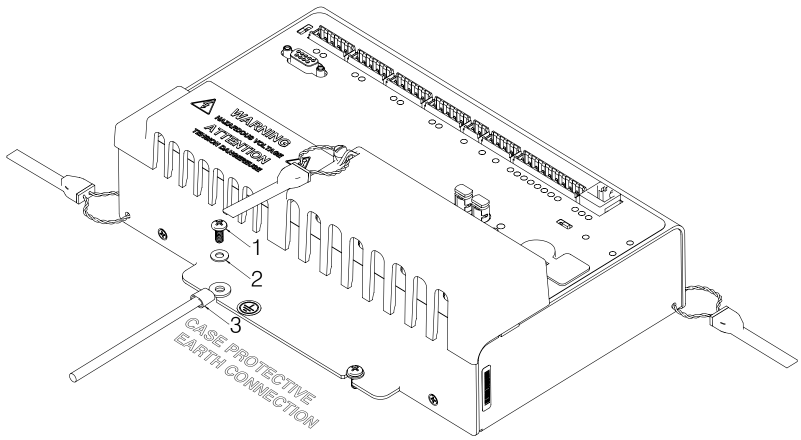


Figure 3-1: Meter Case Earth Ground Connection

The UL Classification of the meter is Measurement Category III, Pollution Degree 2. Measurement Category III is for measurements performed in the building installation at the distribution level. This category refers to measurements on hard-wired hardware such as hardware in fixed installations, distribution boards, and circuit breakers. Other examples are wiring, including cables, bus bars, junction boxes, switches, socket outlets in the fixed installation, and stationary motors with permanent connections to fixed installations.

⚠CAUTION

If the equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment can be impaired.

NOTICE

There is no required preventive maintenance or inspection necessary for safety. However, any repair or maintenance should be performed by the factory.

⚠CAUTION

DISCONNECT DEVICE: The following part is considered the equipment disconnect device. A switch or circuit breaker shall be included in the end-use equipment or building installation. The switch shall be in close proximity to the equipment and within easy reach of the operator. The switch shall be marked as the disconnecting device for the equipment.

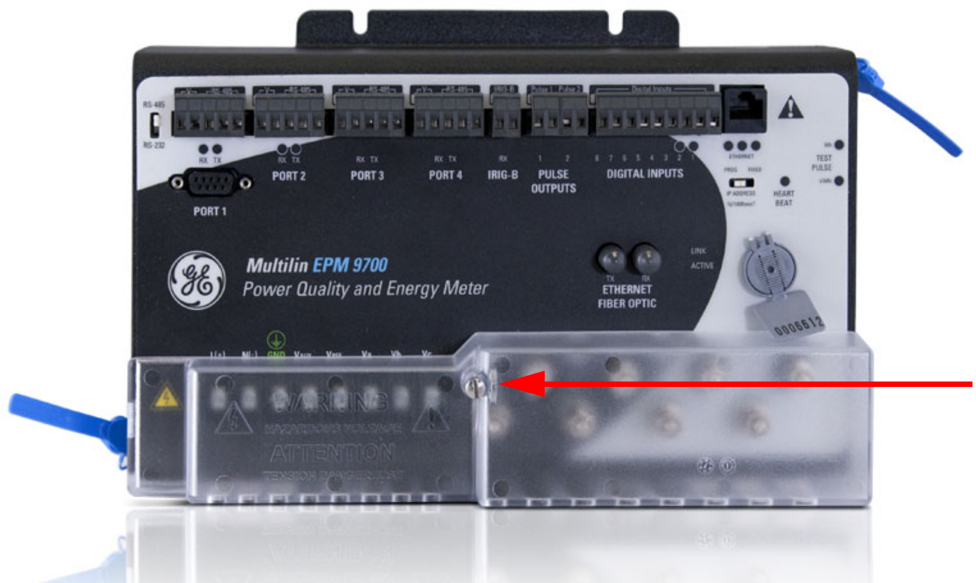
3.1.1 Removing and Reinstalling the Protective Cover

⚠CAUTION

This equipment is intended to be permanently installed within a metal enclosure or panel that is protective earthed, mounted such that the exposed terminals are enclosed. Voltages are measured by connections to the branch supply only.

The EPM 9700 meter has a protective cover over the current and voltage hookups. Before connecting voltage or current wires, you need to remove this cover. After performing wiring, you need to re-attach the cover. Follow this procedure:

1. Use a flat-tipped, 5 1/16 in. blade width screwdriver to unscrew the top screw on the protective cover.
   IMPORTANT! Be careful not to remove screws from the cover.



2. Remove the anti-tamper tag that is around the current post.
3. Follow the wiring instructions and diagrams in sections 3-2 - 3-6.
4. Re-attach the anti-tampering tag around the current post.
5. Be sure the current and voltage wires are inserted through the slots on the protective cover and re-attach the cover by screwing in the center screw with a flat-tipped screwdriver.

3.2 Wiring the Voltage Inputs: Va, Vb, Vc, VAUX, Vref

Select a wiring diagram from *Wiring Diagrams* on page 3–5 that best suits your application. Wire the EPM 9700 meter exactly as shown. For proper operation, the voltage connection must be maintained and must correspond to the correct terminal. The cable required to terminate the voltage sense circuit should have an insulation rating of 600 V AC or greater. Use a minimum of 14 AWG wire for all phase voltage and current connections. The maximum installation torque for both the current input terminals and the voltage connections is 1 Newton-Meter.

For protection, GE requires using 0.25-Amp rated fuses on all voltage inputs as shown in the wiring diagrams (see *Wiring Diagrams* on page 3–5).
The EPM 9700 meter can handle a maximum voltage of 300 V phase to neutral and 600 V phase to phase. Potential Transformers (PTs) are required for higher voltages with the standard rating.

The VAUX connection is an auxiliary voltage input that can be used for any desired purpose, such as monitoring neutral to ground voltage or monitoring two different lines on a switch.

3.3 Wiring the Current Inputs: Ia, Ib, Ic, In

Wiring for the current inputs must have a minimum insulation rating of 600 V AC, and a minimum wire size of 14 AWG. The cable connector (ring lugs) must be rated at 20 A.

⚠WARNING

Do not leave the secondary of the CT open when primary current is flowing. This can cause high voltage, which overheats the CT. If the CT is not connected, provide a shorting block on the secondary of the CT.

It is important to maintain the polarity of the CT circuit when connecting to the EPM 9700 meter. If the polarity is reversed, the meter will not provide accurate readings. CT polarities are dependent upon correct connection of CT leads and the direction CTs are facing when clamped around the conductors.

3.4 Isolating a CT Connection Reversal

For a Wye System, you may either:

- Check the current phase angle reading on the meter's external display (see Chapter 6). If it is negative, reverse the CTs.
- Go to the Phasors screen of the GE Communicator software (see the *GE Communicator Instruction Manual* for instructions). Note the phase relationship between the current and voltage: they should be in phase with each other.

For a Delta System:

- Go to the Phasors screen of the GE Communicator software (see the *GE Communicator Instruction Manual* for instructions). The current should be 30 degrees off the phase-to-phase voltage.

3.5 Power Supply Connections

The EPM 9700 meter requires a separate power source.

To use AC power:

1. Connect the line supply wire to the L+ terminal
2. Connect the neutral supply wire to the N- terminal on the meter.

To use DC power:

1. Connect the positive supply wire to the L+ terminal.
2. Connect the negative (ground) supply wire to the N- terminal on the meter.

Power supply options and corresponding suffixes are listed in the table shown below.

Control Power	Option Suffix
(18-60) V DC	1
(96-276) V AC	0

- Do not ground the unit through the negative of the DC supply. **Separate grounding is required.**
- Externally fuse the power supply with a 5 Amp @250V rated slow blow fuse. GE recommends that you fuse **both** the L+ and N- connections for increased safety, but if you are fusing only one connection, fuse the L+ connection.

3.6 Wiring Diagrams

Choose the diagram that best suits your application from the following pages. If the connection diagram you need is not shown, contact GE for a custom connection diagram.

NOTICE

Any unused sense voltage inputs must be shorted to the Vref input.

Figure 3-2: *4-Wire Wye, 3-Element Direct Voltage with 4 CTs* on page 3–6

Figure 3-3: *4-Wire Wye, 3-Element with 3 PTs and 4 CTs* on page 3–7

Figure 3-4: *4-Wire Wye, 3-Element with 3 PTs and 3 CTs* on page 3–8

Figure 3-5: *3-Wire, 2-Element Open Delta with 2 PTs and 3 CTs* on page 3–9

Figure 3-6: *3-Wire, 2-Element Open Delta with 2 PTs and 2 CTs* on page 3–10

Figure 3-7: *3-Wire, 2-Element Delta Direct Voltage with 2 CTs* on page 3–11

Figure 3-8: *3-Phase, 4-Wire, 2.5 Element with 2 PTs and 3 CTs* on page 3–12

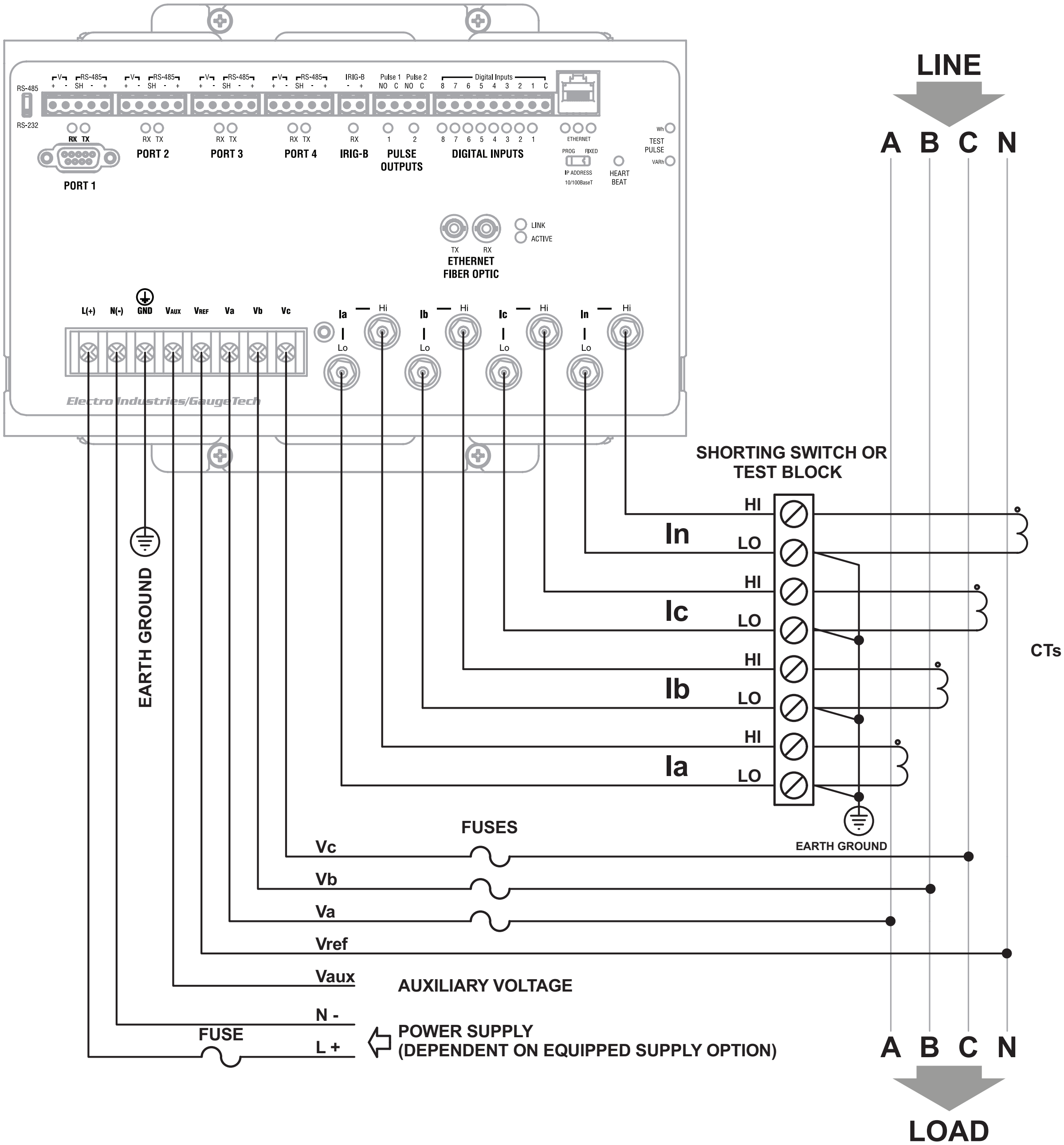


Figure 3-2: 4-Wire Wye, 3-Element Direct Voltage with 4 CTs

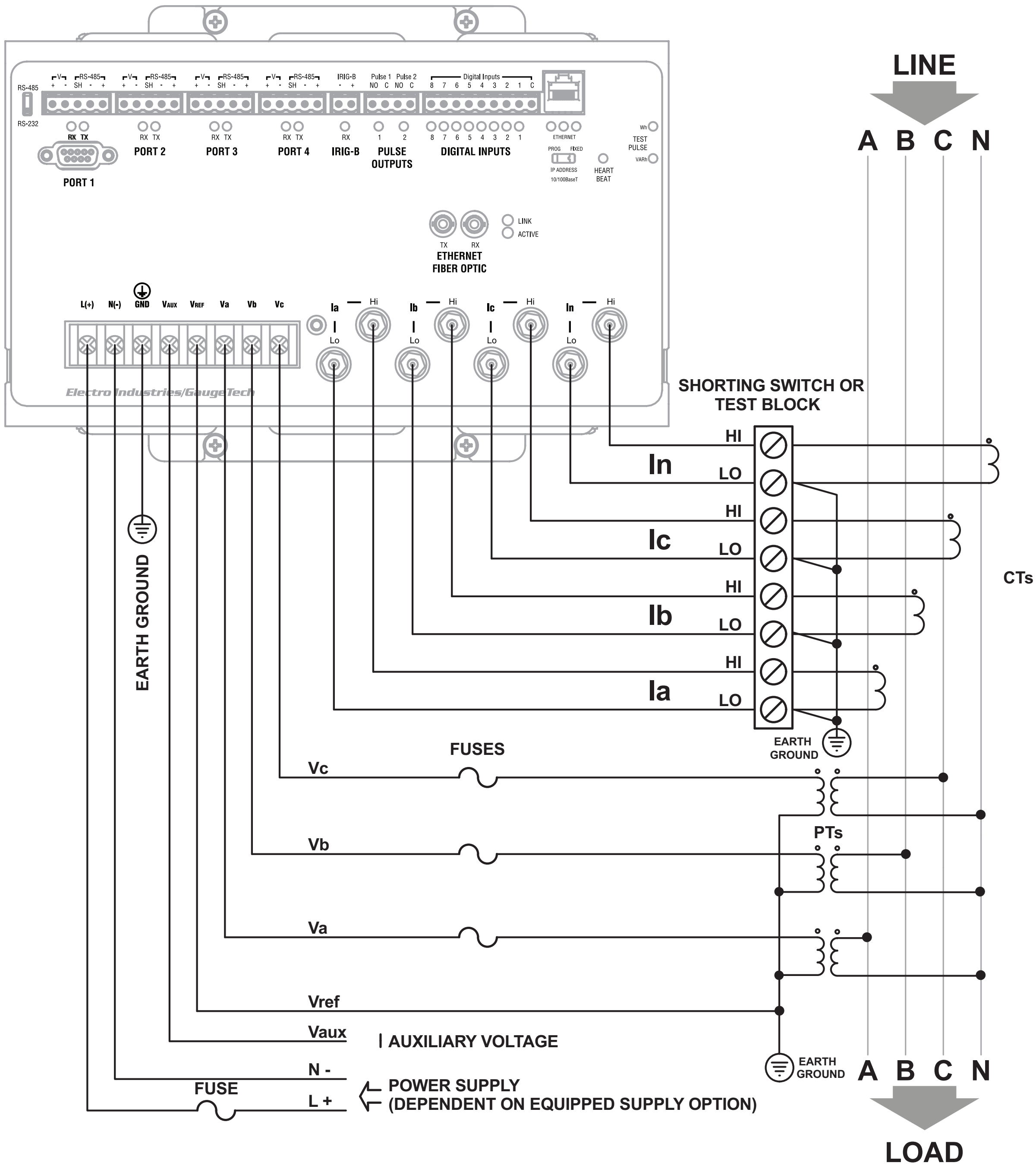


Figure 3-3: 4-Wire Wye, 3-Element with 3 PTs and 4 CTs

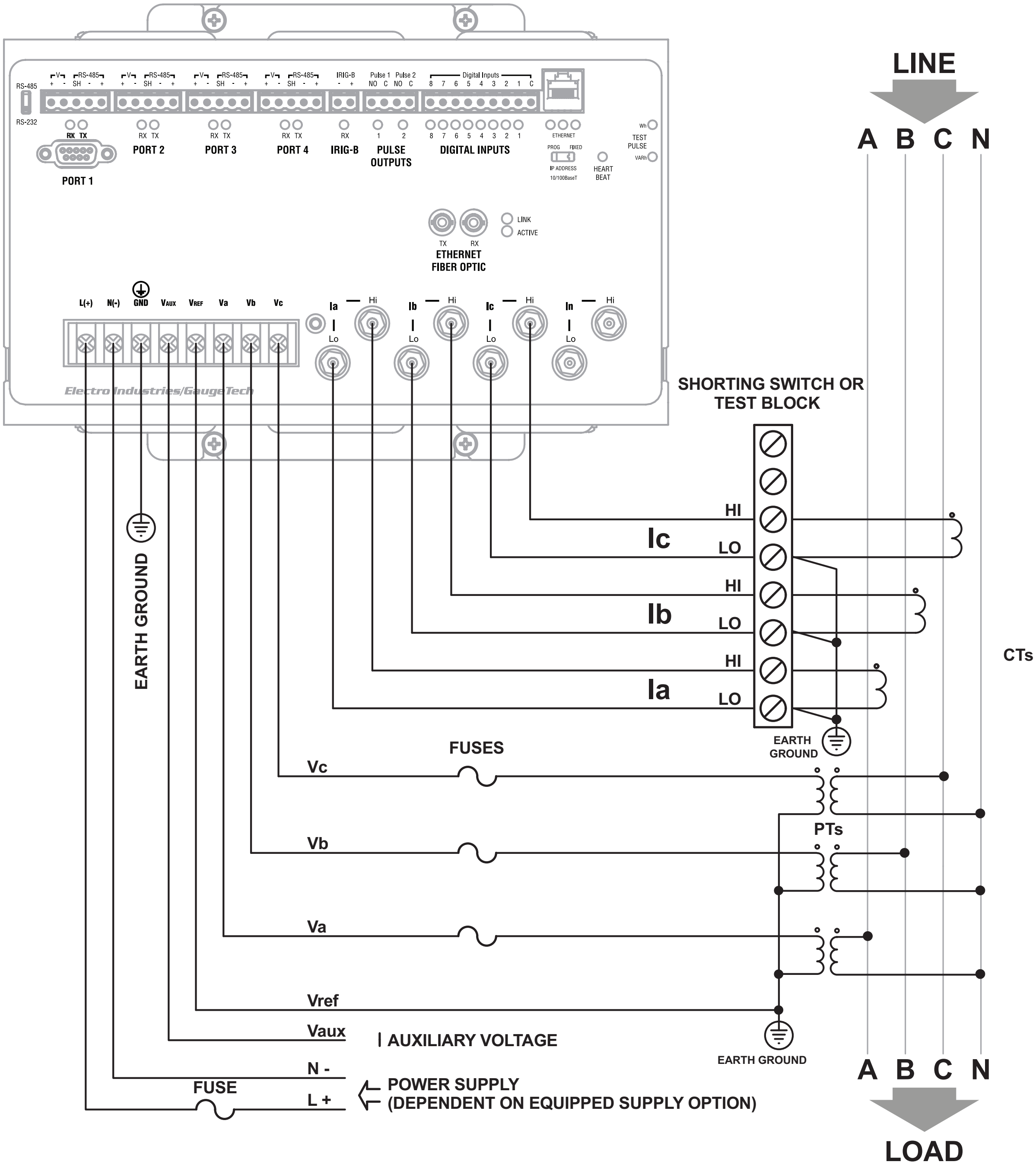


Figure 3-4: 4-Wire Wye, 3-Element with 3 PTs and 3 CTs

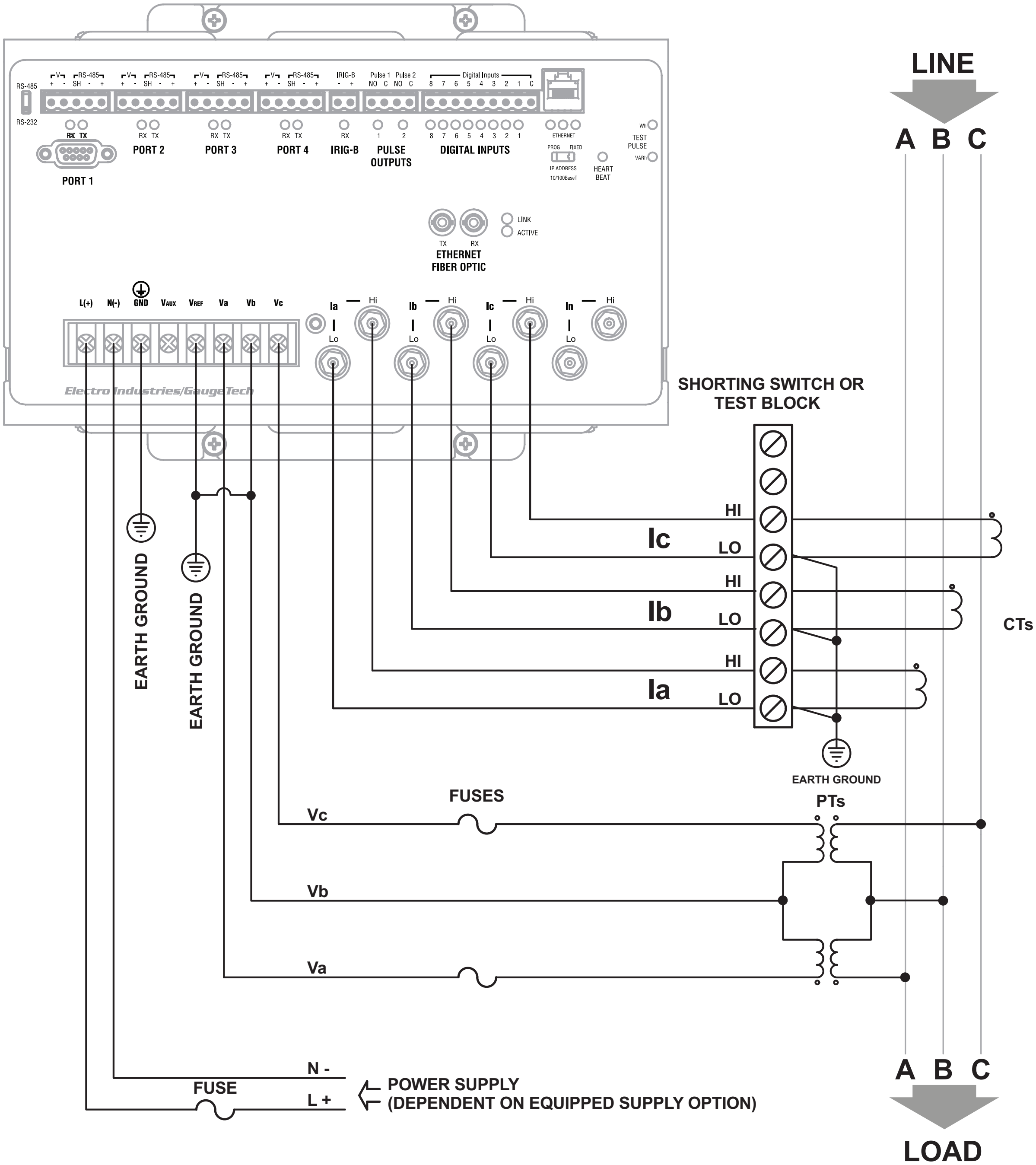


Figure 3-5: 3-Wire, 2-Element Open Delta with 2 PTs and 3 CTs

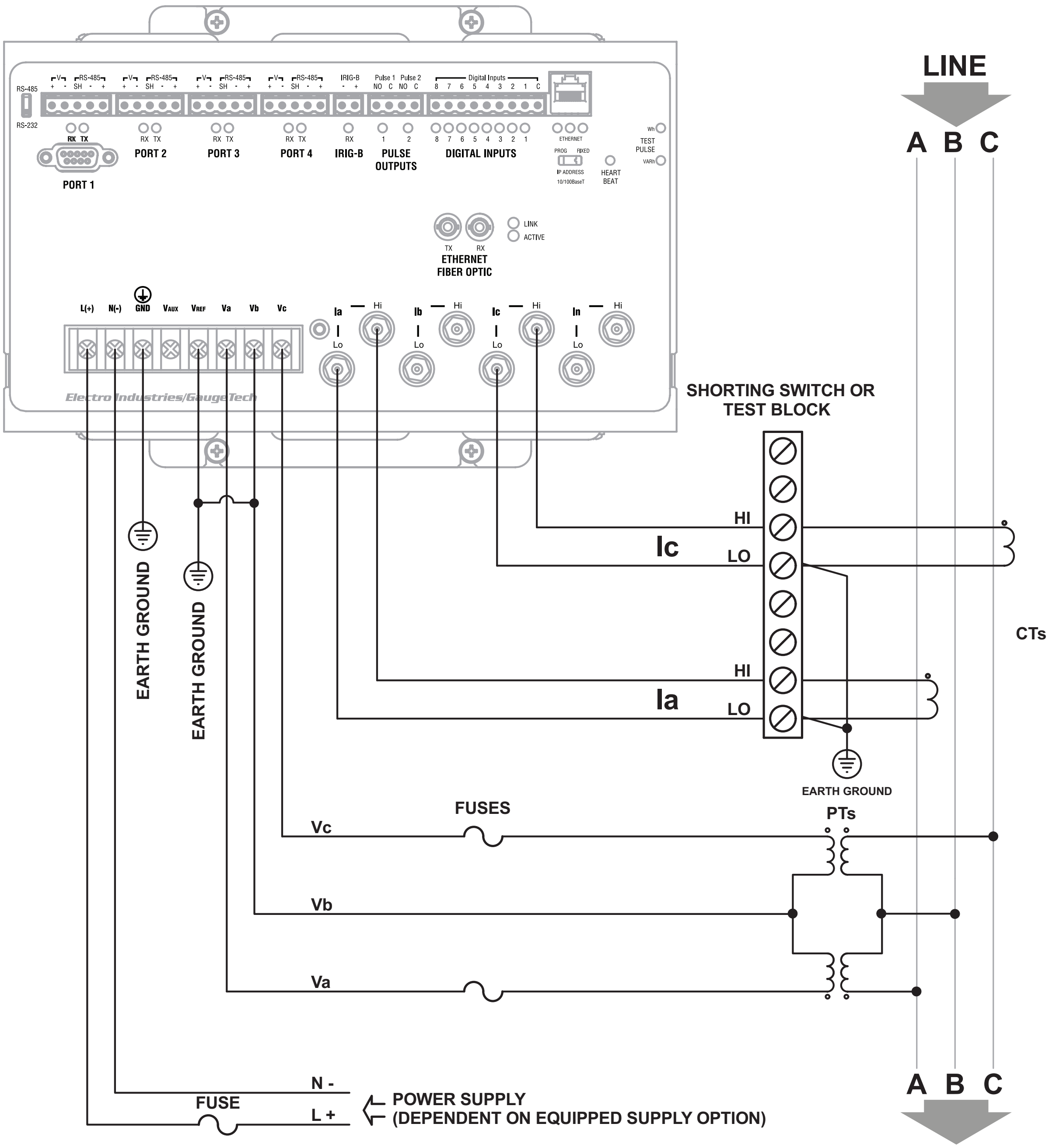


Figure 3-6: 3-Wire, 2-Element Open Delta with 2 PTs and 2 CTs

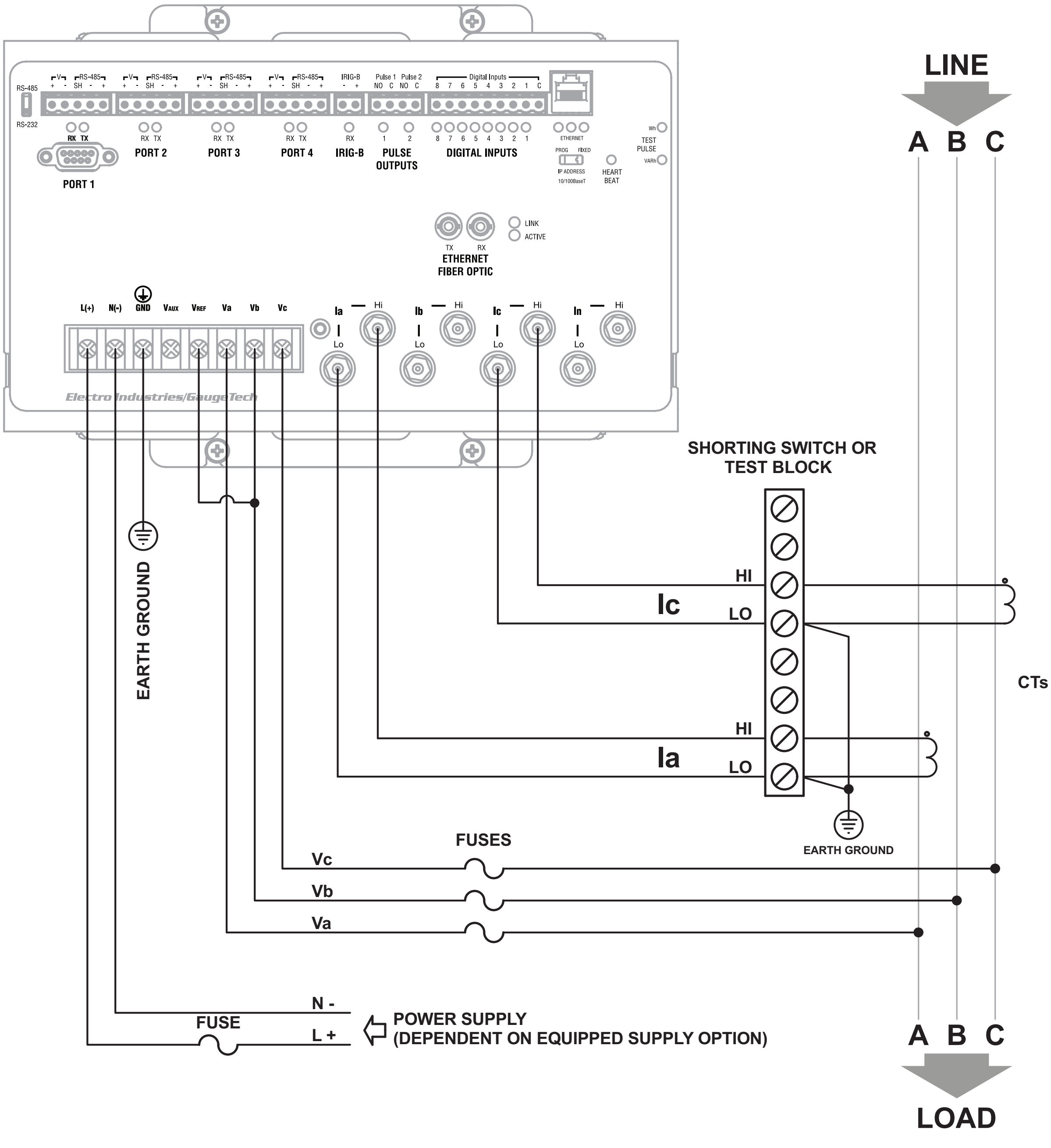


Figure 3-7: 3-Wire, 2-Element Delta Direct Voltage with 2 CTs

⚠CAUTION

External CT shorting blocks must be supplied for each phase into the EPM 9700. Use these external shorting blocks to bypass all CT phases to avoid a possible Arc flash event due to high voltage generation from an open secondary CT condition.

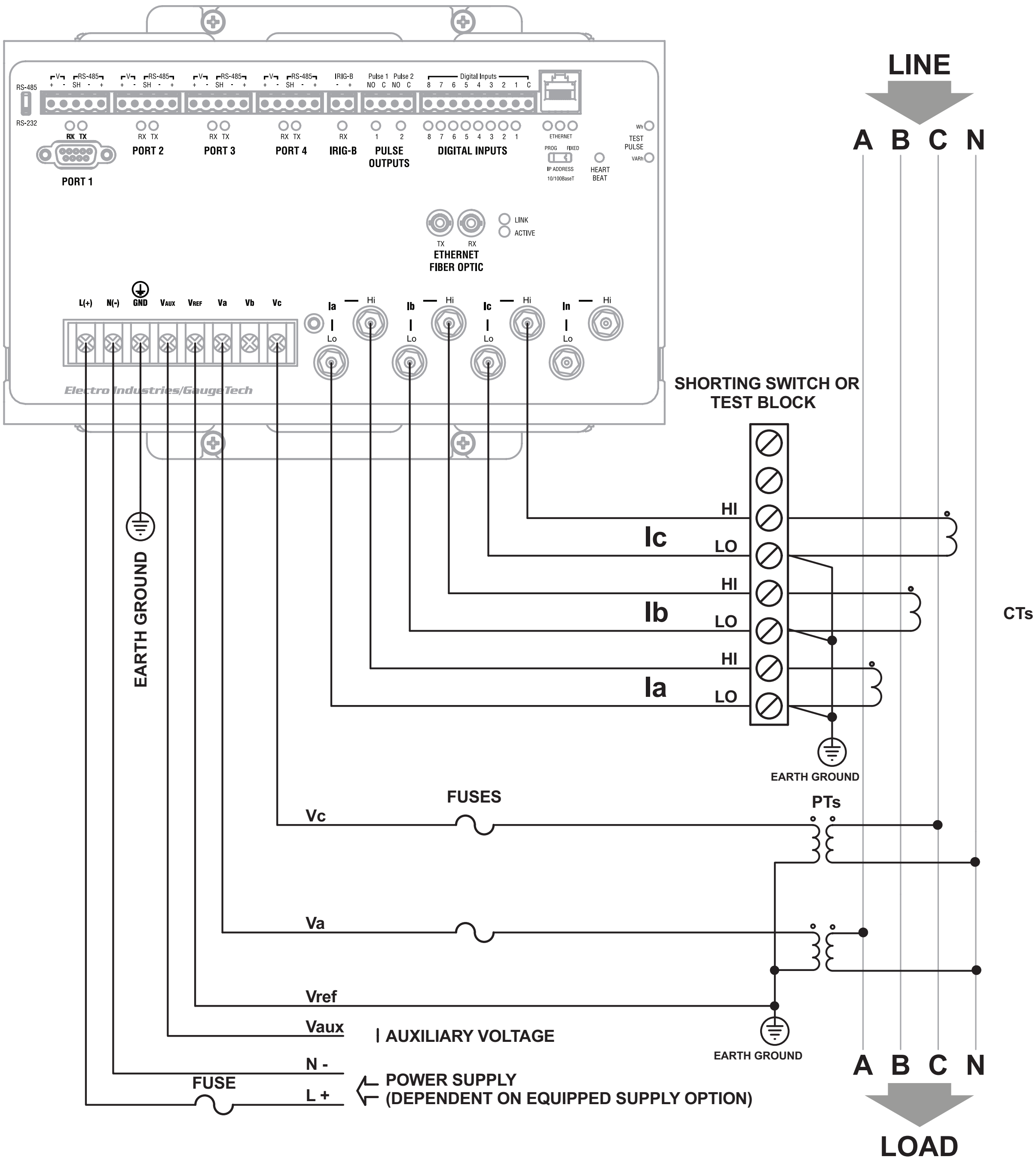


Figure 3-8: 3-Phase, 4-Wire, 2.5 Element with 2 PTs and 3 CTs

Multilin EPM 9700

Chapter 4: Communication Features

The EPM 9700 meter has multiple simultaneous paths for sending data to software systems or other electronic instruments. This chapter provides information on the meter's communication ports, and instructions for using the EPM 9700 meter's standard RS232 and RS485 ports. For instructions on using the Ethernet ports (RJ45 and Fiber Optic), see Chapter 9 *Ethernet Communication*. For information on the optional I/O, see Chapter 10 *Optional I/O*.

4.1 Available Communication Options

The EPM 9700 meter has the following standard communication ports:

- Port #1: RS232/RS485 port, which is capable of either RS485 or RS232 communication.
- Ports # 2-4: RS485 communication ports.
- Port #5: RJ45 10/100BaseT Ethernet port.
- Port #6: Fiber Optic Ethernet port.

All of these communication ports can be used simultaneously.

The meter has the following additional communication features:

- The two Ethernet ports can be set up with different IP addresses.
- Two pulse outputs that can be used for pulse-counting applications (see the *GE Communicator Instruction Manual* instructions on programming the pulse outputs).
- Two IR pulses for testing meter accuracy.
- Eight high-speed inputs (see 4.6 *High Speed Inputs Connection* on page 4–12) that can be used as status inputs or for pulse counting from other meters.
- An IRIG-B port for time synchronization (see 4.7 *IRIG-B Connections* on page 4–13 and 4.8 *Time Synchronization Alternatives* on page 4–14, for details on IRIG-B and time synchronization).

  See Figure 4.1 for the location of the meter's communication ports.

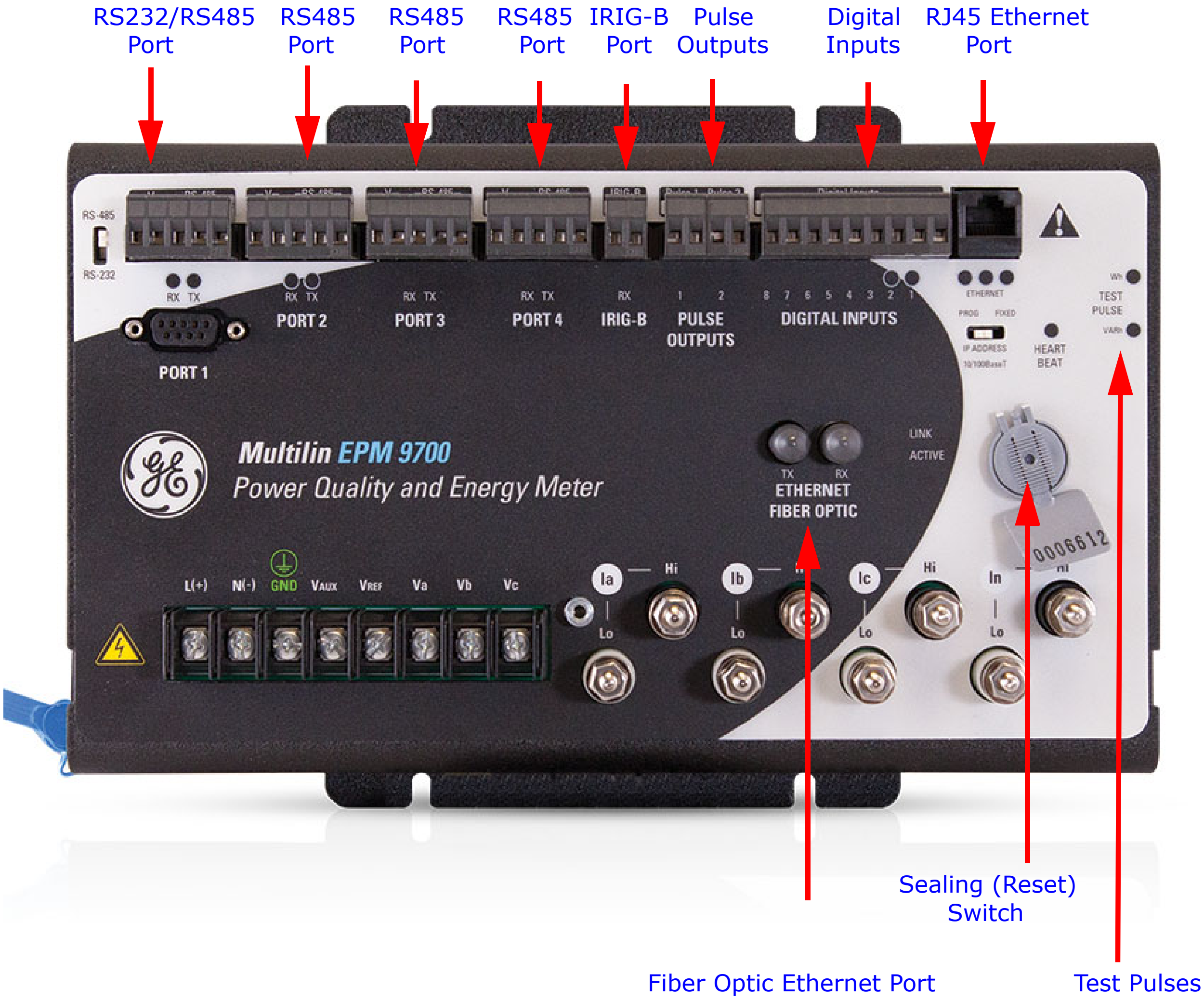


Figure 4-1: Location of Meter Ports and Other Communication Items

NOTE

The Sealing Switch found on the front of the meter provides additional security when enabled, requiring the user to physically break the meter seal and press the Reset button in order to perform any password protected actions within a 30 minute countdown. See both section 2.4 *Removing and Reinstalling the Sealing Switch Cover* on page 2–10 and the *GE Communicator Instruction Manual* Meter Security chapter for details of the Sealing Switch and other security features.

4.2 Communication Basics

- **RS232** communication is used to connect a single EPM 9700 meter with another device, such as a computer, RTU or PLC. The link is viable for a distance of up to 50 feet (15.2 meters) and is available only through the meter's Port 1. You must set the selector switch beneath the port to RS232.
- **RS485** communication allows multiple EPM meters to communicate with another device at a local or remote site. The external displays use RS485 to communicate with the meter, as do the external I/O modules. All RS485 links are viable for a distance of up to 4000 feet (1220 meters). Ports 1 through 4 on the EPM 9700 meter are two-wire, RS485 connections operating up to 115200 baud. To use Port 1 for RS485, set the selector switch to RS485 (the switch is located under the port). Port 4 can also be configured as either an RTU Master, capable of polling up to 128 registers from Modbus Slave devices.
- **RJ45** Ethernet connection allows an EPM 9700 meter to communicate with multiple PC's simultaneously. No other hardware is necessary for this easy-to-use connection.

NOTE

There is a switch under the RJ45 port that is labeled PROG/FIXED. To use the default RJ45 Ethernet port IP address, which is 10.0.0.1, move the switch to FIXED. If you want to program another IP address for the Ethernet port, use the Device Profile Communications setting screen to program a new IP address (see 9.2.1 *Network Connection* on page 9–2, for instructions) and set the switch to PROG before you connect to the meter. This switch can also be used if you forget, or do not know, the IP address that has been programmed for the RJ45 Ethernet port. To recover the address:

a. Move the switch to FIXED and connect to the meter using its default IP address of 10.0.0.1.

b. Open the meter's Device Profile and check the IP address in the Communications setting screen. Make sure to move the switch back to PROG before connecting to the meter with the programmed IP address."

  - The three LEDs below the RJ45 port indicate, from left to right, Active (when lit communication is active), Link (when lit the wiring is correct), and IP address configuration (when lit meter is using the default IP address, which is 10.0.0.1 for RJ45 port #5, and 10.0.1.1 for RJ45 port #6).
- **Fiber Optic** Ethernet connection also allows an EPM 9700 meter to communicate with multiple PC's simultaneously.
  - The two LEDs to the right of the fiber optic port indicate Link (on top) and Active (on bottom).

NOTE

EPM 9700 meters can also communicate with DNP3 protocol over Ethernet.

- See Chapter 9 *Ethernet Communication*, for instructions regarding the RJ45 and Fiber Optic Ethernet network ports.

4.3 General Serial (RS232/RS485) Wiring Information

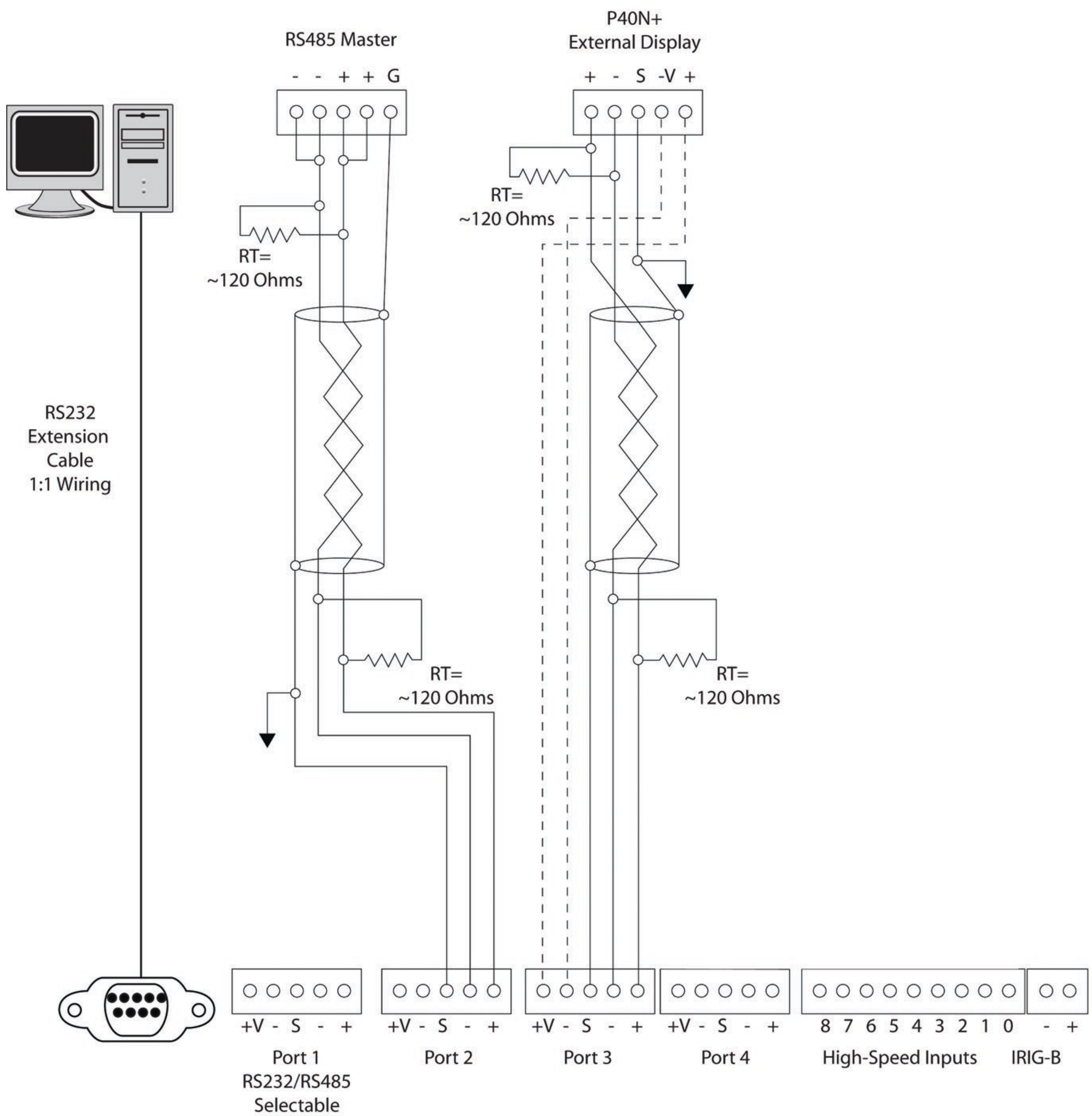


Figure 4-2: Serial Communication Wiring

NOTES:

- External Displays require power connections to the +/- Voltage terminals (dashed lines).
- For all communications: S=Shield. This connection is used to reference the EPM meter's port to the same potential as the source. It is not an earth-ground connection. **You must also connect the shield to earth-ground at one point.**
- You can use any port to connect an external display or RS485 Master - see 4.5.2 *RS485 Connection to an External Display* on page 4–8, for details.

4.4 RS232/RS485 Connection (Port 1)

- Use Port 1 for RS232 communication. Set the selector switch next to the port to RS232.
- Insert one end of an RS232 extension cable into the EPM 9700 meter's 9-pin female serial port. Insert the opposite end into a port on the computer.
- The RS232 standard limits the cable length to 50 feet (15.2 meters).
- The RS232 Port is configured as Data Communications Equipment (DCE).

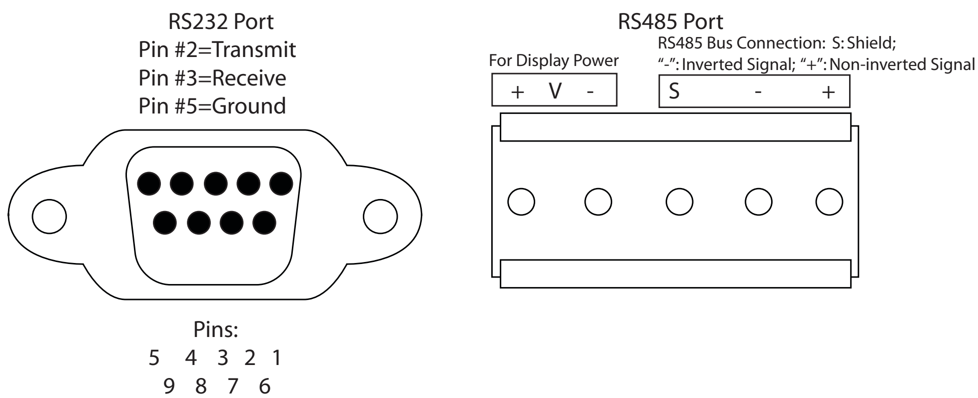


Figure 4-3: RS232/RS485 Port Detail (Meter Face)

4.5 RS485 Communication

RS485 communication allows multiple devices to communicate on a bus. The EPM 9700 meter's Ports 1 to 4 are RS485 terminals, viable for a distance of up to 4000 feet (1220 meters). (Port 1 can be switched between RS232 and RS485.) The following figure shows wiring detail of a 2-wire RS485 port.

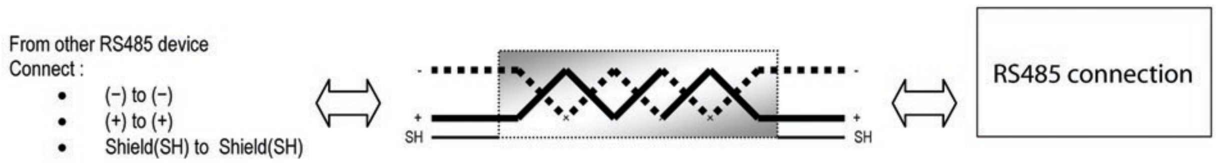


Figure 4-4: 2-Wire RS485 Port Detail

All of the EPM 9700 meter's RS485 ports have the following connections:

- +V- (Voltage terminals for power connections): use with EPM Displays ONLY. The EPM 9700 meter supplies 18 V DC through the +V- terminal connections. DO NOT accidentally connect RS485 to this power connection - it may cause damage to the RS485 driver components.

NOTE

Do not connect these pins to devices that receive power from another source—e.g., a computer—or to devices that do not require power to operate.

- S (Shield): the Shield connection is used to reference the meter's port to the same potential as the source. It is not an earth-ground connection. You must also connect the shield to earth-ground at one point. Do not connect the shield to ground at multiple points, as this will interfere with communication.
- +/- (Two-wire, RS485 communication terminals): connect the + terminal of the EPM meter's port to the + terminal of the device; connect the - terminal of the EPM meter's port to the - terminal of the device.

NOTES on RS485 Communication:

- Use a shielded twisted pair cable 22 AWG (0.33 mm^2) or larger, grounding the shield at one end only.
- Establish point-to-point configurations for each device on an RS485 bus: connect (+) terminals to (+) terminals; connect (-) terminals to (-) terminals; connect shield to shield (if available on other devices).
- Protect cables from sources of electrical noise.
- Avoid both "star" and "tee" connections (see Figure 4.5). No more than two cables should be connected at any one point on an RS485 network, whether the connections are for devices, converters or terminal strips.
- Include all segments when calculating the total cable length of a network. If you are not using an RS485 repeater, the maximum length for cable connecting all devices is 4000 feet (1219 meters).

- **RT EXPLANATION**: Termination Resistors are generally used on both ends of longer length transmission lines. The value of the Termination Resistors is determined by the electrical parameters of the cable. Use RTs only on Master and Last Slave when connecting multiple meters.

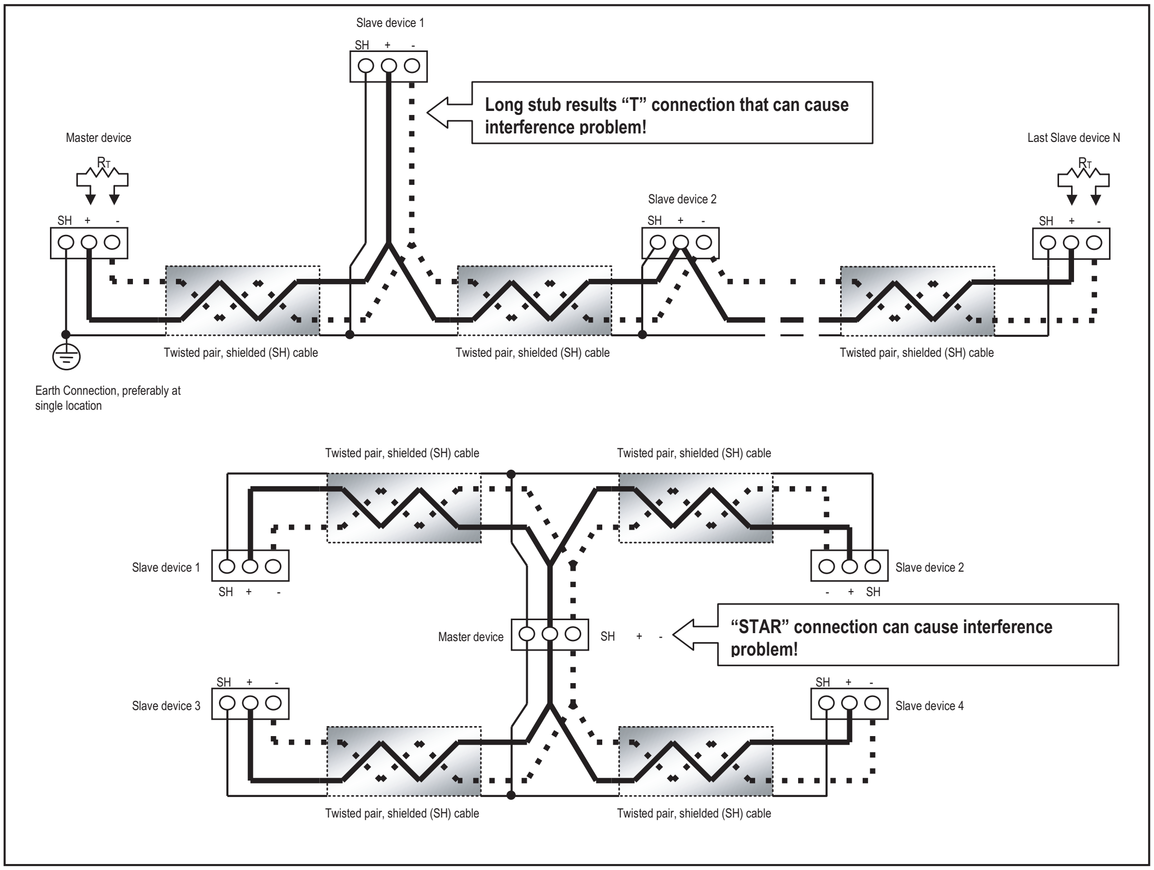


Figure 4-5: Incorrect "T" and "Star" Topologies

4.5.1 RS485 Connection

- Use any of ports 1-4 on the EPM 9700 meter. If you use Port 1, set the selector switch beside the port to RS485.
- You must use an RS485 to RS232 converter.
- Do not use the V(+)/V(-) pins: they supply power to the EPM displays and external I/O modules.

4.5.2 RS485 Connection to an External Display

Insert one end of the supplied RS485 cable into any of the RS485 ports 1-4 of the meter (if you are using Port 1, make sure the RS485/RS232 switch is set for RS485). Insert the other end of the cable into the back of the P40N^{PLUS} or P70N display. (The connectors fit only one way into the ports.) Note that the P70N has separate connectors for the power and RS485 connections, while the P40N^{PLUS} has one connector for both power supply and RS485. See the images below.

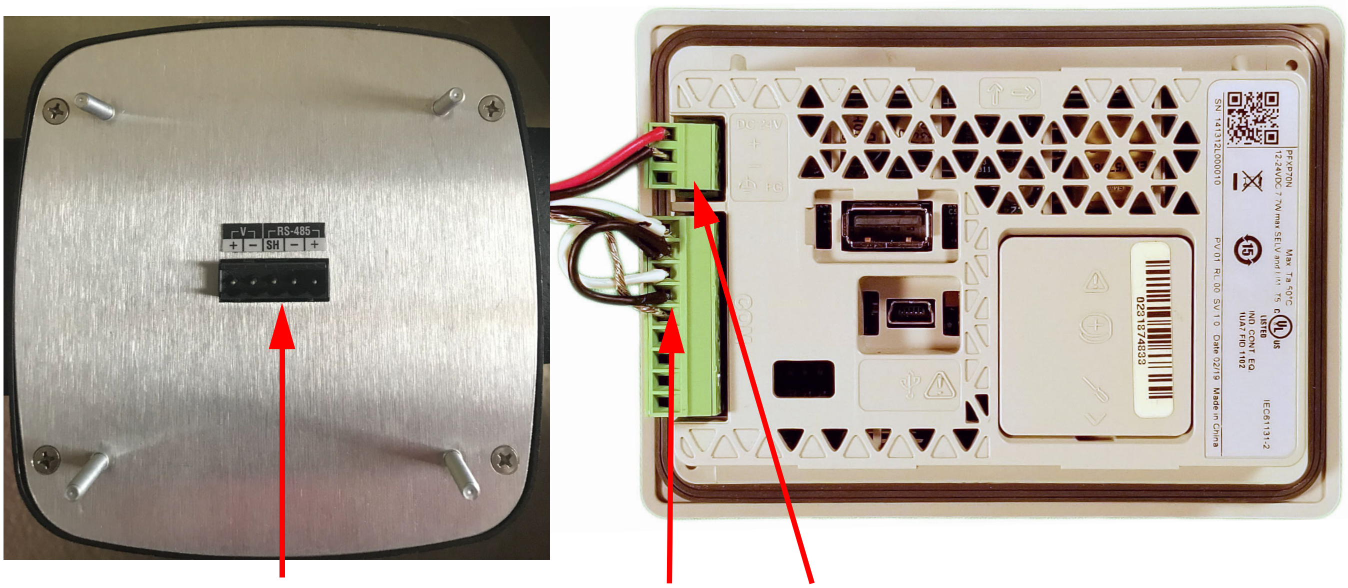


Figure 4-6: Display Connectors

The cable harness brings 18 V DC to the displays from the EPM meter. RS485 communication is viable for up to 4000 feet (1219 meters). If your cable length exceeds 200 feet you must use a remote power supply, such as the PSIO, and:

1. Connect the shield to the shield (S) terminal on the EPM display port. The (S) terminal on the EPM meter is used to reference the EPM meter's port to the same potential as the source. It is not an earth-ground connection. **You must also connect the shield to earth-ground at one point.**
2. Provide termination resistors at each end, connected to the + and - lines. RT is approximately 120 Ohms. See RT EXPLANATION in Section 4.5 *RS485 Communication* on page 4–6.

EPM Display VA Ratings		
P40N^{PLUS}	LED Display	3.3 VA typical, 3.8 VA max.
P70N	LCD Touchscreen Display	3.6 W or less

4.5.3 Daisy Chaining Multiple EPM Meters

You may connect a total of 31 EPM meters on a single bus using RS485. The cable length may not exceed 4000 feet (1219 meters). Before assembling the bus, each EPM meter must be assigned a unique address. See *GE Communicator Instruction Manual* for instructions.

- Connect the + and - terminals of each EPM meter. Use jumpers on any RS485 Master connected at the end of the chain.
- Connect the shield to the (S) terminal on each EPM meter and to the Ground on the RS485 Master. This connection is used to reference the EPM meter's port to the same potential as the source. It is not an earth-ground connection. **You must also connect the shield to earth-ground at one point.**
- For longer runs, provide termination resistors at each end, connected to the (+) and (-) lines. RT is approximately 120 Ohms, but this value may vary based on length of cable run, gauge or the impedance of the wire. See RT EXPLANATION in Section 4.5 *RS485 Communication* on page 4–6.

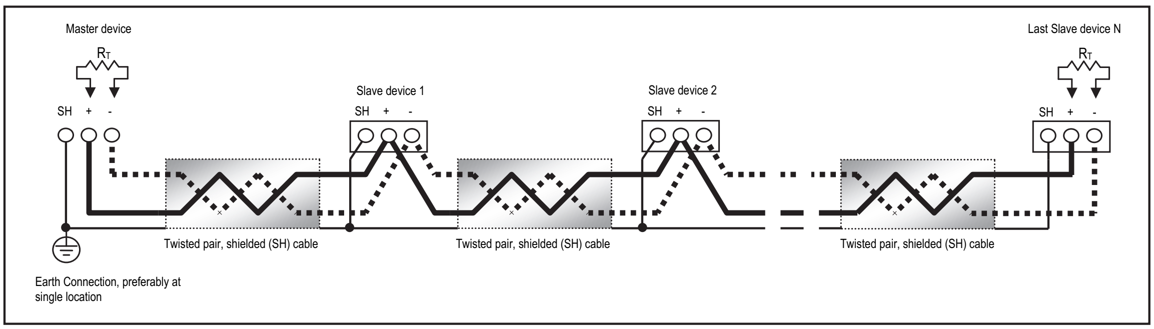


Figure 4-7: Linking Multiple EPM Meters in Series

You can use an RS485 repeater to network several links of instruments.

NOTES:

- A maximum number of 31 EPM meters may be connected to one repeater.
- A maximum number of 31 repeaters may be included on the same network.

4.5.4 Remote Serial Communication

The following two sections explain remote communication for the RS232 and RS485 serial ports.

4.5.4.1 Remote Communication—RS232

The link using RS232 is viable for up to 50 feet (15.2 meters).

Set the selector switch under Port 1 to RS232.

Use an RS232 serial extension cable connected to the 9-pin female serial port of the EPM 9700 meter's Port 1. Program this port for Modbus ASCII. See Chapter 13 in the *GE Communicator Instruction Manual* for details.

- You must use a Null Modem or Null Cable between the EPM meter and the remote modem when using RS232. A Null Modem enables two DCE devices to communicate. The figure below details how a null modem reconfigures the RS232 pins.

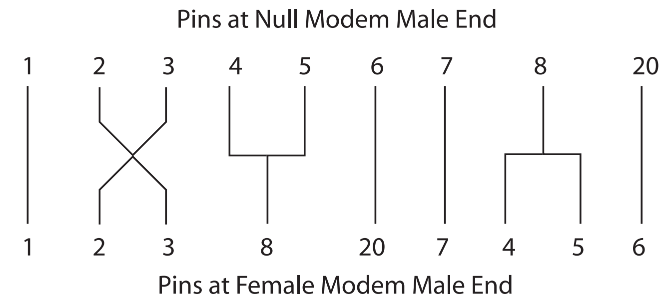


Figure 4-8: Standard Null Modem Configuration

NOTE: The remote modem must be programmed for auto-answer and set at a fixed baud rate of 9600 with no Flow Control. See 4.5.4.3 *Programming Modems for Remote Communication* on page 4–10, and the *CGE Communicator Instruction Manual* for further details.

4.5.4.2 Remote Communication—RS485

Use any Port on the EPM 9700 meter. If you use Port 1, set the selector switch beneath the port to RS485. The link using RS485 is viable for up to 4000 feet (1219 meters).

Use GE Communicator software to set the port's baud rate to 9600 and enable Modbus ASCII protocol. See the *GE Communicator Instruction Manual* for instructions. Remember, Modbus RTU will not function properly with modem communication. You **must** change the protocol to Modbus ASCII.

You must use an RS485 to RS232 converter and a Null Modem.

4.5.4.3 Programming Modems for Remote Communication

You must program a modem before it can communicate properly with most RS485 or RS232-based devices. This task is often quite complicated because modems can be unpredictable when communicating with remote devices.

Set the following strings to communicate with the remote EPM meter(s). Consult your modem manual for the proper string settings or see 4.5.4.4 *Selected Modem Strings* on page 4–11, for a list of selected modem strings.

Modem Connected to a Computer (the Originate Modem)

- Restore modem to factory settings. This erases all previously programmed settings.
- Set modem to display Result Codes. The computer will use the result codes.
- Set modem to Verbal Result Codes. The computer will use the verbal result codes.
- Set modem to use DTR Signal. This is necessary for the computer to ensure connection with the originate modem.
- Set modem to enable Flow Control. This is necessary to communicate with remote modem connected to the EPM meter.
- Instruct modem to write the new settings to activate profile. This places these settings into nonvolatile memory; the setting will take effect after the modem powers up.

Modem Connected to the EPM Meter (the Remote Modem)

- Restore modem to factory settings. This erases all previously programmed settings.
- Set modem to auto answer on n rings. This sets the remote modem to answer the call after *n* rings.
- Set modem to ignore DTR Signal. This is necessary for the EPM meter, to insure connection with originate modem.
- Set modem to disable Flow Control. The EPM meter's RS232 communication does not support this feature.
- Instruct modem to write the new settings to activate profile. This places these settings into nonvolatile memory; the setting will take effect after the modem powers up.
- When programming the remote modem with a terminal program, make sure the baud rate of the terminal program matches the EPM meter's baud rate.

4.5.4.4 Selected Modem Strings

Modem	String/Setting
Cardinal modem	AT&FE0F8&K0N0S37=9
Zoom/Faxmodem VFX V.32BIS(14.4K)	AT&F0&K0S0=1&W0&Y0
Zoom/Faxmodem 56Kx Dual Mode	AT&F0&K0&C0S0=1&W0&Y0
USRobotics Sportster 33.6 Faxmodem: DIP switch setting	AT&F0&N6&W0Y0 (for 9600 baud) Up Up Down Down Up Up Up Down
USRobotics Sportster 56K Faxmodem: DIP switch setting	AT&F0&W0Y0 Up Up Down Down Up Up Up Down

4.6 High Speed Inputs Connection

The EPM 9700 meter's built-in High Speed Inputs can be used in many ways:

- Attach the KYZ Outputs from other meters for totalizing.
- Attach relaying contacts for breaker status or initiated logging.
- Set as an Input Trigger for Event log.

Refer to the *GE Communicator Instruction Manual* for instructions on programming these features.

The High Speed Inputs can be used with either dry or wet field contacts. No user programming is necessary to use either wet or dry field contacts.

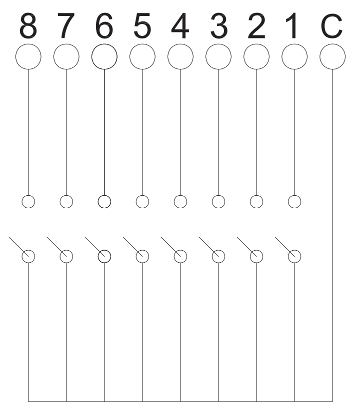


Figure 4-9: High-Speed Inputs Connections

These inputs can be used for either status detection or KYZ pulse counting. The function selection is part of the Device Profile, which can be configured using GE Communicator software. See Chapter 27 in the *GE Communicator Instruction Manual* for instructions.

INPUT SPECIFICATIONS:

Number of inputs: 8
Sensing type: ....Dry contact status detection, only
Input open circuit voltage: ....24 V DC, internally generated
Input short circuit current: ....2.5 mA – constant current regulated
Filtering: ....De-bouncing with 50 ms delay time
Detection scan rate:....................240 scans per second except for use in aggregator mode, which has a de-bouncing of 10 ms
Maximum Pickup Rates:.............10 ms (50 Hz) -for the aggregator function
5 ms (100 Hz) -input change detection (with events logged)
400 µs (2.5 kHz) -triggering waveform captures
Isolation: ....AC 2500 V system to inputs

4.7 IRIG-B Connections

IRIG-B is a standard time code format that synchronizes event time-stamping to within 1 millisecond. An IRIG-B signal-generating device connected to the GPS satellite system synchronizes EPM 9700 meters located at different geographic locations. EPM meters use an un-modulated signal from a satellite-controlled clock (such as Arbiter 1093B). For details on installation, refer to the User's Manual for the satellite-controlled clock in use.

Connection

Connect the (+) terminal of the EPM meter to the (+) terminal of the signal generating device; connect the (-) terminal of the EPM meter to the (-) terminal of the signal generating device.

Installation

Set Time Settings for the meter being installed.

1. From the GE Communicator application's Device Profile menu:
   - Click **General Settings > Time Settings > one of the Time Settings lines**, to open the Time Settings screen.
   - Set the Time Zone and Daylight Savings (Select **AutoDST** or **Enable** and set dates).
   - Click **Update Device Profile** to save the new settings. (See the *GE Communicator Instruction Manual* for details.)
2. Before connection, check that the date on the meter clock is correct (or, within 2 Months of the actual date). This provides the right year for the clock (GPS does not supply the year).
3. Connect the (+) terminal of the EPM meter to the (+) terminal of the signal generating device; connect the (-) terminal of the EPM meter to the (-) terminal of the signal generating device.

Troubleshooting Tip: The most common source of problems is a reversal of the two wires. If you have a problem, try reversing the wires.

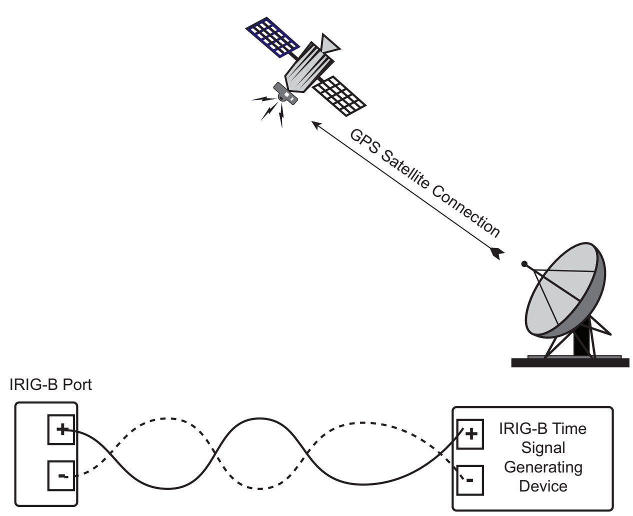


Figure 4-10: Figure 4.11: IRIG-B Communication

NOTE

Please make sure that the selected clock can drive the amount of wired loads.

4.8 Time Synchronization Alternatives

(See the *GE Communicator Instruction Manual* for details.)

IRIG-B

All EPM 9700 meters are equipped to use IRIG-B for time synchronization.

If IRIG-B is connected, this form of time synchronization takes precedence over the internal clock. If the GPS Signal is lost, the internal clock takes over time keeping at the precise moment the signal is lost.

Line Frequency Clock Synchronization

All EPM 9000 Series meters are equipped with Line Frequency Clock Synchronization, which may be enabled or disabled for use instead of IRIG-B. If Line Frequency Clock Synchronization is enabled and power is lost, the internal clock takes over at the precise moment power is lost. Note that if Wide Band Auto Frequency is being used by the meter, this method of time synchronization is not available.

Internal Clock Crystal

The EPM 9700 meter is equipped with an internal clock crystal which is accurate to 3.5 PPM for (-40 to +70) ^{o}C and 5 PPM over ten years of aging, and which can be used if Line Frequency Clock Synchronization is not enabled. The meter's internal real time clock has a low drift: - less than 10 seconds drift per month over the temperature range; typical drift for (0 to +40) ^{o}C is less than six seconds per month.

SNTP Time Synchronization

With Simple Network Time Protocol (NTP) Time Synchronization you access a Network Time Protocol (NTP) Server to synchronize the meter's clock. The NTP server can be either a device with a real-time clock that is networked with your meter, or an NTP server on the Internet. Seethe *GE Communicator Instruction Manual* for details on programming SNTP time synchronization for the meter.

DNP3 Time Synchronization

DNP3 can also be used as a time synchronization method. See the *GE Communicator Instruction Manual*, for instructions on setting up DNP time sync.

Other Time Setting Tools

- **Tools > Set Device Time**: For manual or PC time setting
- **Script & Scheduler**: For time stamps on retrieved logs and data
- **MV-90:** Can synchronize time on retrievals in the form of a time stamp. See the *GE Communicator Instruction Manual* for MV-90 details.

Multilin EPM 9700

Chapter 5: Using the External Displays

This chapter provides information on the EPM 9700 meter's external displays.

5.1 Overview

GE offers two external displays for use with the EPM 9700 meter.

- The P40N^{PLUS} LED display provides easy-to-use access to the information stored in your EPM 9700 meter. The P40N^{PLUS} display also features a USB port for direct data download.
- The P70N display is explained in 5.3: P70N LCD Touchscreen Display, on page 5-17.

Plug one of the external displays into any of the RS485 ports 1-4 of the meter, using the cable supplied with the display. The displays operate at 9600 baud, which is the factory default for the ports. (see Chapter 4 *Communication Features* on page 4–1, for communication details).

5.2 P40N^{PLUS} LED External Displays

The P40N^{PLUS} LED external display can be used alone or as the Master for a grouping of displays. The Master P40N^{PLUS} prepares the data for the Slave displays. Once every second, it sends a request to the EPM meter. All necessary data for the Slave displays is returned to the Master display upon this request, and the Master sends the data to the Slaves in the proper format.

The P40N^{PLUS} Slave displays listen to the Master, and display and update values on the screen when they receive proper data. These displays have no keypads. Data can only be received; it cannot be changed. If there is no data for more than 5 seconds, "Communication Lost" appears on the bottom of the screen. The following data is displayed when it is received:

- Current Display: Current A, Current B, Current C

The P40N^{PLUS} LED external display has a USB port on the front for direct data downloads. You can connect to the USB port with GE Communicator software to poll and configure the meter attached to the display. To use the USB, follow these instructions:

1. Download and install the GE Communicator software and the driver for the P40N^{PLUS} USB port.
    a. Go to https://www.gegridsolutions.com/multilin/catalog/epm9700.htm
    b. Click **Software** on the left menu and download the GE Communicator package and P40N^{PLUS} USB driver.
    c. Unzip and install both software packages:
2. Connect the USB cable from your PC to the port: using a USA-A Male to USB-B Male cable, attach the USB-A connector to the PC and attach the USB-B connector to the P40N^{PLUS} USB port. See Figure 5.1.

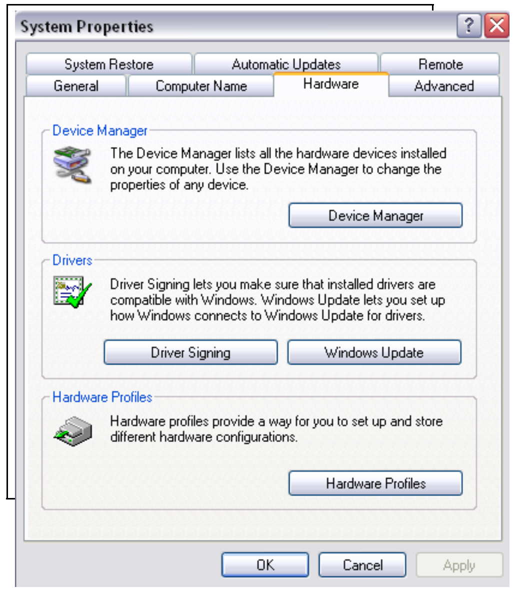
Figure 5-1: USB-B Male Connector and P40N^{PLUS} USB Port

3. Once the USB cable is connected to the P40N^{PLUS}, the display clears and the message “USB in Use” scrolls at the bottom of the display. Additionally, the USB LED icon lights up when the USB connection is being used.

You connect to the USB port using GE Communicator software the same way you connect to a meter with the software. Follow these instructions:

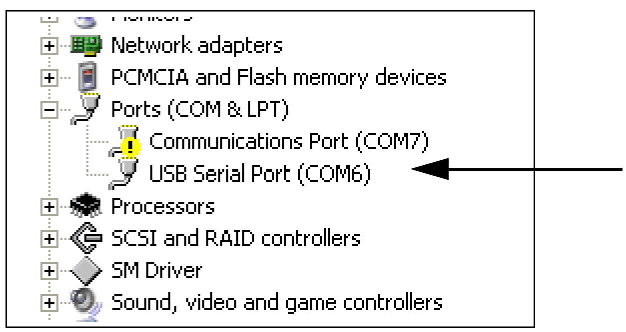
1. Determine which port the PC's USB is using:
    a. On your PC, click **Start>Settings>Control Panel**.
    b. Double-click the **System** folder.

c. Click the **Hardware** tab. You will see the screen below.

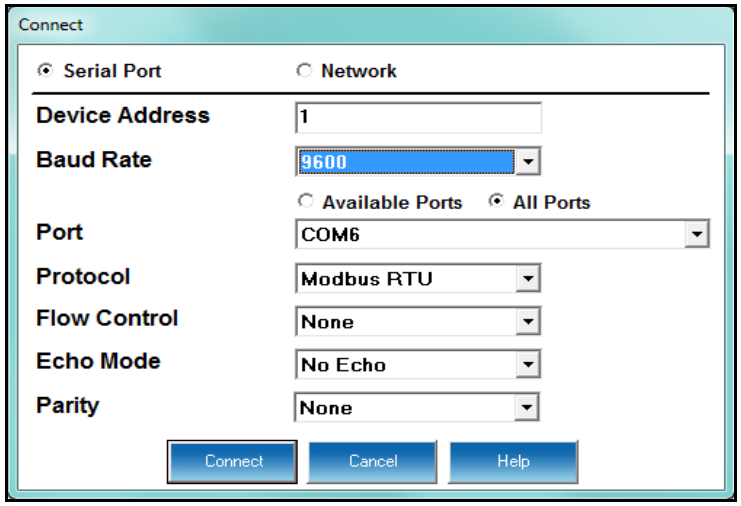


d. Click the **Device Manager** button. You will see a list of the computer's hardware devices.

e. Click the plus sign next to Ports (COM & LPT). The COM ports are displayed. Note the COM number for the USB Serial Port. This is the number you will use to connect to the P40N^{PLUS} through GE Communicator software. See the figure below.



2. Open GE Communicator software and click the **Connect** icon in the Icon bar. See the screen shown below.



3. Click the **Serial Port** button if it's not already selected.
4. Set the Baud Rate to 9600. (It uses 9600 because it shares an existing Com port for displayed readings.)
5. Click the **Available Ports** button and select the USB COM Port number from the drop-down list.
6. Protocol should be Modbus RTU.
7. Flow Control should be None.
8. Echo Mode should be No Echo.
9. Click **Connect**. The software connects to the meter through the P40N PLUS. Refer to the *GE Communicator Instruction Manual* for programming instructions. (Click **Help > Contents** from the GE Communicator application Title Bar to view the manual.)

5.2.1 Connect Multiple Displays

One cable (housing two-wire RS485 and two-wire power wires plus shield) is used to connect the displays. The EPM 9700 meter's ports support 12 VA. Each P40N^PLUS requires 3.3 VA (maximum 3.8 VA). The Master display is the master in communication. The Amp, Power and EPM devices are slaves in communication. Therefore, the Master display should be at the end of the daisy-chained units as shown in Figure 5.2.

Figure 5-2: Daisy Chaining Displays

5.2.2 P40N^PLUS Display Modes

The P40N^PLUS LED external display has three modes:

- Dynamic Readings mode (sections 5.2.3 *Dynamic Readings Mode* on page 5–5 and 5.2.4 *Navigation Map of Dynamic Readings Mode* on page 5–8).
- EPM Information mode (sections 5.2.5 *Information Mode* on page 5–9 and 5.2.6 *Navigation Map of Information Mode* on page 5–10).
- Display Features mode (sections 5.2.7 *Display Features Mode* on page 5–11 and 5.2.8 *Navigation Map of Display Features Mode* on page 5–12).

Each mode is divided into groups. Most groups are further broken down into readings.

- Use the MODE button to scroll between modes.
- Use the UP/DOWN arrows to scroll from group to group within each mode.
- Use the LEFT/RIGHT arrows to scroll from reading to reading within each group.

Use the GE Communicator software to Flash Update the P40N^PLUS external display. Refer to the *GE Communicator Instruction Manual* for instructions.

5.2.3 Dynamic Readings Mode

The P40N^PLUS external display puts itself in the Dynamic Readings Mode upon power-up. Use the Mode button to access the Dynamic Readings from other Modes. Use the Up/Down arrows to navigate from Group to Group within this Mode. See 5.2.4 *Navigation Map of Dynamic Readings Mode* on page 5–8.

Group 1: Line to Neutral Voltages (Use the Left/Right arrows to access the following readings, in order.)

- Voltage AN/BN/CN

- Maximum Voltage AN/BN/CN
- Minimum Voltage AN/BN/CN
- Voltage AN/BN/CN % THD
- Voltage AN/BN/CN Maximum % THD
- Voltage AN/BN/CN Minimum % THD

Group 2: Line to Line Voltages (Use the Left/Right arrows to access the following readings, in order.)

- Voltage AB/BC/CA
- Minimum Voltage AB/BC/CA
- Maximum Voltage AB/BC/CA

Group 3: Current (Use the Left/Right arrows to access the following readings, in order.)

- Current A/B/C
- Maximum Current
- Minimum Current
- Current 5 % THD
- Current Maximum % THD
- Current Minimum % THD
- Current Calculated N/Measured N
- Maximum Current Calculated N/Measured N

Group 4: Watt/VAR (Use the Left/Right arrows to access the following readings, in order.)

- Watt/VAR
- Maximum +kWatt/+kVAR/CoIn kVAR
- Maximum -kWatt/-kVAR/CoIn kVAR
- Block (Fixed) Window Average Maximum +kWatt/+kVAR/CoIn kVAR
- Predictive Rolling (Sliding) Window Maximum +kWatt/+kVAR/CoIn kVAR

Group 5: VA/PF/Frequency (Use the Left/Right arrows to access the following readings, in order.)

- kVA/PF lag/Hz
- Maximum kVA/Hz
- Minimum kVA/Hz
- Maximum Quadrant 1 Total PF
- Minimum Quadrant 1 Total PF
- Maximum Quadrant 2 Total PF
- Minimum Quadrant 2 Total PF
- Maximum Quadrant 3 Total PF
- Minimum Quadrant 3 Total PF
- Maximum Quadrant 4 Total PF
- Minimum Quadrant 4 Total PF

Group 6: Delivered Energy (Use the Left/Right arrows to access the following readings, in order.)

- +kWatthr Quadrant 1+Quadrant 4 (Primary)
- +kVAhr Quadrant 1 (Primary)
- +kVARhr Quadrant 1 (Primary)
- +kVAhr Quadrant 4 (Primary)
- -kVARhr Quadrant 4 (Primary)

Group 7: Received Energy (Use the Left/Right arrows to access the following readings, in order.)

- -kWatthr Quadrant 2+Quadrant 3 (Primary)
- +kVAhr Quadrant 2 (Primary)
- +kVARhr Quadrant 2 (Primary)
- +kVAhr Quadrant 3 (Primary)
- -kVARhr Quadrant 3 (Primary)

Group 8: Accumulations (Use the Left/Right arrows to access the following readings, in order.)

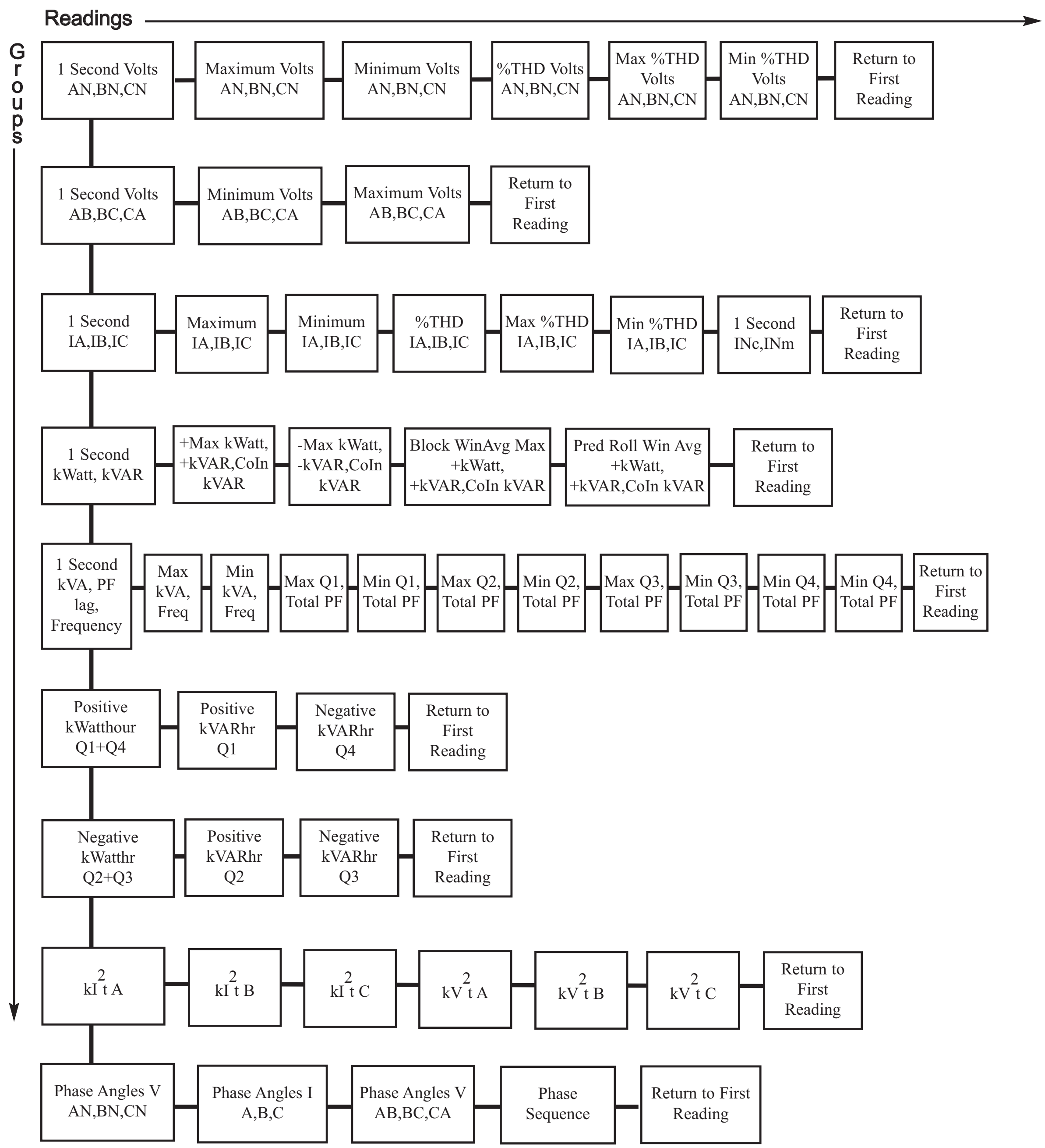
- kI2t A
- kI2t B
- kI2t C
- kV2t A
- kV2t B
- kV2t C

Group 9: Phase Angles (Use the Left/Right arrows to access the following readings, in order.)

- Phase Angle Van/bn/cn
- Phase Angle Ia/b/c
- Phase Angle Vab/bc/ca
- Phase Sequence

5.2.4 Navigation Map of Dynamic Readings Mode

- Use Left/Right arrow keys to navigate Readings
- Use Up/Down arrows to scroll between groups.



5.2.5 Information Mode

Use the Mode button to access the EPM Information mode from other modes. Use the Up/ Down arrows to navigate from group to group within this mode. See 5.2.6 *Navigation Map of Information Mode* on page 5–10.

Group 1: Device Time

- Meter Time

Group 2: Communication Settings (Use the Left/Right arrows to access the following readings, in order.)

- Communication Settings Port 1: Baud/Address/Protocol
- Communication Settings Port 2: Baud/Address/Protocol
- Communication Settings Port 3: Baud/Address/Protocol
- Communication Settings Port 4: Baud/Address/Protocol

Group 3: PT/CT Ratios (Use the Left/Right arrows to access the following readings, in order.)

- PT Ratio
- CT Ratio

Group 4: External Display Units

- Primary/Secondary:

  Select either Primary or Secondary units for the External Display using the GE Communicator software (see the *GE Communicator Instruction Manual*).

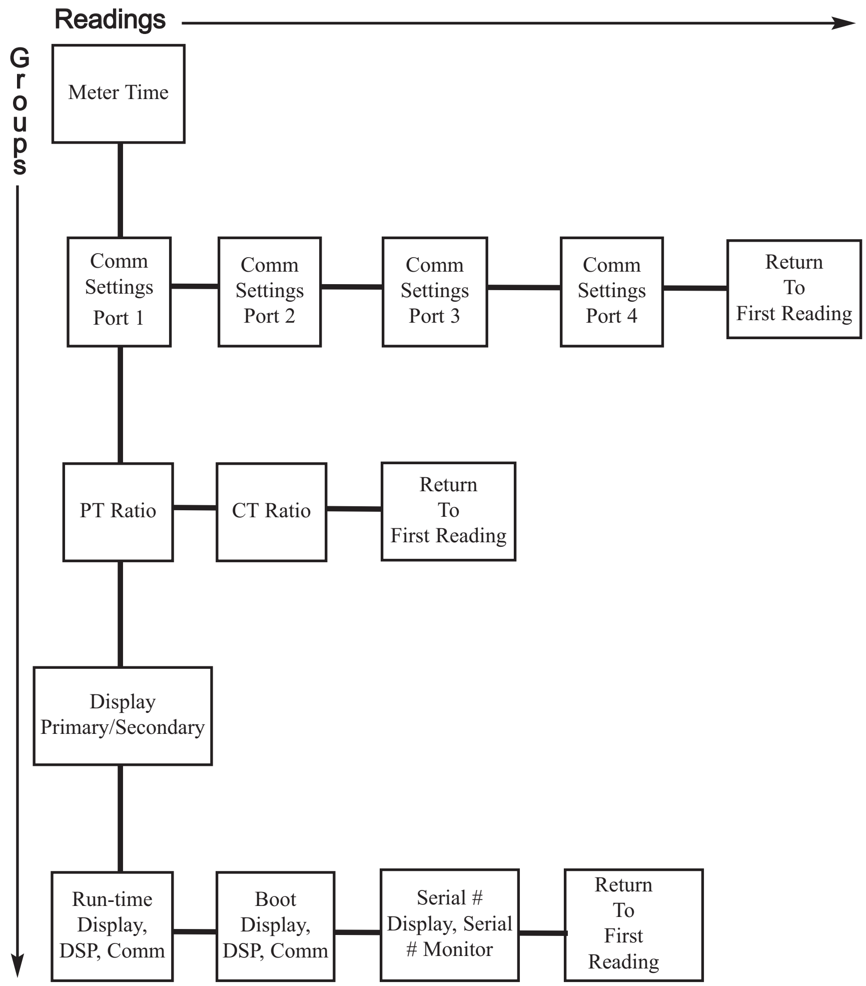
  - When Primary is selected, the Display shows all readings in Primary units based on the user programmed PT and CT Ratios.
  - When Secondary is selected, the Display shows all readings in Secondary units.

Group 5: Firmware Versions and Serial Numbers (Use the Left/Right arrows to access the following readings, in order.)

- Run Time External Display/Run Time DSP/RunTime Comm
- Boot External Display/Boot DSP/Boot Comm
- Serial Number External Display; Serial Number EPM Monitor

5.2.6 Navigation Map of Information Mode

- Use Left/Right arrow keys to navigate Readings
- Use Up/Down arrows to scroll between groups



5.2.7 Display Features Mode

Use the Mode button to access the Display Features Mode from other modes. Use the Up/ Down arrows to navigate from group to group within this mode. See 5.2.8 *Navigation Map of Display Features Mode* on page 5–12.

Group 1: Reset Max/Min

Press **Enter** to reset the Max and Min values.

NOTE

If the Password Protection feature has been enabled through GE Communicator software, you will need to enter a password to reset the Max/Min readings. Follow this procedure:

1. Press **Enter**.
2. Enter the password, one character at a time, by pressing the Up or Down arrows. (Each password character begins as an "A". Press the Up arrow to increment the character from "A-Z" and then from "0-9". Press the Down arrow to decrement the character from "A" to "9-0" and then from "Z-A".)
3. Press **Set** to enter each character in the password.
4. When the entire password is shown on the Display screen, press **Enter**.
5. Once the password is entered correctly, press **Enter** again to reset the Max/Min values.

Group 2: Reset Energy

Press **Enter** to reset the Energy readings.

NOTE

If the Password Protection feature has been enabled through GE Communicator software, you will need to enter a password to reset the Energy readings. Follow steps 1-4, above. Then press **Enter** again to reset energy.

Group 3: Display Baud Rate/Address

Group 4: Display Communication Protocol

Group 7: Lamp Test

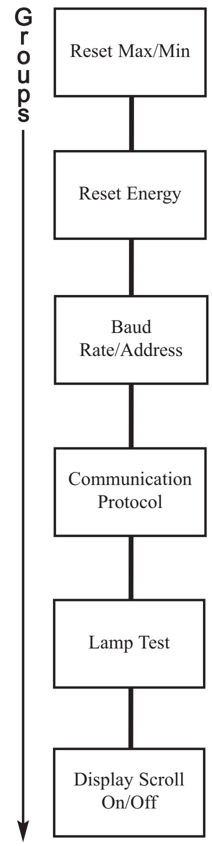
Press **Enter** to conduct an LED test.

Group 8: Display Scroll ON/OFF

Press **Enter** to turn the scroll feature on or off. When the scroll feature is on, the P40N^PLUS external display scrolls through the first reading of each group in the Dynamic Readings mode. If a button is pressed during the scroll, scrolling pauses for one minute.

5.2.8 Navigation Map of Display Features Mode

Use Up/Down arrows to scroll between groups.



5.3 Using the P70N LCD Touchscreen Display

The P70N touchscreen display lets you view meter readings remotely from EPM 9700 meters. The P70N comes with pre-configured screens. The display screens' Navigation map is shown in 5.3.2 *Display Navigation Map* on page 5–14. The screens are explained in 5.3.3 *Display Screens* on page 5–18.

5.3.1 Display Wiring

The P70N display is connected via its 6 foot cable (shipped with it) from its power supply and RS485 connections to one of the meter's RS485 ports, which then provides both communication and power to the display. See the figure.

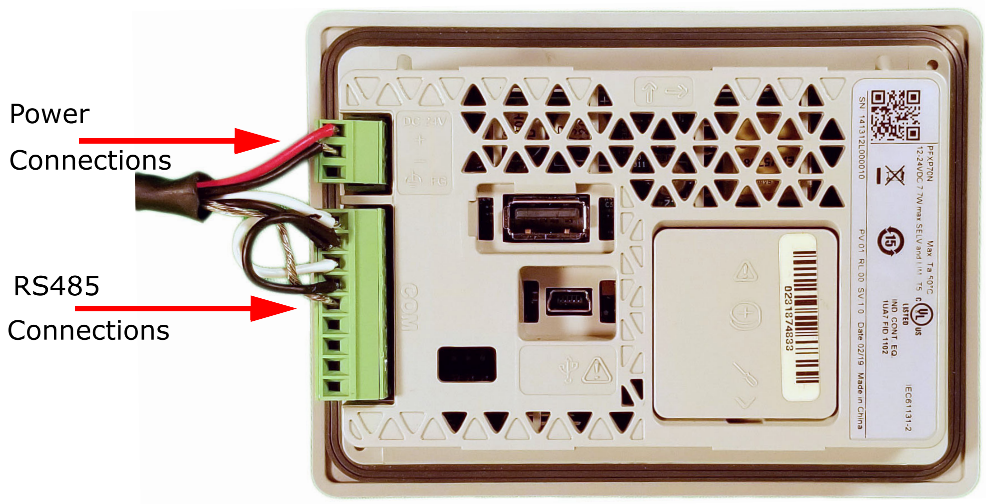


Figure 5-3: P70N Display Back, Showing Connections

The display's default communication settings are:

- Baud Rate: 9600
- Protocol: Modbus RTU
- Parity: none
- Stop bits: 1
- Data Bits: 8
- Modbus Address: 1
- Timeout: 5 seconds
- Retry: 5 seconds
- Wait to Send: 50 ms

See 4.5.2 *RS485 Connection to an External Display* on page 4–8, for details on RS485 connection for the P70N.

5.3.2 Display Navigation Map

The navigation map for the P70N display begins on the following pages. The display startup sequence is shown below.

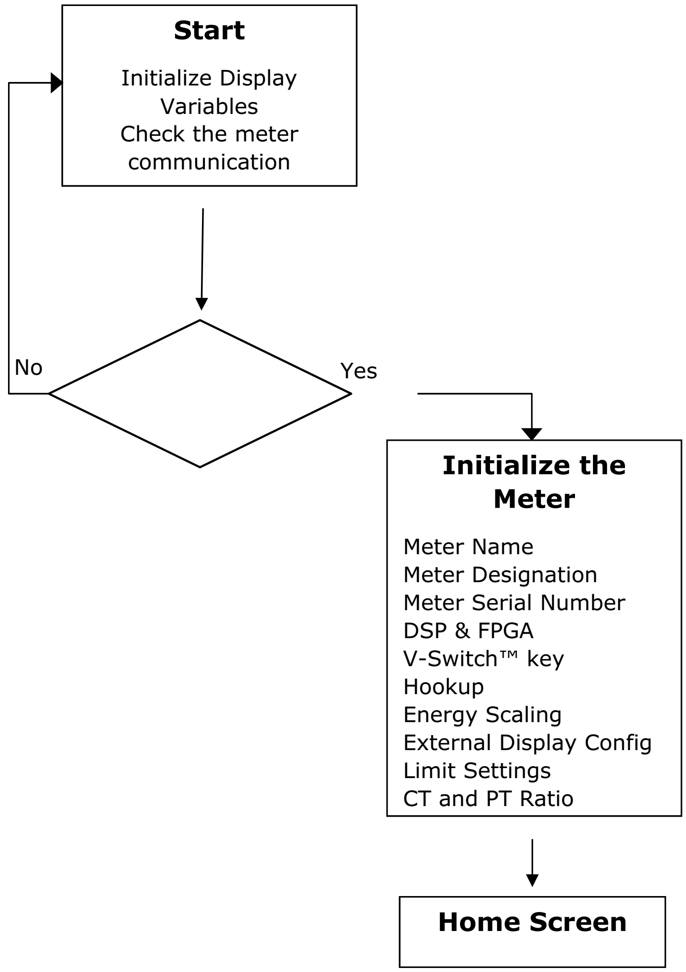
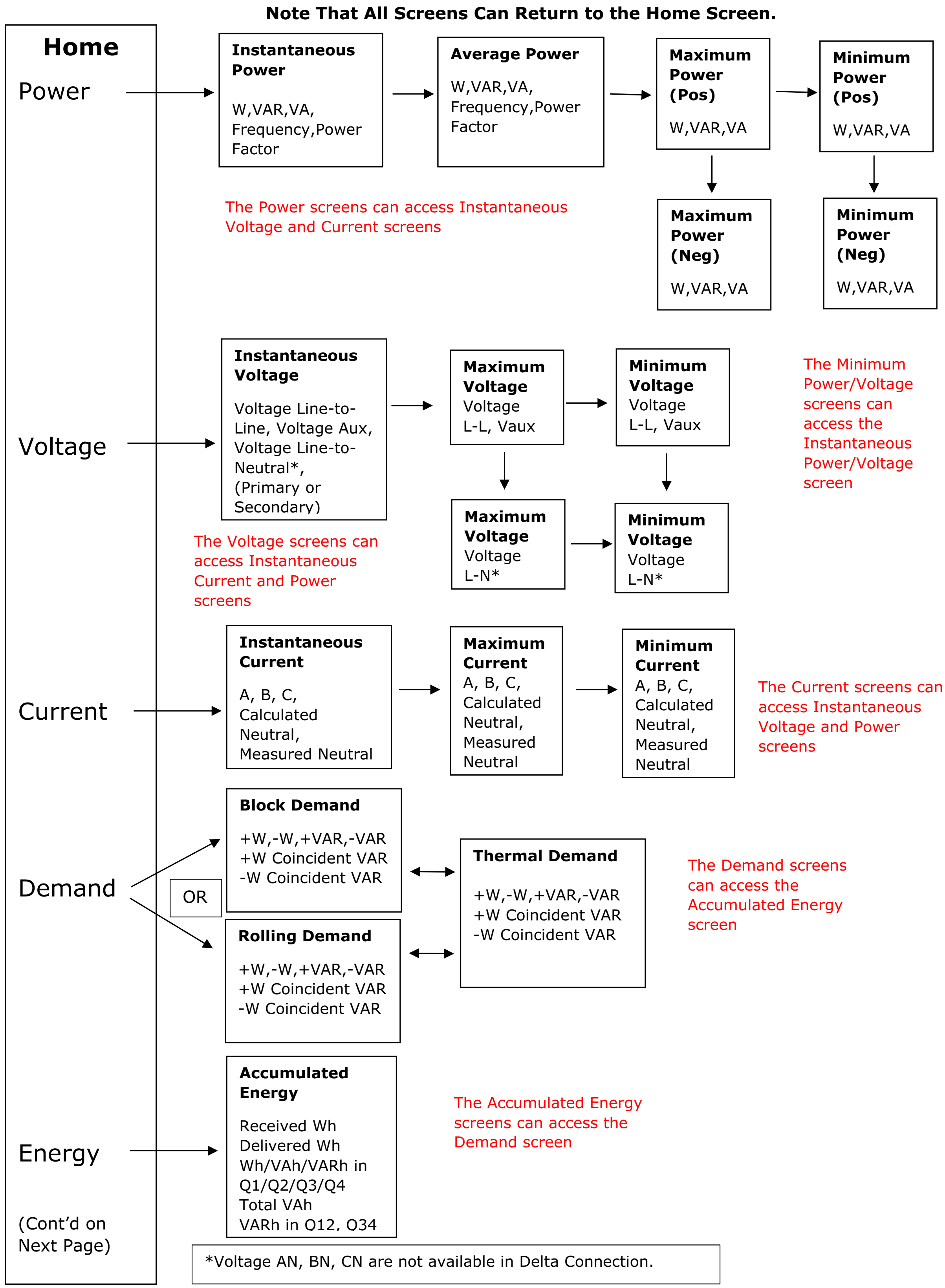
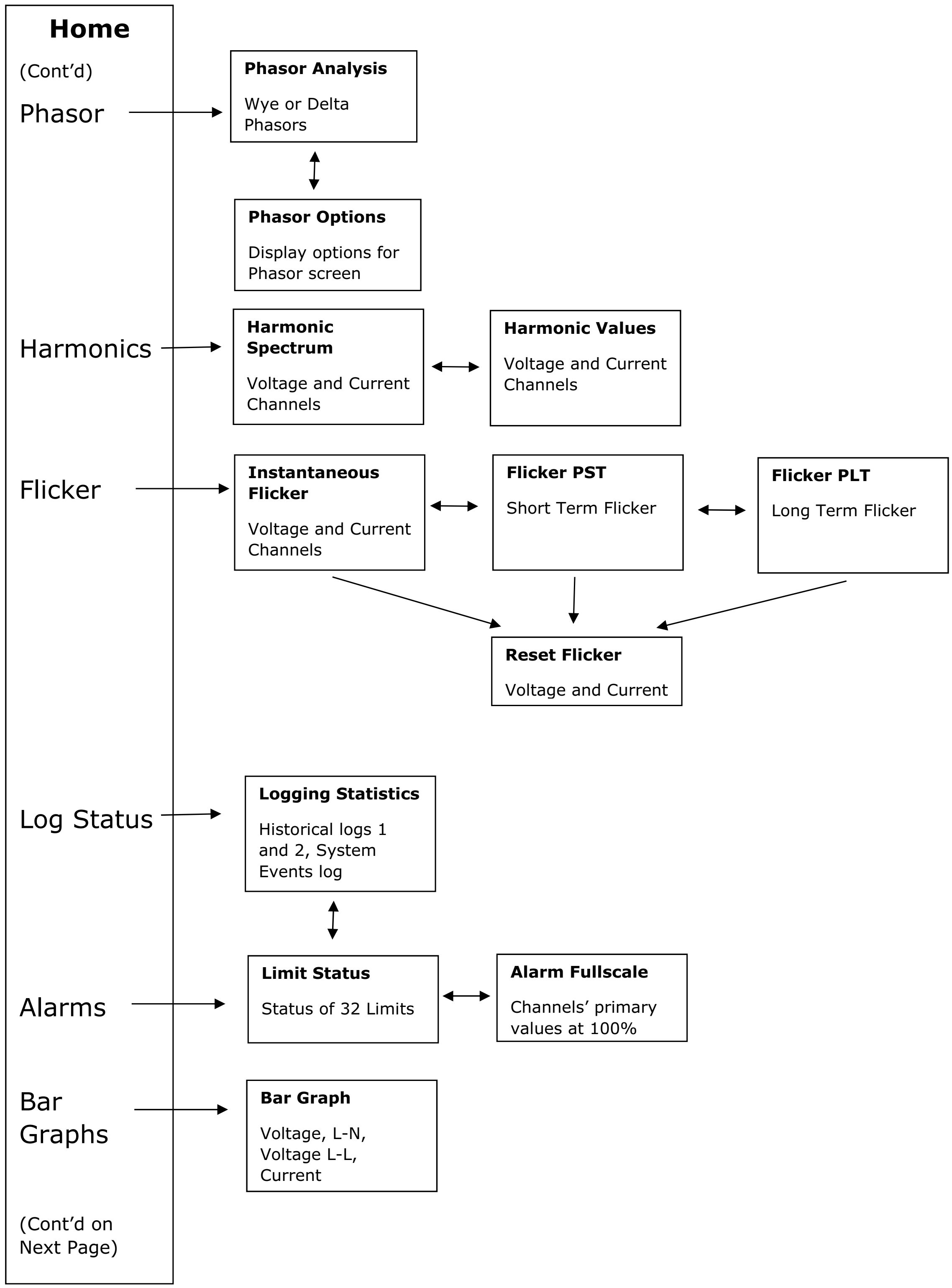
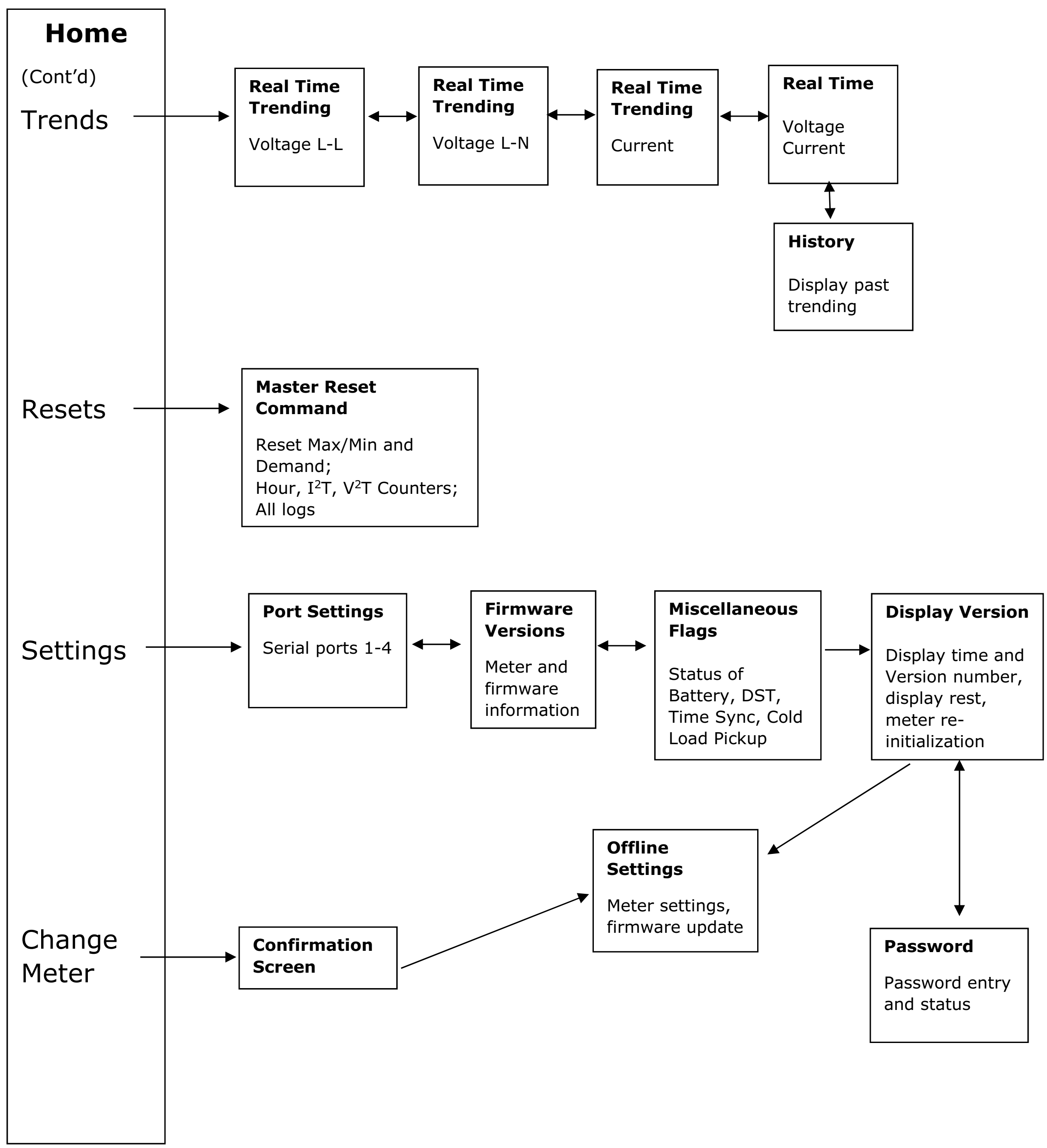


Figure 5-4: Run Mode Navigation Block Diagram


Note That All Screens Can Return to the Home Screen.
Home
Power
Voltage
Current
Demand
Energy
(Cont'd on Next Page)
Instantaneous Power
W,VAR,VA, Frequency,Power Factor
Average Power
W,VAR,VA, Frequency,Power Factor
Maximum Power (Pos)
W,VAR,VA
Minimum Power (Pos)
W,VAR,VA
Maximum Power (Neg)
W,VAR,VA
Minimum Power (Neg)
W,VAR,VA
The Power screens can access Instantaneous Voltage and Current screens
Instantaneous Voltage
Voltage Line-to-Line, Voltage Aux, Voltage Line-to-Neutral*, (Primary or Secondary)
Maximum Voltage
Voltage L-L, Vaux
Minimum Voltage
Voltage L-L, Vaux
Maximum Voltage
Voltage L-N*
Minimum Voltage
Voltage L-N*
The Minimum Power/Voltage screens can access the Instantaneous Power/Voltage screen
The Voltage screens can access Instantaneous Current and Power screens
Instantaneous Current
A, B, C, Calculated Neutral, Measured Neutral
Maximum Current
A, B, C, Calculated Neutral, Measured Neutral
Minimum Current
A, B, C, Calculated Neutral, Measured Neutral
The Current screens can access Instantaneous Voltage and Power screens
Block Demand
+W,-W,+VAR,-VAR
+W Coincident VAR
-W Coincident VAR
OR
Rolling Demand
+W,-W,+VAR,-VAR
+W Coincident VAR
-W Coincident VAR
Thermal Demand
+W,-W,+VAR,-VAR
+W Coincident VAR
-W Coincident VAR
The Demand screens can access the Accumulated Energy screen
Accumulated Energy
Received Wh
Delivered Wh
Wh/VAh/VARh in Q1/Q2/Q3/Q4
Total VAh
VARh in Q12, Q34
The Accumulated Energy screens can access the Demand screen
*Voltage AN, BN, CN are not available in Delta Connection.


Home
(Cont'd)
Phasor
Phasor Analysis
Wye or Delta Phasors
Phasor Options
Display options for Phasor screen
Harmonics
Harmonic Spectrum
Voltage and Current Channels
Harmonic Values
Voltage and Current Channels
Flicker
Instantaneous Flicker
Voltage and Current Channels
Flicker PST
Short Term Flicker
Flicker PLT
Long Term Flicker
Reset Flicker
Voltage and Current
Log Status
Logging Statistics
Historical logs 1 and 2, System Events log
Limit Status
Status of 32 Limits
Alarms
Alarm Fullscale
Channels' primary values at 100%
Bar Graphs
Bar Graph
Voltage, L-N, Voltage L-L, Current
(Cont'd on Next Page)

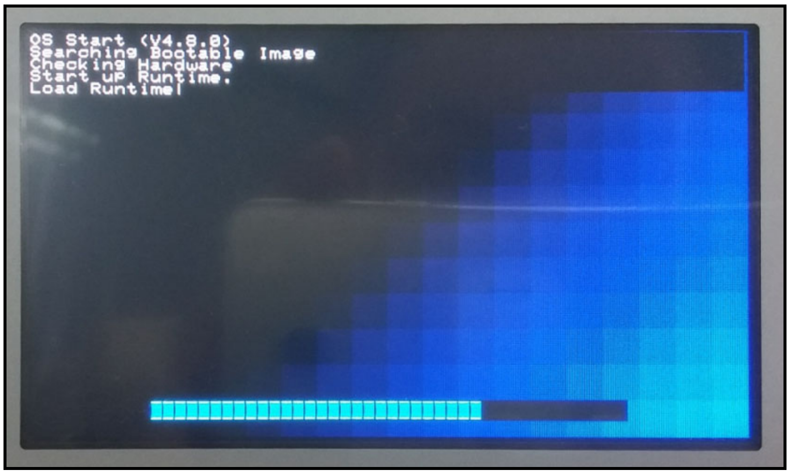

Home
(Cont'd)
Trends
Real Time Trending
Voltage L-L
Real Time Trending
Voltage L-N
Real Time Trending
Current
Real Time
Voltage
Current
History
Display past trending
Resets
Master Reset Command
Reset Max/Min and Demand;
Hour, I2T, V2T Counters;
All logs
Settings
Port Settings
Serial ports 1-4
Firmware Versions
Meter and firmware information
Miscellaneous Flags
Status of Battery, DST, Time Sync, Cold Load Pickup
Display Version
Display time and Version number, display rest, meter re-initialization
Offline Settings
Meter settings, firmware update
Password
Password entry and status
Change Meter
Confirmation Screen

5.3.3 Display Screens

The display screens are shown in this section. Note that depending on your meter's Software Option and programmable settings, you may not see all of these screens.

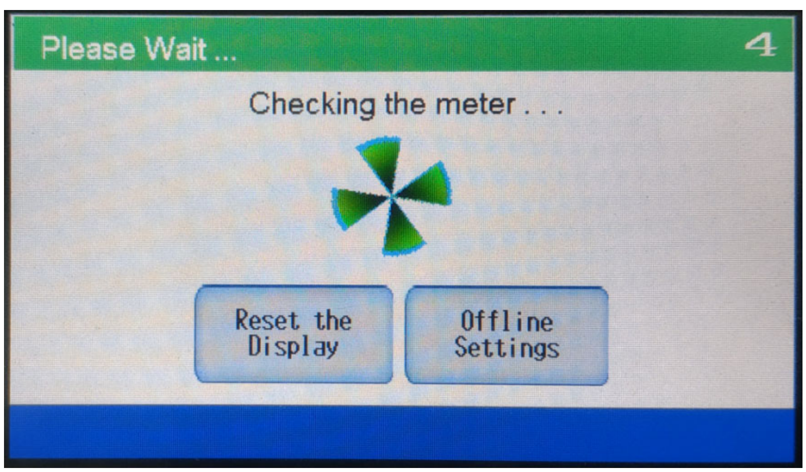
Startup Screen

You will see this screen after the display powers up. It indicates that the operating system is loading

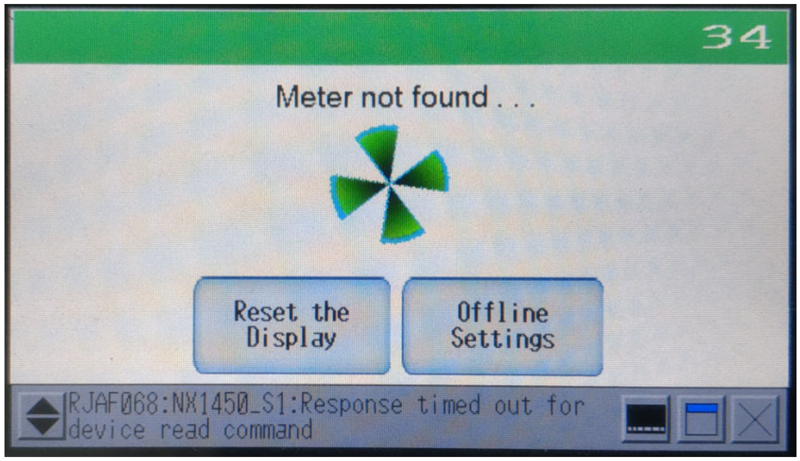


Checking the Meter and Initialize Display

You will see this screen as the display connects to the meter. In most cases, the display will start automatically. If you want to reset the display to its default values, touch Reset the Display. This should allow the display to easily connect to the meter.



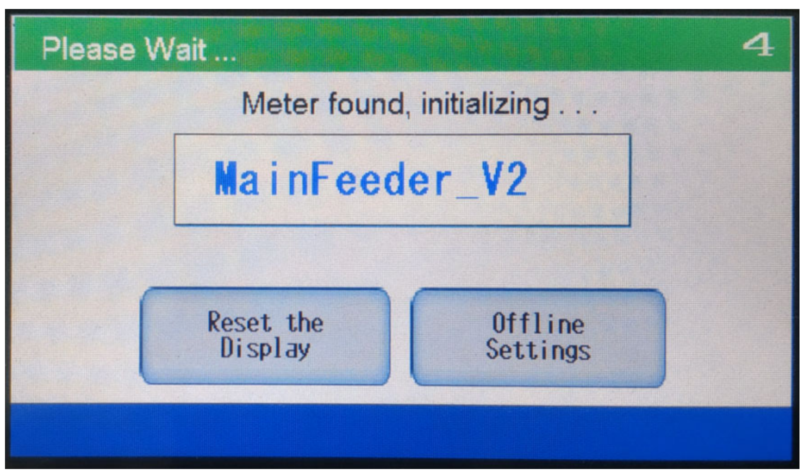
If the meter is not found, the following screen is displayed.



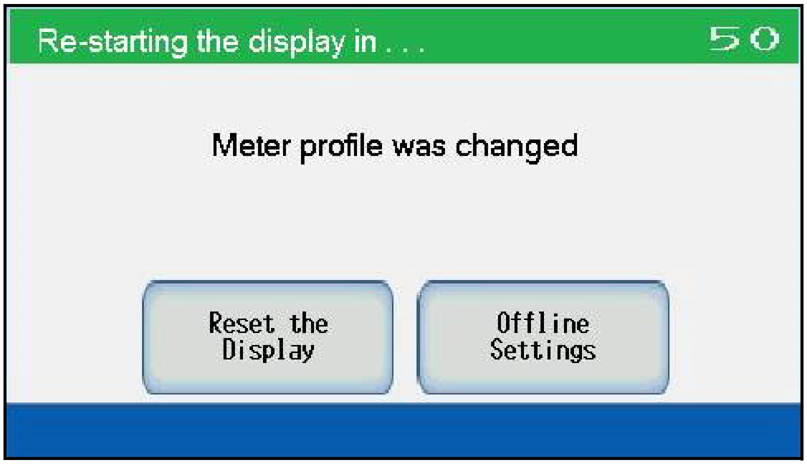
You can verify the meter's connection settings through Offline Settings - the procedure is explained later in this section (see "Offline Settings" on page 54).

Meter Initialization

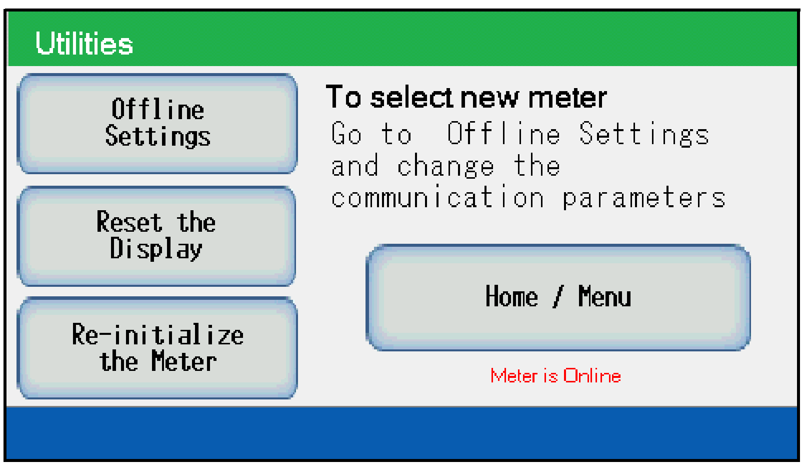
Once the display finds the meter, it will check the meter's settings.



- If the meter is not an EPM 9700 meter, if the meter settings have been changed, if the meter was changed, or if the meter firmware was updated, this screen displays, with the appropriate message text (below is an example):



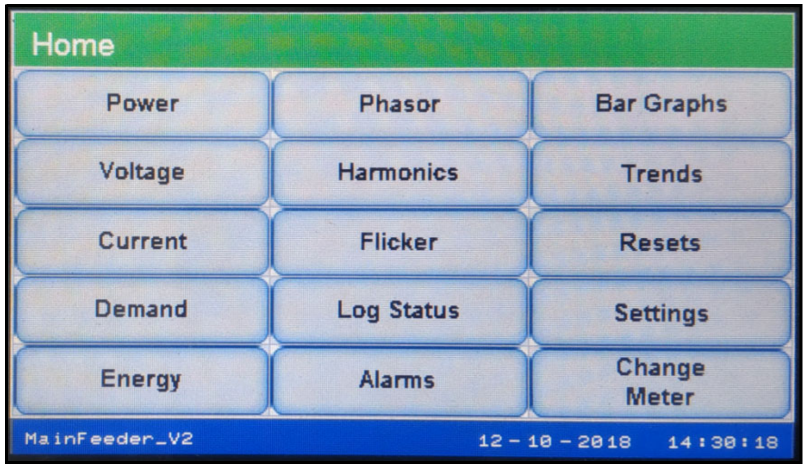
  - Within two minutes the display restarts, and then re-initializes and checks the meter connection.
  - Touch Offline Settings to select the meter or correct the communication settings - see "Offline Settings" on page 54, for instructions.
- If there is a communication error or if the meter goes offline for 60 minutes, you will see the following screen:



  - If there has been a change in communication settings or to check that the communication settings are correct, touch Offline Settings. Instructions for using the Offline screens to check communication parameters are shown in "Offline Settings" on page 54.
  - To set the display back to its default values so that it can re-connect to the meter, touch **Reset the Display**.
  - If you have changed meter settings, such as CT and PT ratios, limits, or other non-communication settings, touch Re-initialize the Meter. This will let the display connect to the meter with its updated settings.

Home Screen

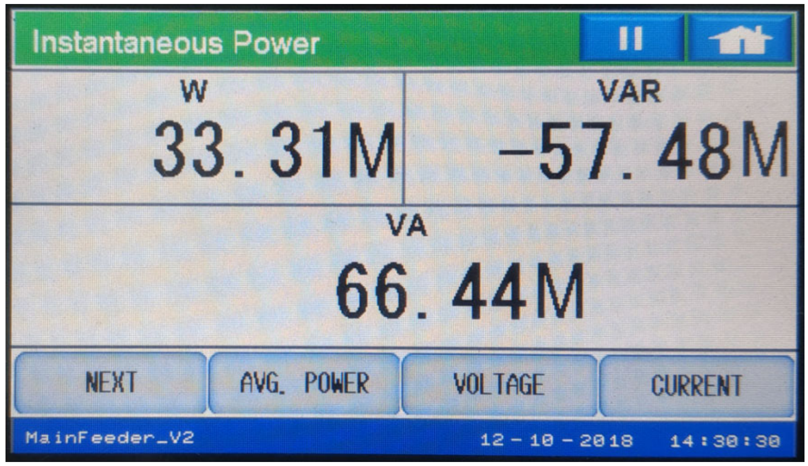
Once the P70N is connected to the meter, you will see the **Home** screen.



- Touch a button to display that screen.
- When scrolling is enabled, the display scrolls the Power, Voltage, Current, Demand, and Energy screens every eight seconds if you take no action (such as manually selecting a screen).
- The bottom of the screens shows the meter ID (as set in the meter's Device profile) on the left and the meter date and time on the right in their default format of MM-DD-YYYY and HH:MM:SS.
- Examples of all of the P70N display screens are shown on the following pages. Here are some links to commonly used setting screens:
  - Meter name - see *Firmware Versions (for EPM 9700)* on page 5–50.
  - Firmware version - see *Firmware Versions (for EPM 9700)* on page 5–50.
  - Display version - see *Display Version (for P70N)* on page 5–52.
  - Password entry - see *Password Screen* on page 5–53.
  - Communication port settings - see *Port Settings (for EPM 9700)* on page 5–49.
  - Select a new meter - see *Offline Settings* on page 5–54.

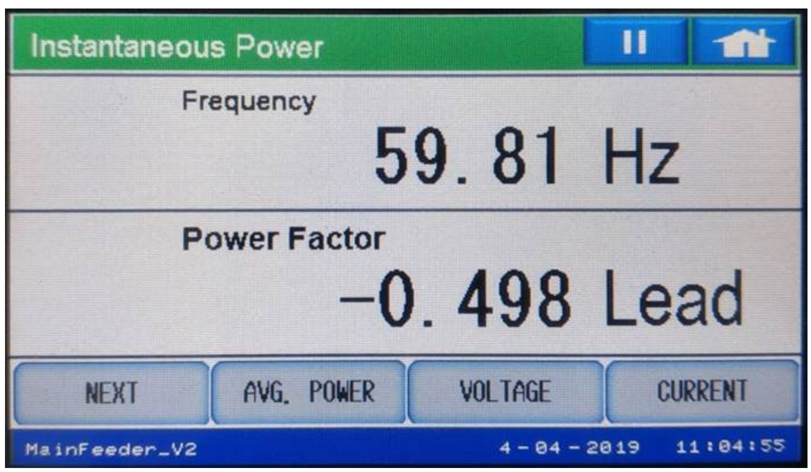
Power Screens

Instantaneous Power



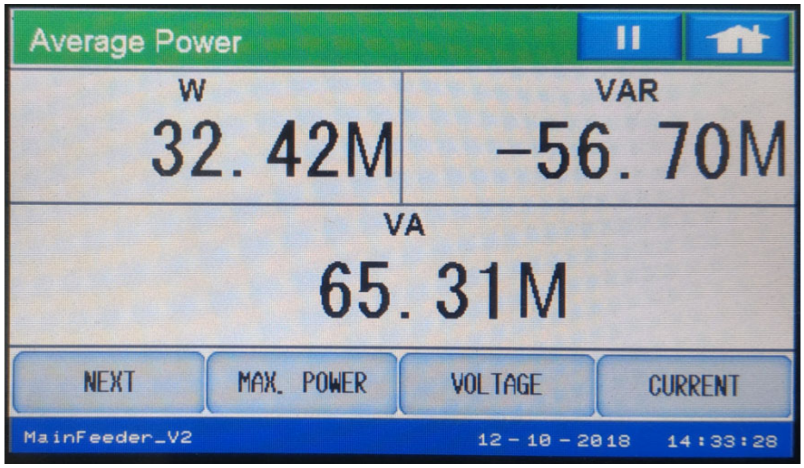
The first Power screen is **Instantaneous Power** for W, VAR, and VA.

- You can see **Average (Avg.) Power, Voltage,** or **Current** by touching their respective buttons. The **Average Power** is defined in the programmable settings' average integration interval.
- Touch the **Next** button to display the next page of the **Instantaneous Power** screen, showing frequency and power factor readings.

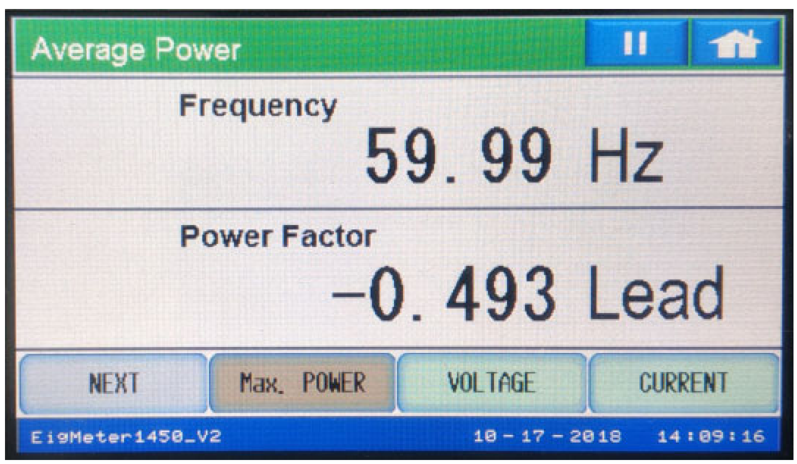


Average Power

Touch **Ave. Power** to display the first **Average Power** screen, showing data for W, VAR, and VA.

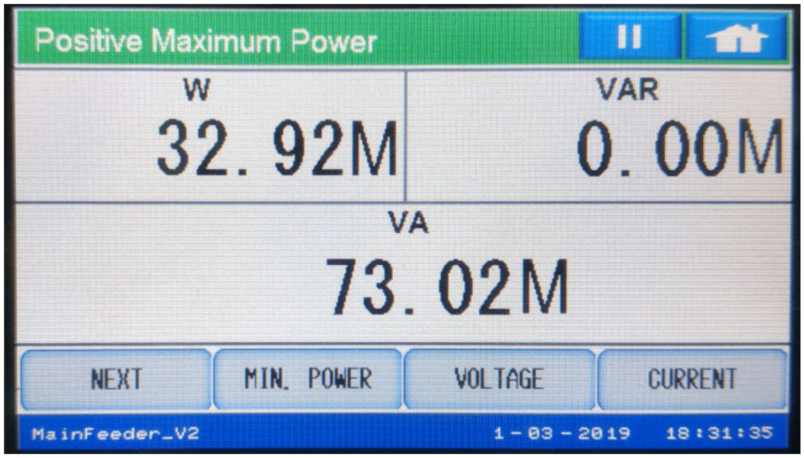


Touch **Next** to display the second **Average Power** screen, showing readings for frequency and power factor.

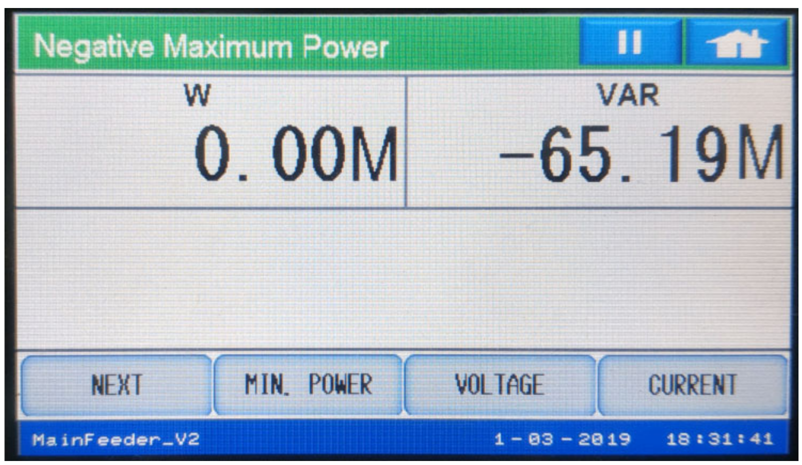


Maximum/Minimum Power

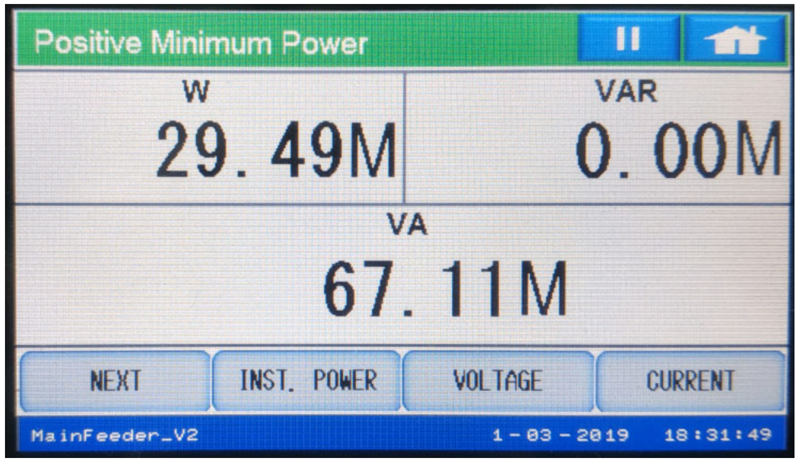
Touch **Max. Power** to display the **Positive Maximum Power** screen for watt, VAR, and VA. Since the EPM 9700 meter is a full bi-directional power meter, it displays the positive and negative max and min readings for both delivered and received in separate registers.



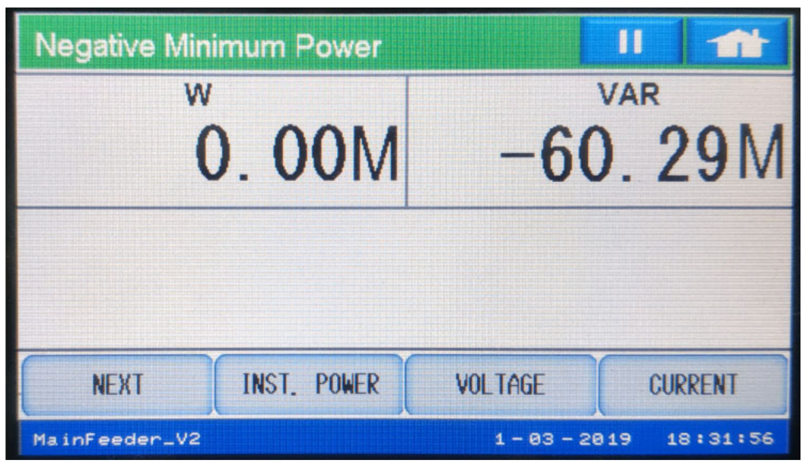
Touch **Next** to display the **Negative Maximum Power** Screen for W and VAR.



Touch **Min. Power** to display the **Positive Minimum Power** screen for W, VAR, and VA.



Touch **Next** to display the **Negative Minimum Power** screen for Watt and VAR.

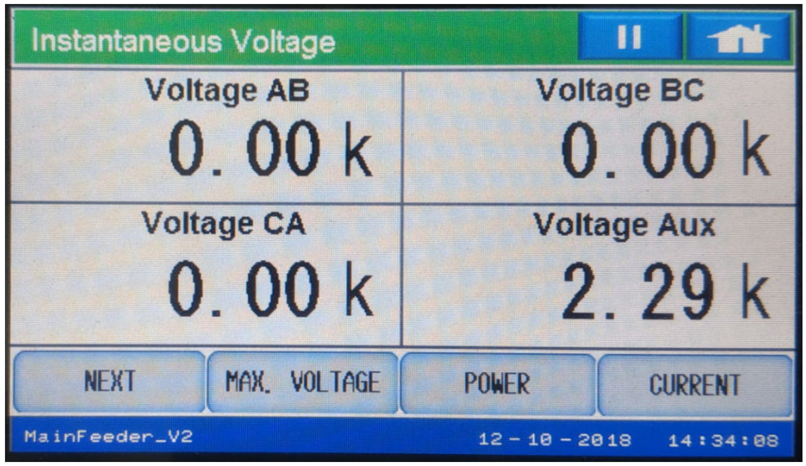


Touch **Inst. Power** to return to the first **Power** screen.

Voltage Screens

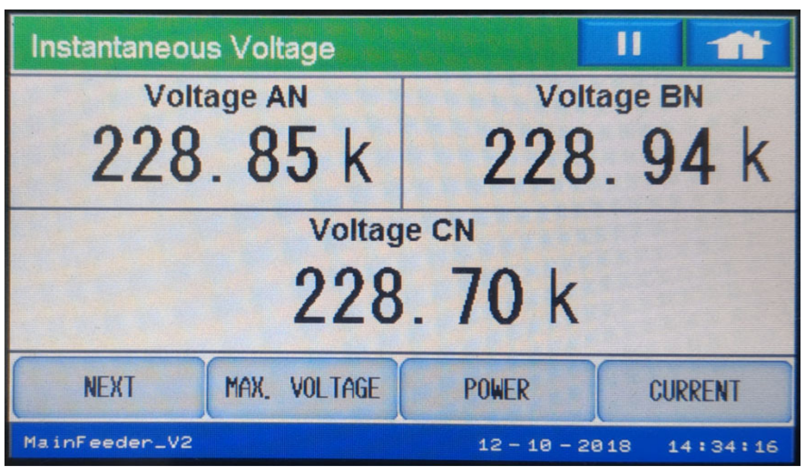
Instantaneous Voltage

Touch **Voltage** to display the first **Instantaneous Voltage** screen, which shows line-to-line voltage.



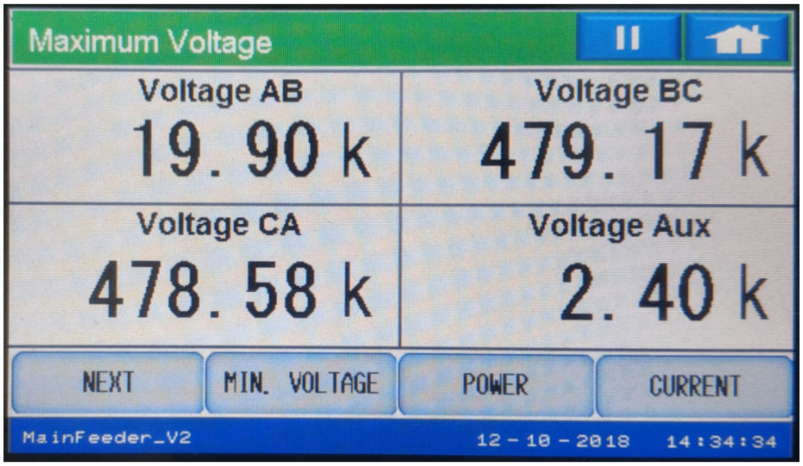
The **VAUX** reading shows the value of the fourth voltage input, which can be used for looking at voltage on both sides of a switch.

Touch **Next** to see the second page of the **Instantaneous Voltage** screen, which shows line-to-neutral voltage.

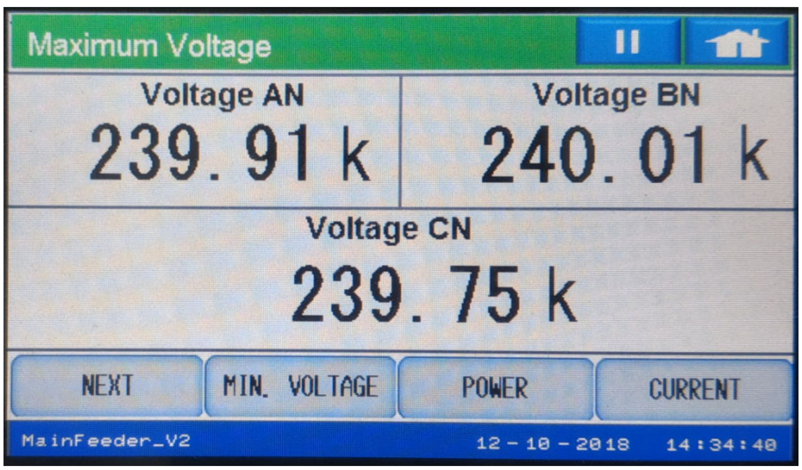


Maximum/Minimum Voltage

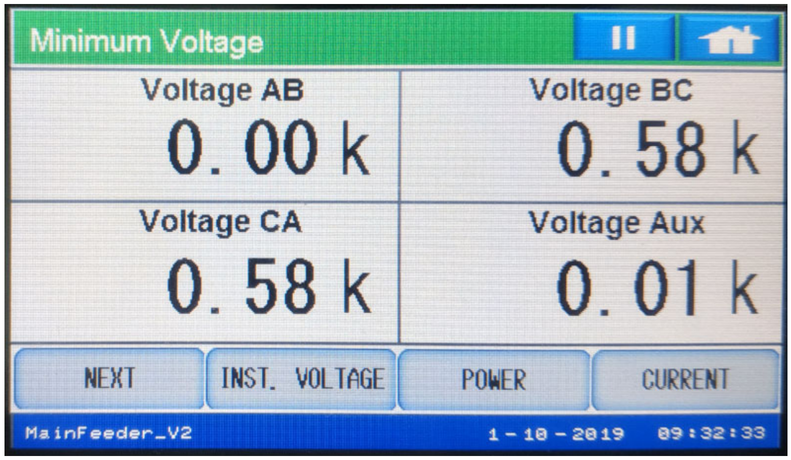
Touch **Max. Voltage** to display the first **Max Voltage** screen, which shows maximum voltage line-to-line.



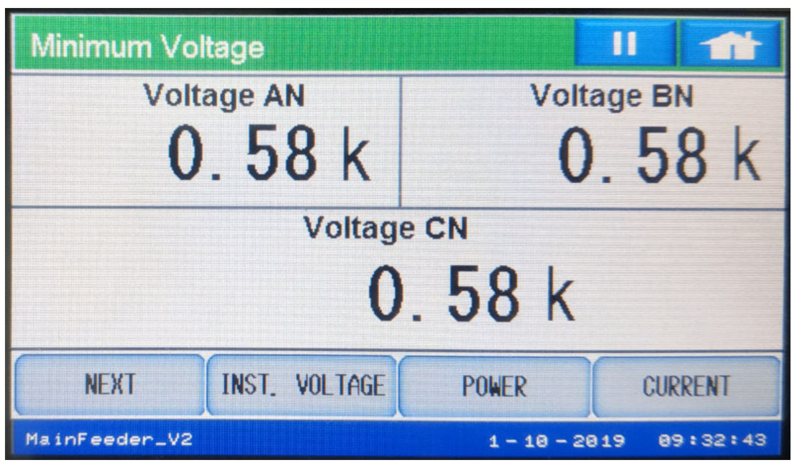
Touch **Next** to display the second **Max Voltage** screen, which shows maximum voltage line-to-neutral.



Touch **Min. Voltage** to display the first **Min Voltage** screen, which shows minimum voltage line-to-line.



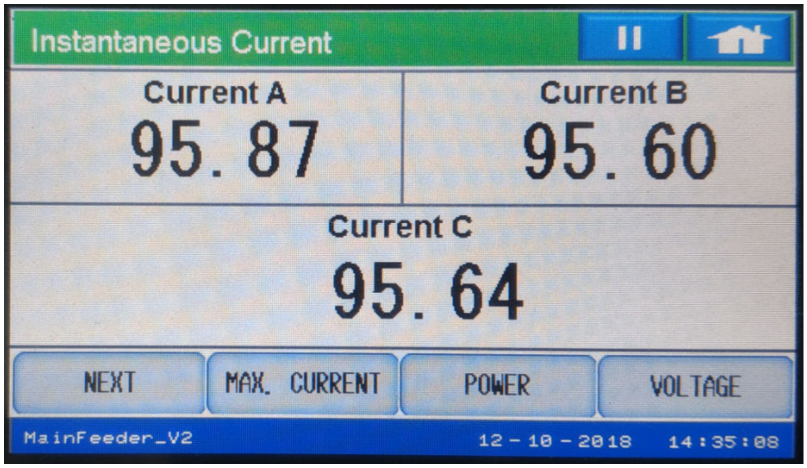
Touch **Next** to display the second **Min Voltage** screen, which shows minimum voltage line-to-neutral.



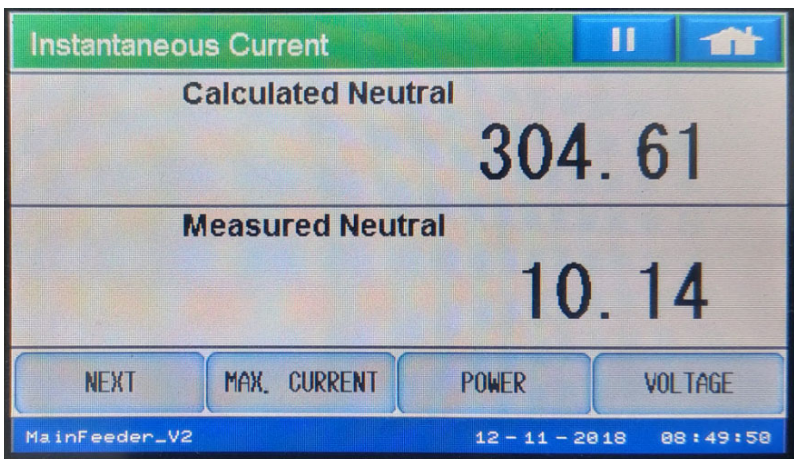
Current Screens

Instantaneous Current

Touch **Current** to display the first **Instantaneous Current** screen, which shows current for phases A,B, and C.

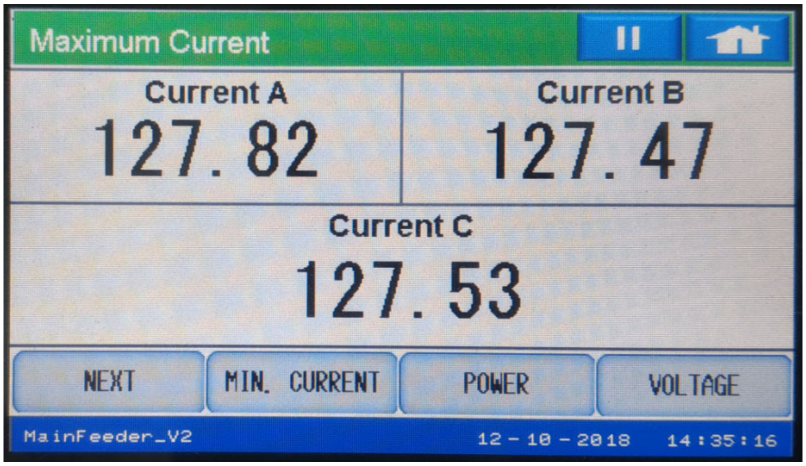


Touch **Next** to display the second **Instantaneous Current** screen, which shows calculated and measured neutral current.

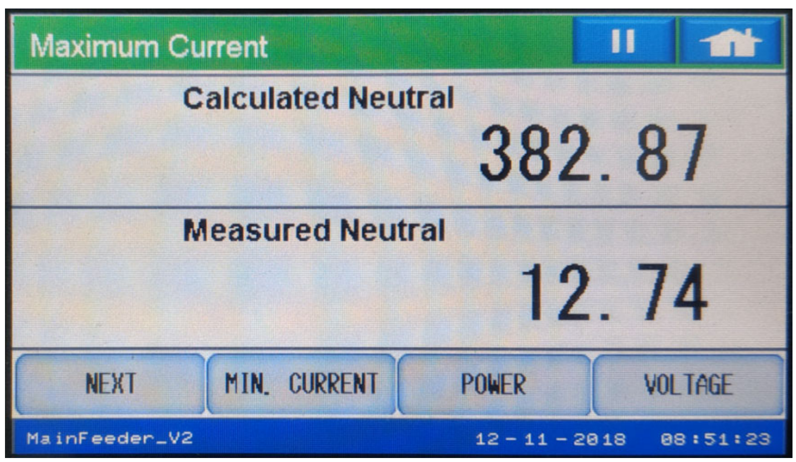


Maximum/Minimum Current

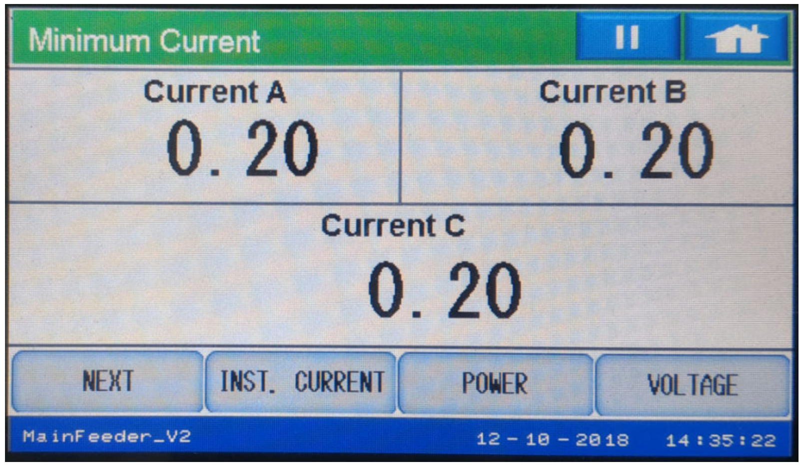
Touch **Max. Current** to display the first **Maximum Current** screen, for current phases A,B, and C.



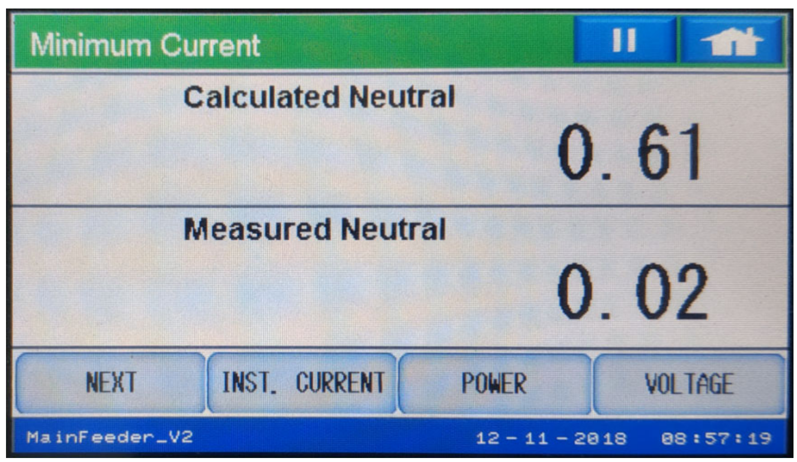
Touch **Next** to display the second **Maximum Current** screen, for measured and calculated neutral current.



Touch **Min. Current** to display the first **Minimum Current** screen, for current phases A,B, and C.



Touch **Next** to display the second **Minimum Current** screen, for measured and calculated neutral current.

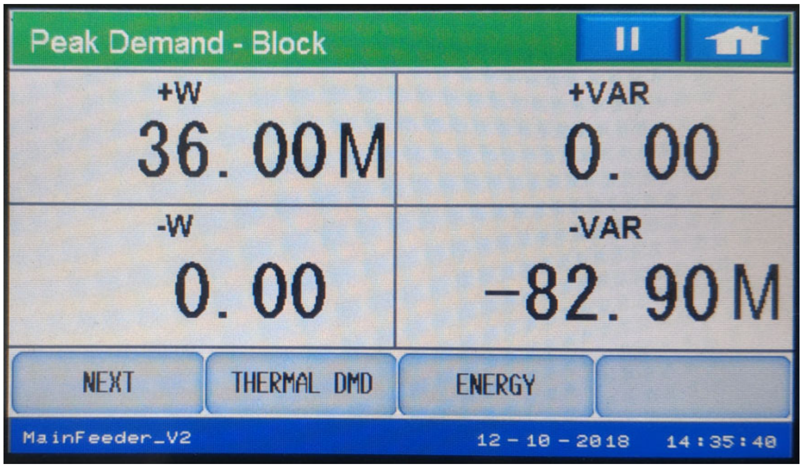


Demand Averaging Screens

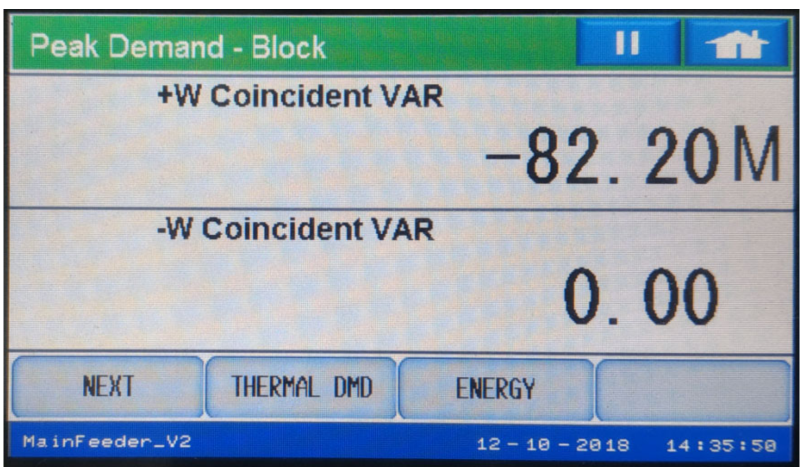
Touch Demand from the Home menu screen to open the first Demand screen. Depending on how Demand was configured for the meter, you will see either the Block Demand or Rolling Demand screen.

Block Demand

This is the first Block Peak Demand screen, showing positive and negative watt and VAR readings.

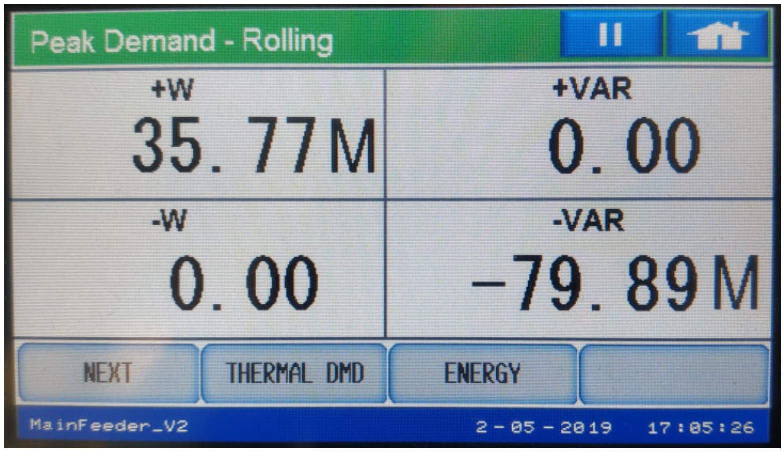


Touch **Next** to display the second **Block Peak Demand** screen, showing positive and negative watt coincident VAR readings.

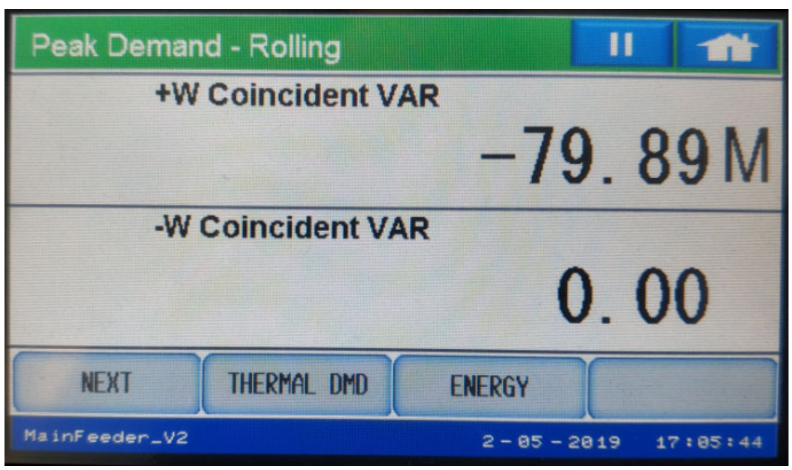


Rolling Demand

This is the first **Rolling Demand** screen, showing positive and negative watt and VAR readings.

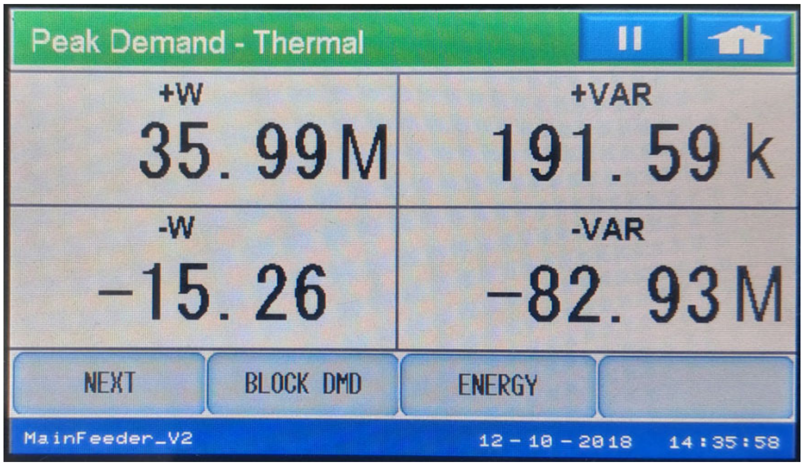


Touch **Next** to display the second **Rolling Demand** screen, showing positive and negative watt coincident VAR readings.

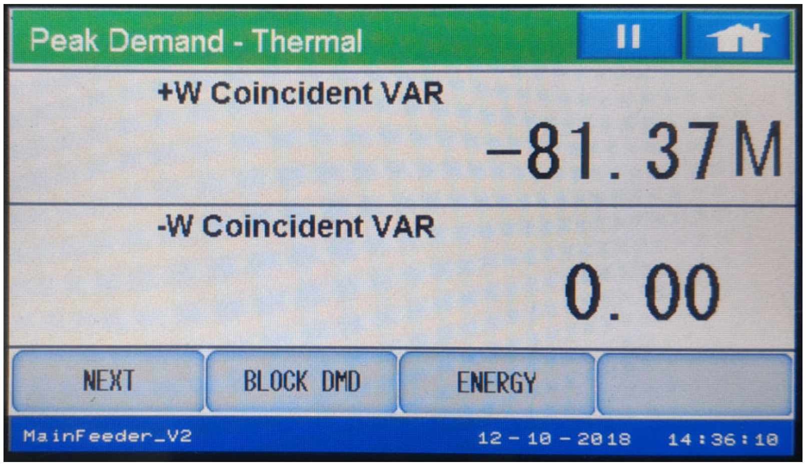


Thermal Demand

From either the **Block Demand** or **Rolling Demand** screen, touch **Thermal DMD** to display the first **Thermal Peak Demand** screen, showing positive and negative watt and VAR readings.



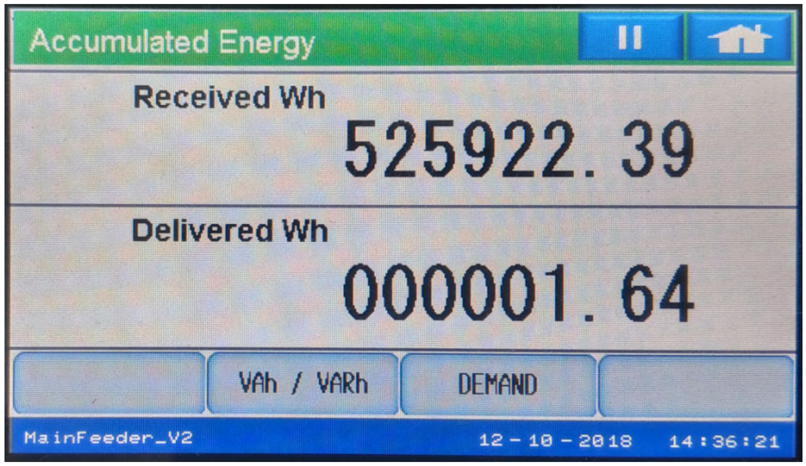
Touch **Next** to display the second **Thermal Peak Demand** screen, showing positive and negative watt coincident VAR readings.



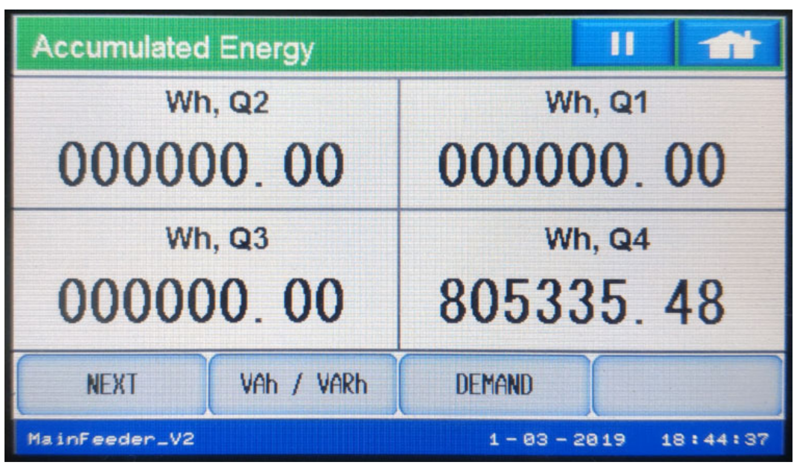
Energy Screens

Accumulated Energy

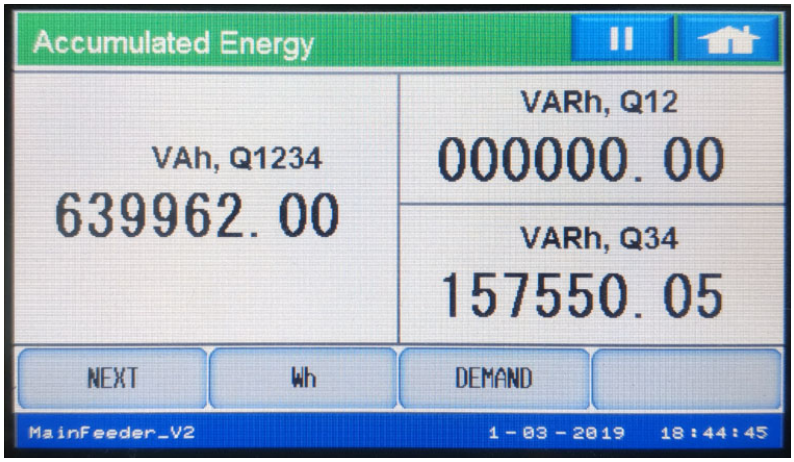
From the **Home** menu screen, touch **Energy** to display the first **Accumulated Energy** screen, which shows Received and Delivered watt-hours.



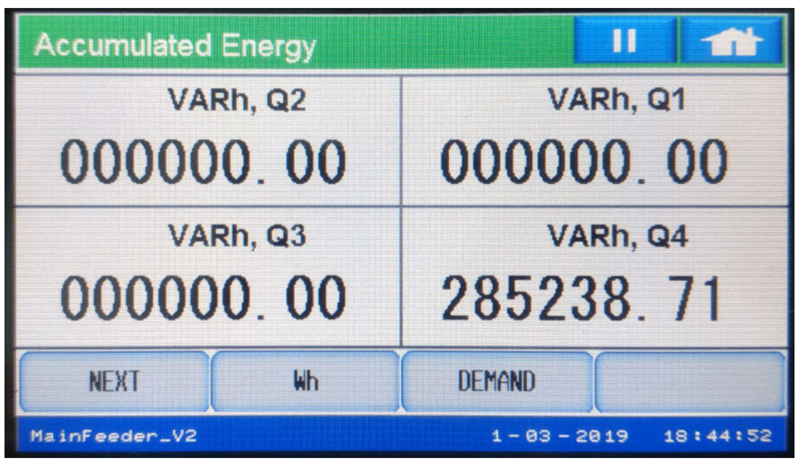
Touch **Next** to display the second **Accumulated Energy** screen, which shows watt-hours in the quadrants.



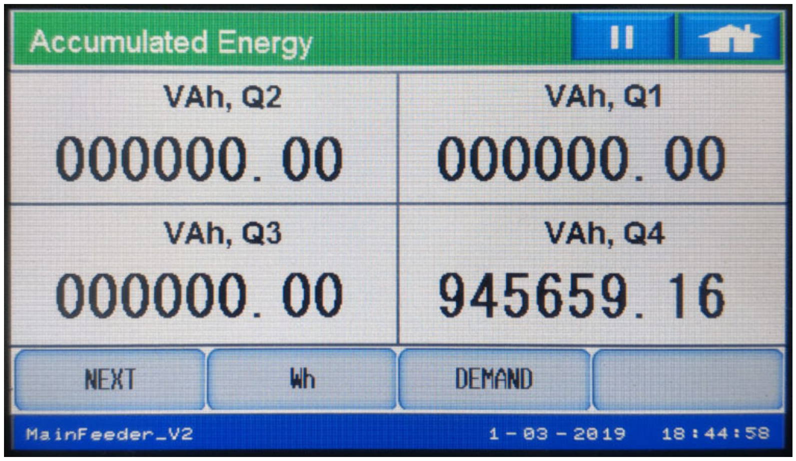
Touch **Next** to display the third **Accumulated Energy** screen, which shows VAh and VARh in the quadrants.



Touch **Next** to display the fourth **Accumulated Energy** screen, which shows VARh in each of the four quadrants.

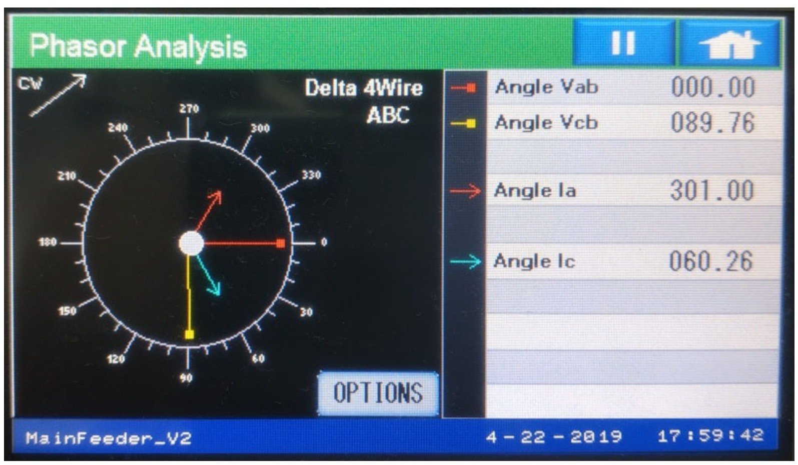


Touch **Next** to display the fifth **Accumulated Energy** screen, which shows VAh in each of the four quadrants.

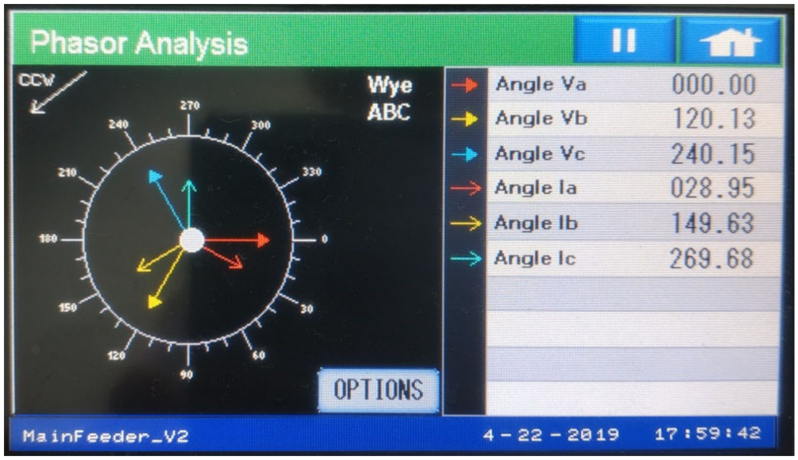


Phasor Screens

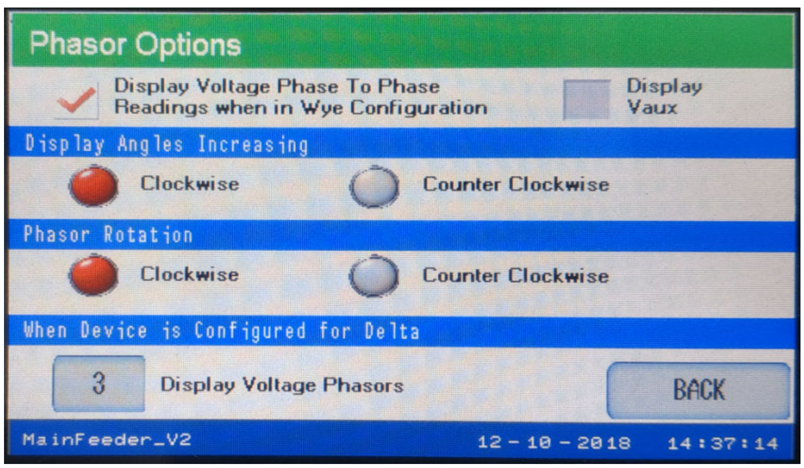
From the **Home** menu screen, touch **Phasor** to display the first **Phasor Analysis** screen, showing voltage and current angles. This is an example of a screen for a Delta wiring system.



This is an example screen for a Wye wiring system.

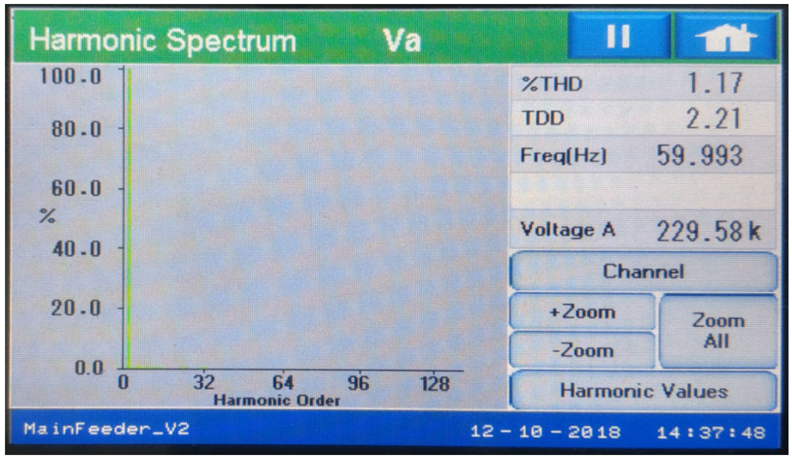


Touch **Options** to display the **Phasor Options** screen, where you can set Phasor display options, such as angle direction and phase rotation; as well as specific settings for when the meter is configured for Delta or Wye wiring systems.

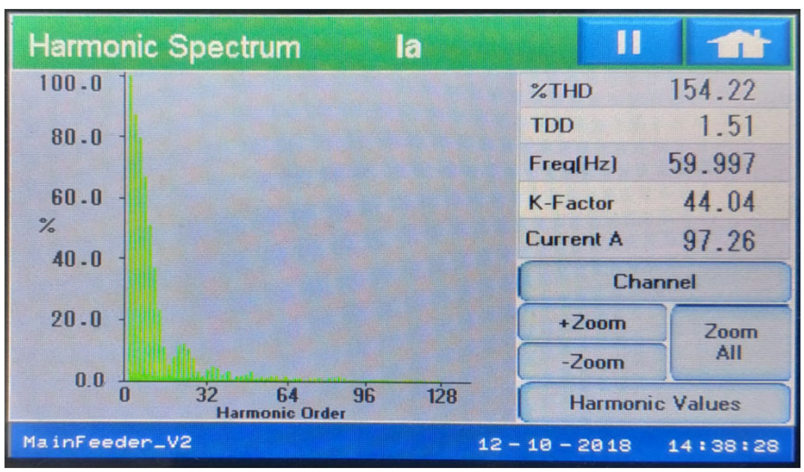


Harmonics Screens

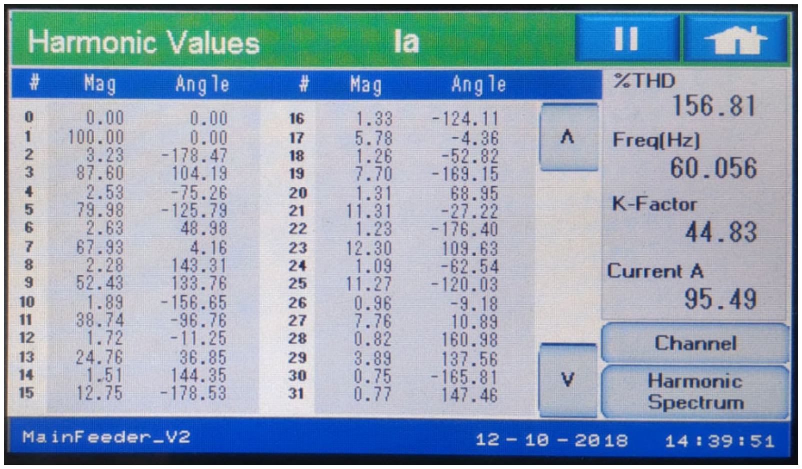
From the **Home** menu screen, touch **Harmonics** to display the first **Harmonic Spectrum** screen.



Click **Channel** to display data for another voltage phase or a current channel - see the example below.



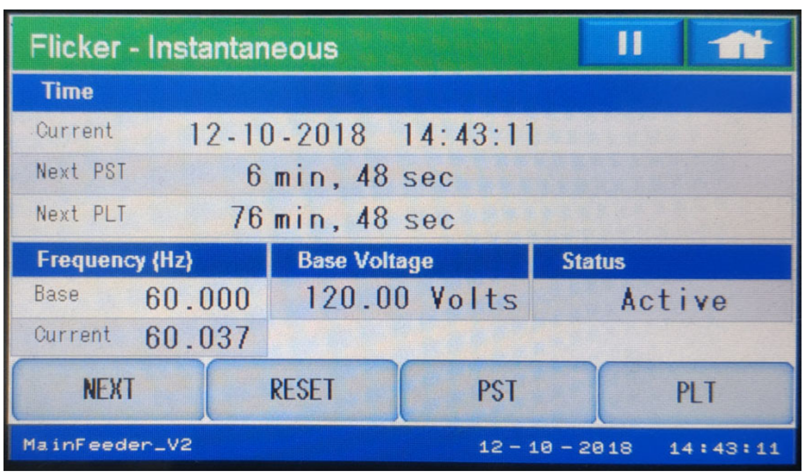
Touch **Harmonic Values** to display the **Harmonic Values** screen. Use the up and down arrows to see more information.



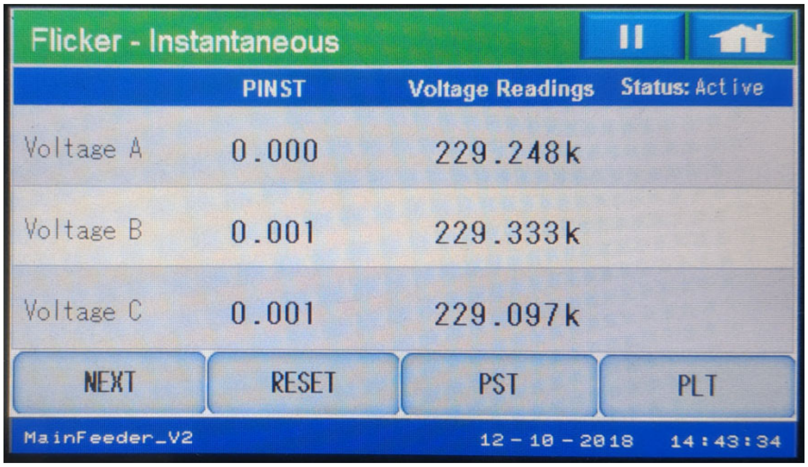
Flicker Screens

Instantaneous Flicker

From the **Home** menu screen, touch **Flicker** to display the first **Instantaneous Flicker** screen. If you want to reset Flicker, touch **Reset** from one of the following Flicker screens. A message window opens, which asks you to confirm the reset.

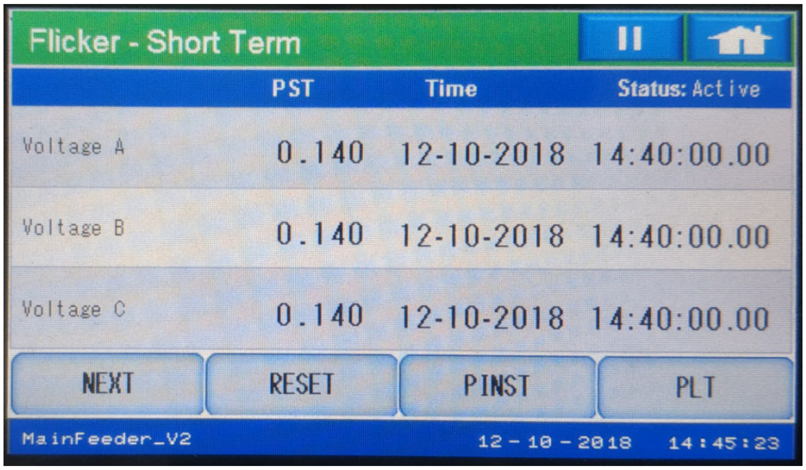


Touch **Next** to display the second **Instantaneous Flicker** screen.

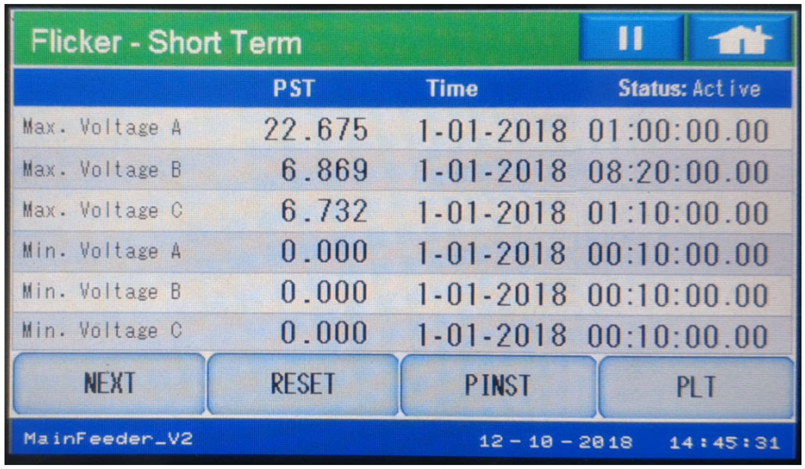


Short Term Flicker

Touch **PST** to display the first **Short Term Flicker** screen.

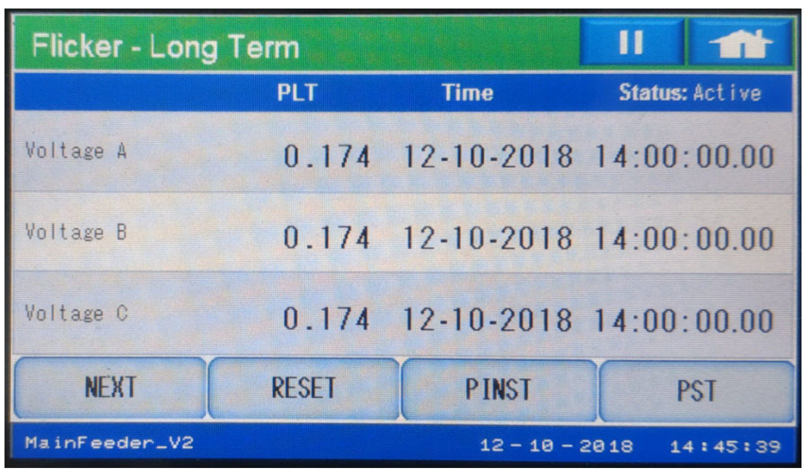


Touch **Next** to display the second **Short Term Flicker** screen.

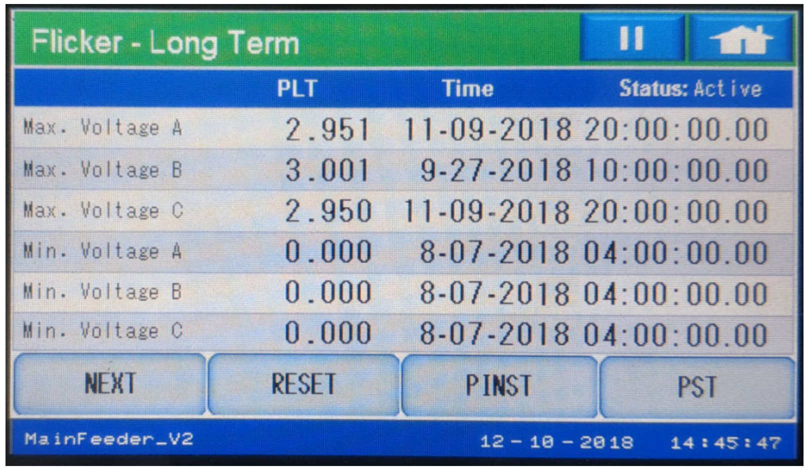


Long Term Flicker

Touch **PLT** to display the first **Long Term Flicker** screen.



Touch **Next** to display the second **Long Term Flicker** screen.



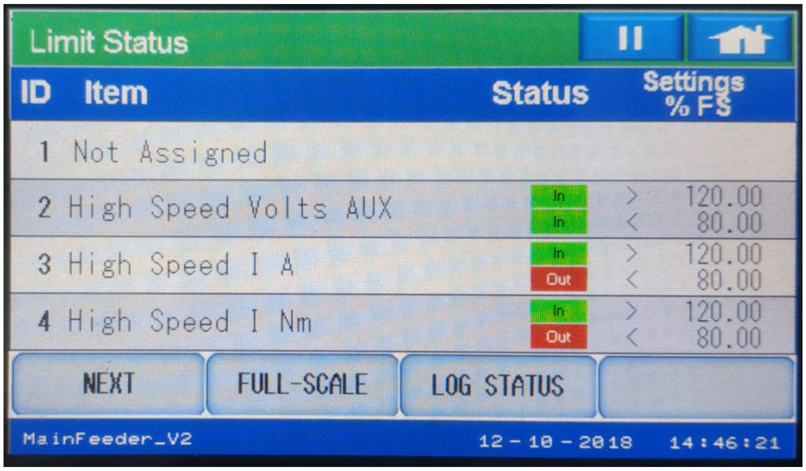
Logging Statistics Screen

From the **Home** menu screen, touch **Log Status** to display the Logging Statistics screen, which shows data for Historical logs 1 and 2 and the System Events log.There are additional logs that can be viewed using GE Communicator software.

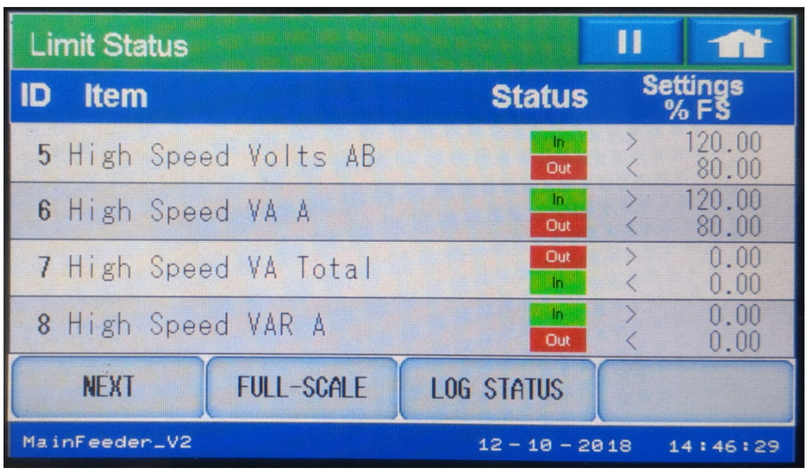
Limits/Alarm Screen

Limit Status

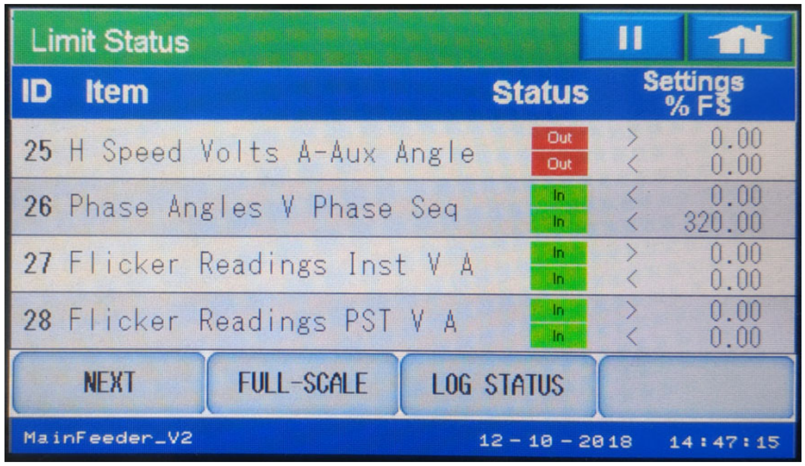
Either touch **Alarms** from the **Home** menu screen or touch **Limit Status** from the **Logging Statistics** screen to display the first **Limit Status** screen. This screen displays any of the out of limit alarms and their set points.



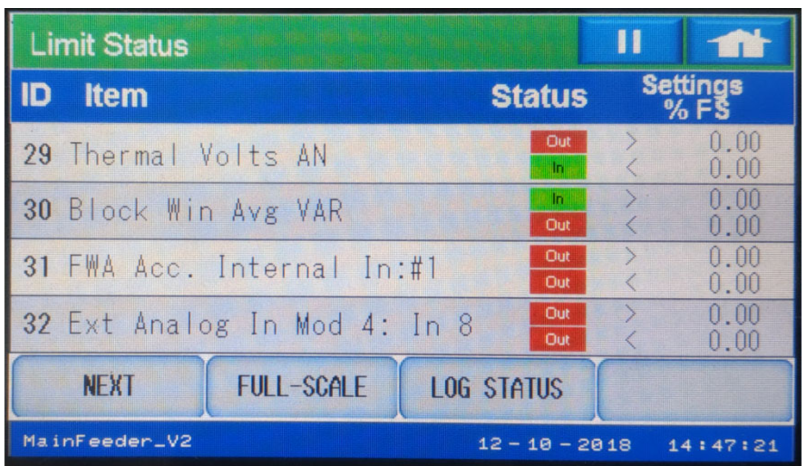
Use the **Next** button to display all of the 32 limits, in order - see the example screen, below.



Click **Next** to display the third **Limit Status** screen.

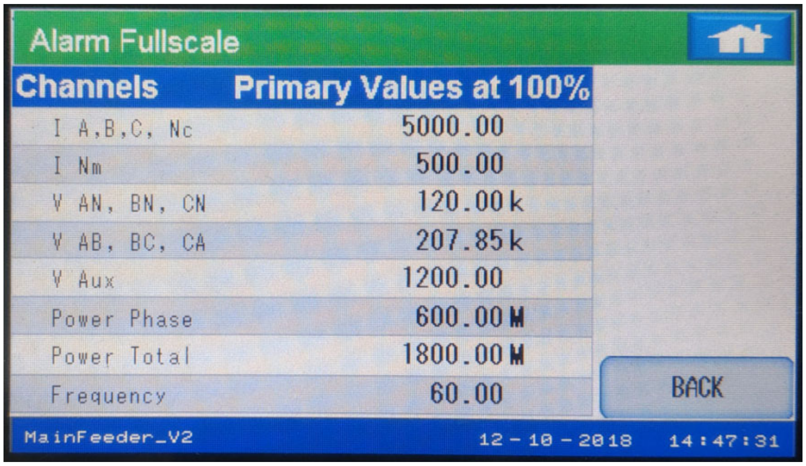


Click **Next** to display the fourth **Limit Status** screen.



Alarm Fullscale

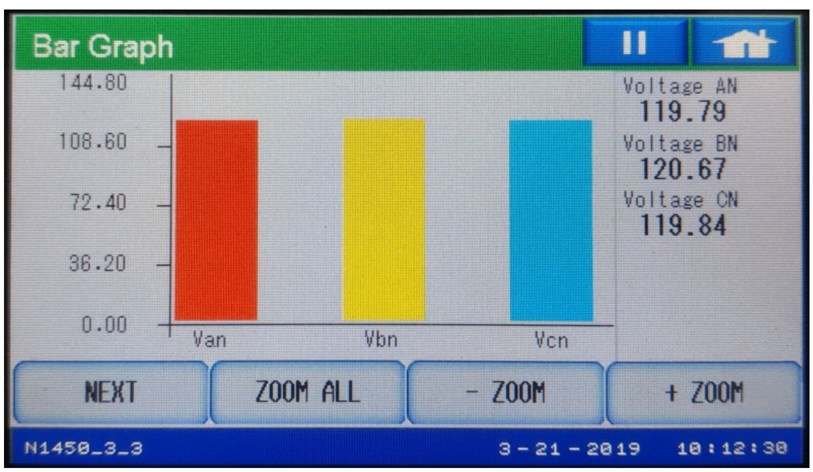
Touch **Full-Scale** to display the **Alarm Fullscale** screen, which show the channels' primary values at 100%.



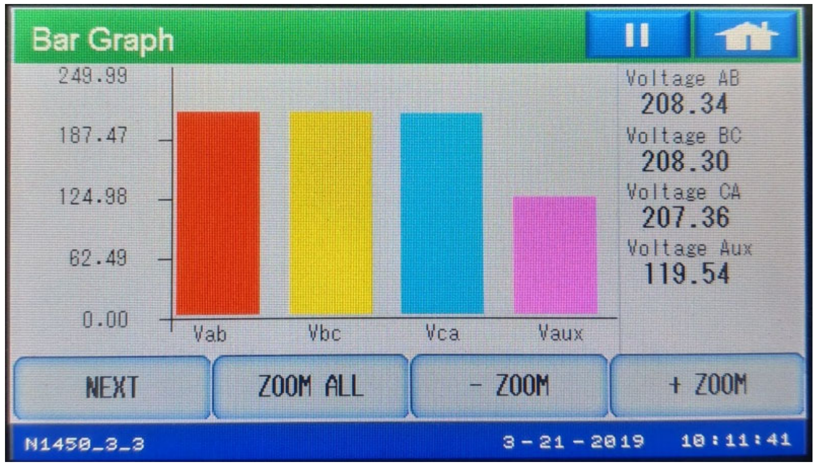
Bar Graph Screens

Voltage

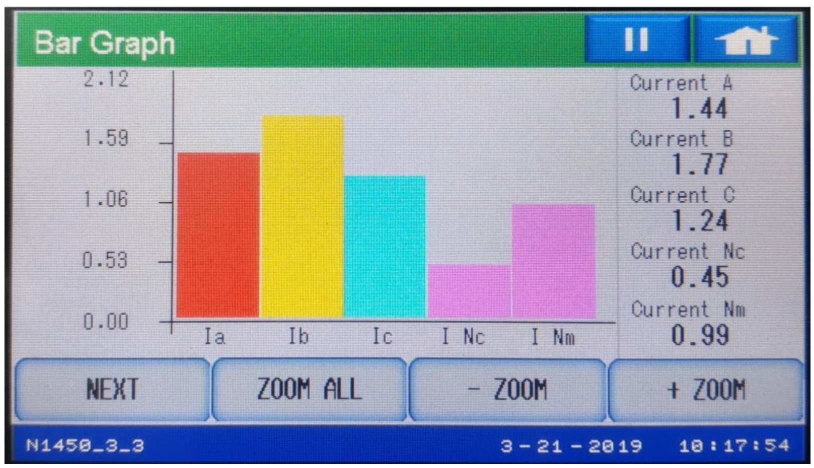
From the **Home** menu screen, touch B**ar Graphs** to display the first voltage **Bar Graph** screen, showing line-to-neutral data.



Touch **Next** to display the second voltage **Bar Graph** screen, showing line-to-line data.



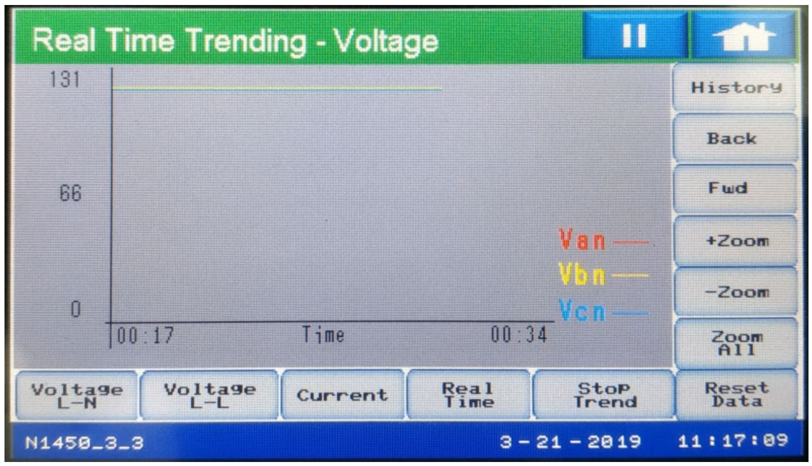
Touch **Next** to display the third **Bar Graph** screen, showing current data.



Trends Screens

Real Time Trending

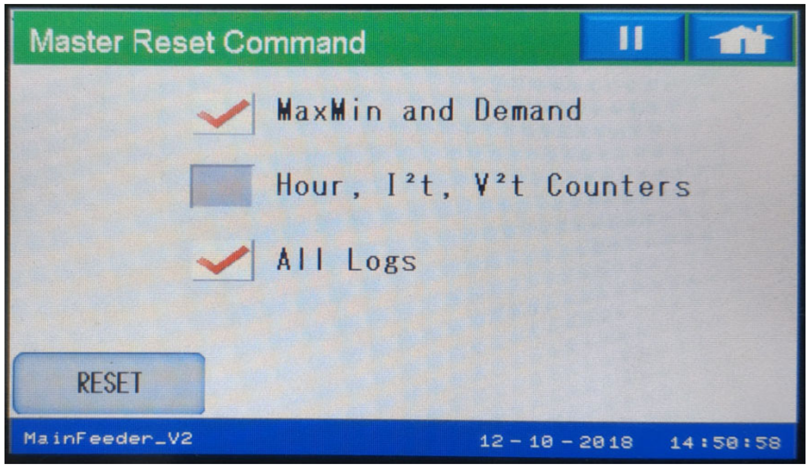
From the **Home** menu screen, touch **Trends** to display the **Real Time Trending** screen, displaying voltage line-to-line. Touch any of the buttons at the bottom of the screen to display that **Real Time Trending** screen, e.g., **Voltage L-N**.
Note that each screen has a maximum of 1440 samples for all parameters on the screen, e.g., all voltages line-to-line, and the data is sampled every 5 seconds. When the maximum data is reached, the old data is overwritten by new readings.



- **Real Time** - displays the real time screen for the channel being displayed; e,g., if viewing Real Time Current, touch Real Time to see the Instantaneous Current screen (see "Instantaneous Current" on page 29).
- **Stop Trend/Start Trend** - touch to stop and restart trending.
- **Reset Data** - touch to reset the trending data for the fields in the screen you are viewing, e.g., Van, Vbn, and Vcn for the Voltage L-L screen.
- **Zoom buttons** - use to enlarge or diminish the display of data.
- **History** - will display the past trending data for the channel.
- **Back/Fwd** - from the History screen, click to view the previous screen/return to the current screen.

Reset Screen

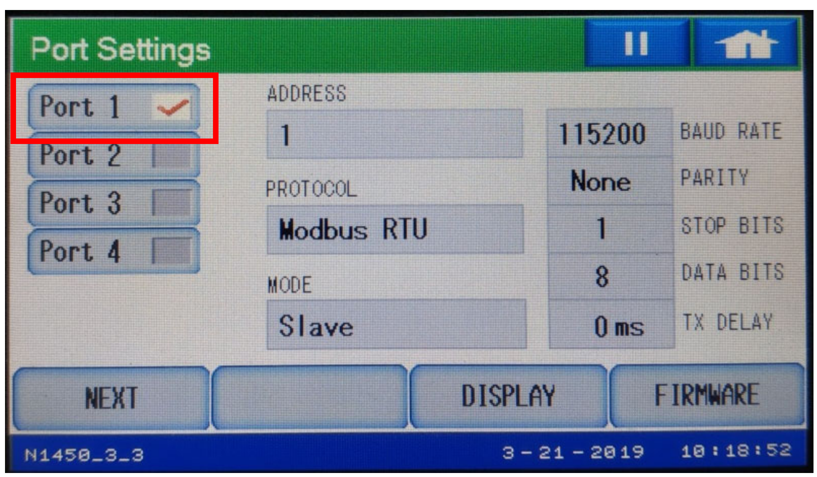
From the **Home** menu screen, touch **Reset** to display the **Master Reset Command** screen. Check the button next to what you want to reset, and touch **Reset**. If reset is password protected, the password screen will be displayed (see "Password Screen" on page 53, for instructions). After you enter the correct password, you can touch Reset to perform the resets.



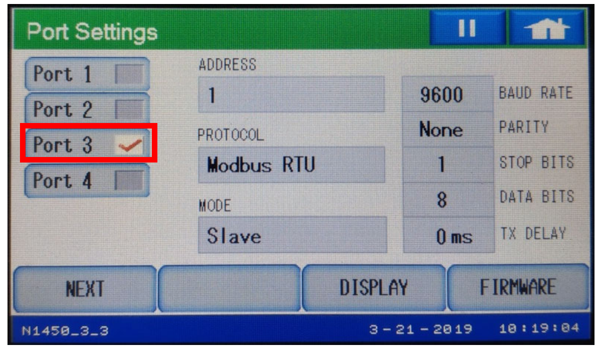
Settings Screens

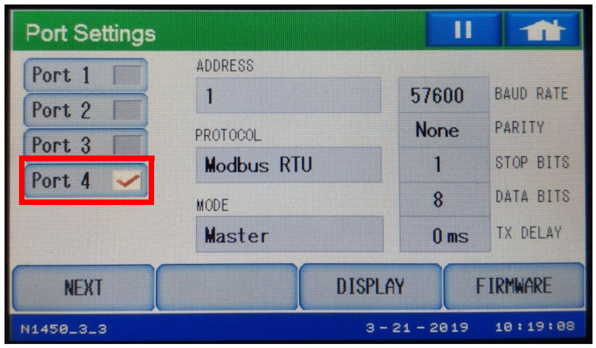
Port Settings (for EPM 9700)

From the **Home** menu screen, touch **Settings** to display the communications' settings screens for the host meter's four serial ports. The P70N display can be connected to any of these ports. The first screen shows the settings for Port 1.



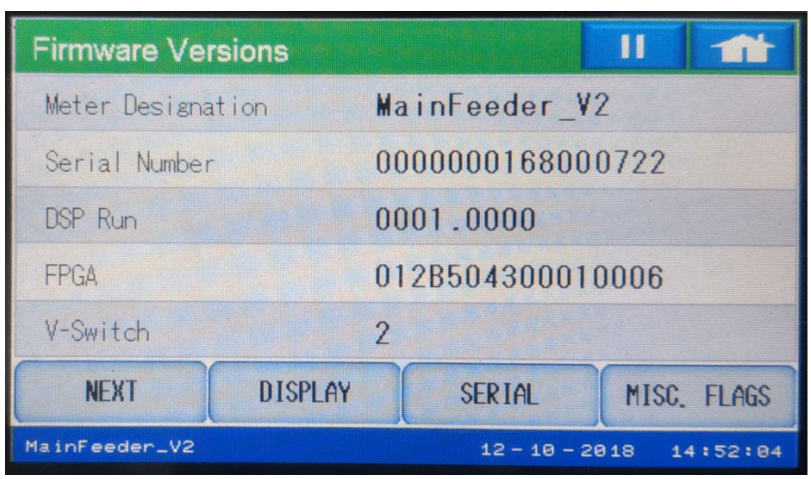
Click Port 2-Port 4 to view settings for the meter's other ports.





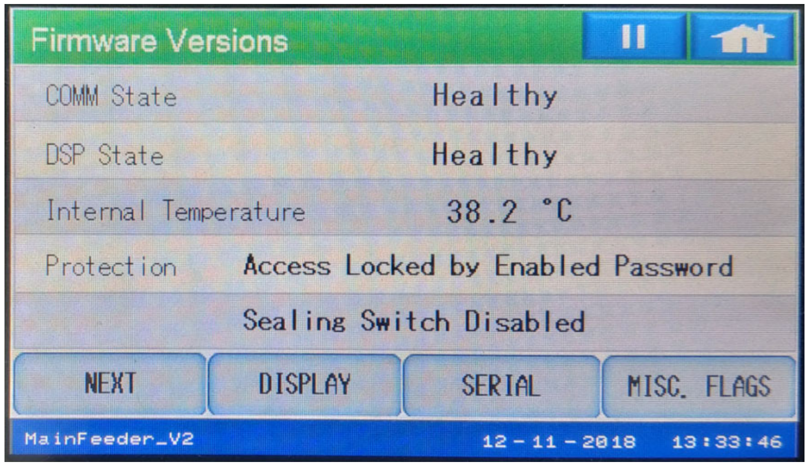
Firmware Versions (for EPM 9700)

Click **Firmware** to display the first **Firmware Versions** screen.



This screen displays the **Meter Designation** (meter name), the meter serial number, digital signal processor (DSP) runtime and FPGA firmware versions, and the meter's Software Option.

Touch **Next** to display the second **Firmware Versions** screen.

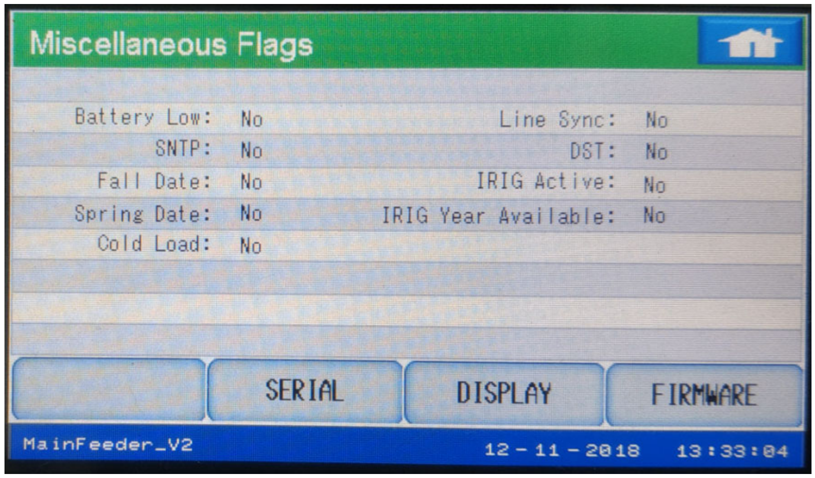


This screen displays the state of the meter's communication processor and DSP, the temperature of the meter in Celsius, and whether password protection and the meter's sealing switch are enabled.

Miscellaneous Flags (for EPM 9700)

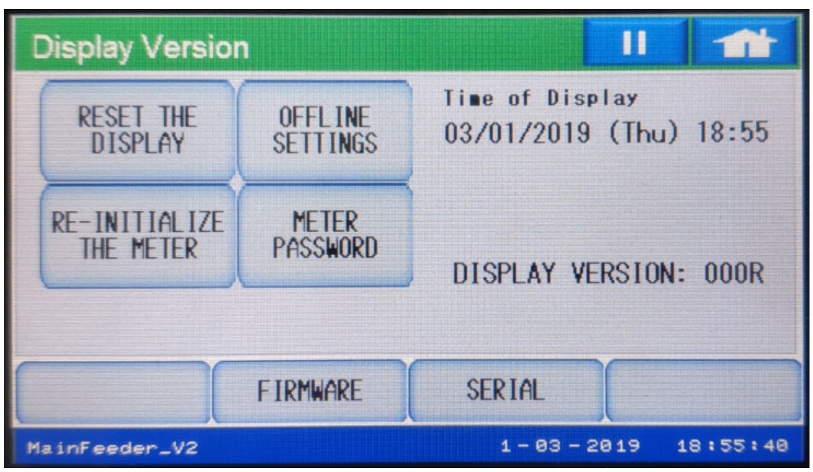
Touch Misc. Flags to display the Miscellaneous Flags screen, which shows the following information:

- **Battery Low**: whether the meter battery is low.
- **SNTP**: whether SNTP time synchronization is enabled for the meter.
- **Fall Date:** whether current date and time are after the Daylight Savings Time (DST) ending time of the current year.
- **Spring Date:** whether the current date is before the DST period of the current year.
- **Cold Load**: whether cold load pickup is enabled in the meter.
- **Line Sync:** whether line frequency time synchronization is enabled for the meter.
- **DST:** whether DST is enabled for the meter.
- **IRIG Active:** whether IRIG-B time synchronization is enabled in the meter.
- **IRIG Year Available**: whether IRIG-B year information is available.



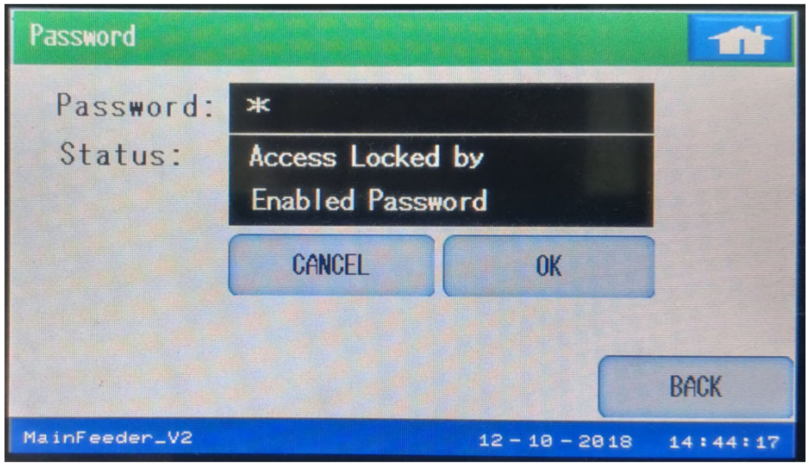
Display Version (for P70N)

Touch **Display** to see the P70N **Display Version** screen. The display version is shown; you can also reset the display to its default values, access the Offline settings screens, access the Password screen, and re-initialize the meter from this screen by touching the buttons for these tasks.

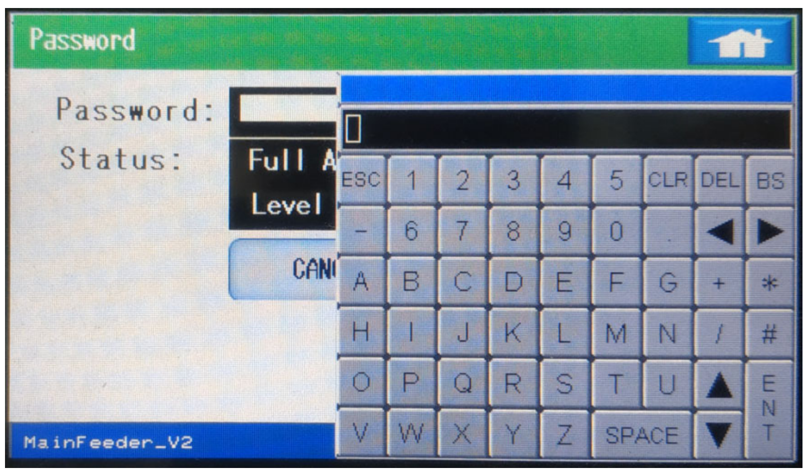


Password Screen

The **Password** screen opens if you try to perform an action that is password protected on the EPM 9700 meter, e.g., Resets.



Touch the **Password** field to display the password keypad, which you use to enter the password.



If the password entered is correct, you will be able to perform the action.

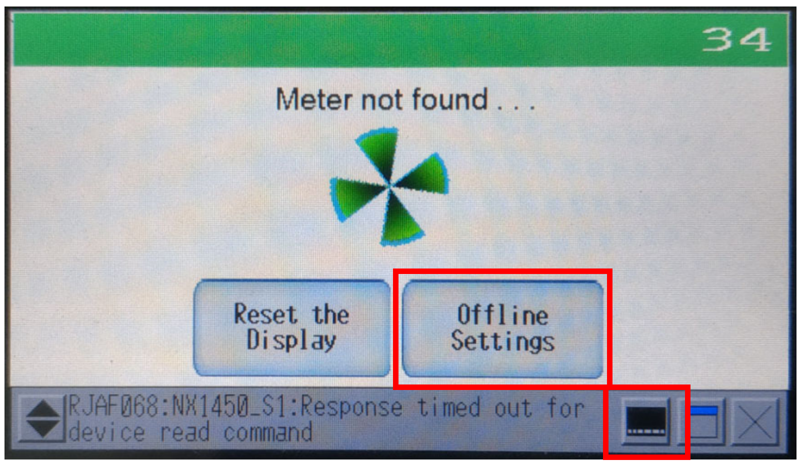
Offline Settings

You can use the **Offline Settings** screen to change the display's communication settings, such as baud rate, to choose the meter to connect to if the meter wasn't found, and/or to select a new meter.

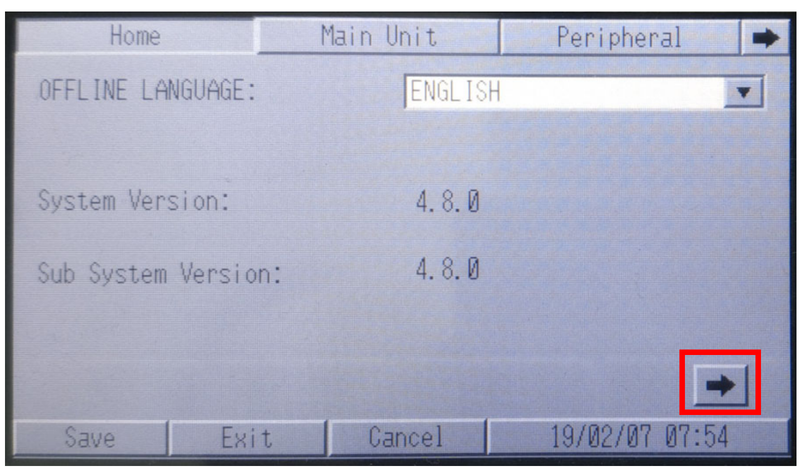
There are two ways to access the **Offline Settings** screen:

Touch Offline Settings from the Display Version screen - see *Display Version (for P70N)* on page 5–52.

Touch the **Offline Settings** icon or **Offline Settings** from an error message screen - see the image below.



The first **Offline Settings** screen is the **Home** screen, which displays information about the system, such as system and sub-system versions. Press the right arrow button at the bottom of the screen to see additional system information.



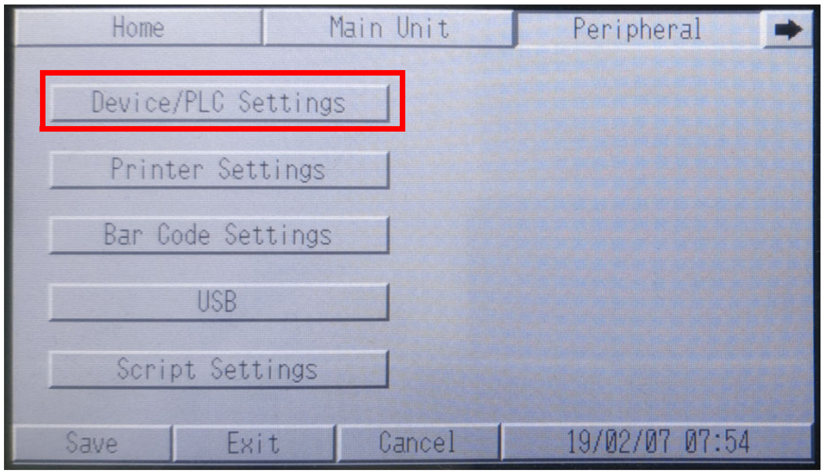
To access this screen from one of the other Offline screens, touch the **Home** tab at the top of the screen.

The buttons at the bottom of the screen let you save any setting changes and stay in Offline mode (**Save**), **Exit** Offline mode, with or without saving changes (**Exit** - you will see a confirmation screen that asks if you want to save changes and exit, or exit without saving changes), return settings to their previous state (**Cancel**).

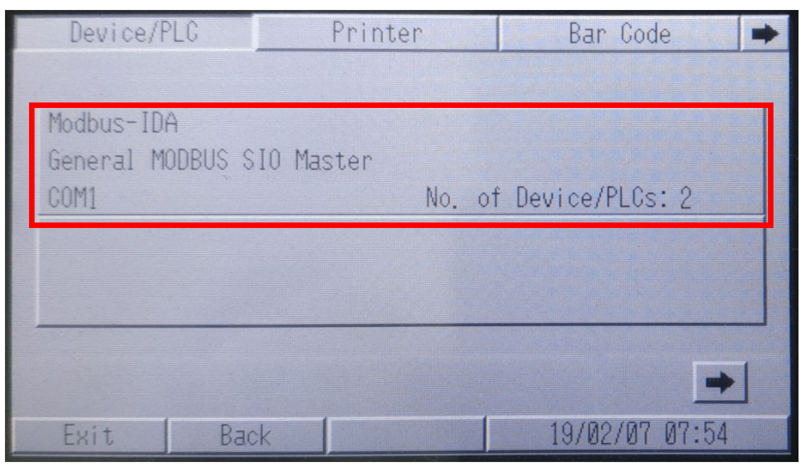
NOTE: In this manual we only describe in detail the Offline screens with settings you may need to change when working with the EPM 9700 meter.

Peripheral Tab

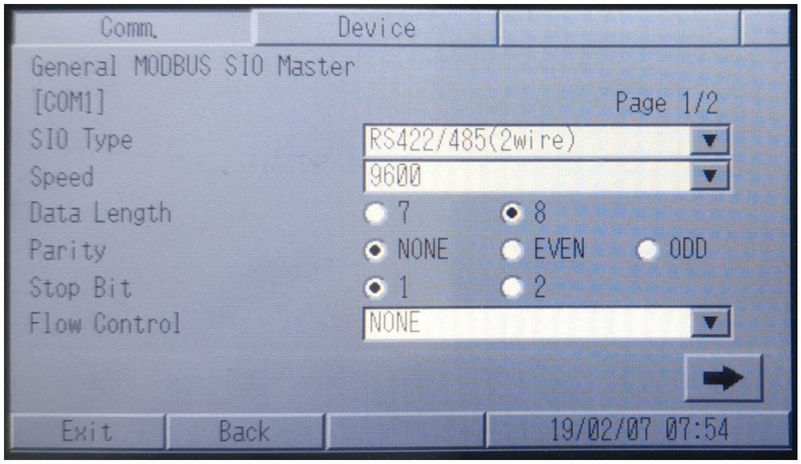
You can access device communication settings by first touching the **Peripheral** tab and then touching **Device/PLC Settings**.



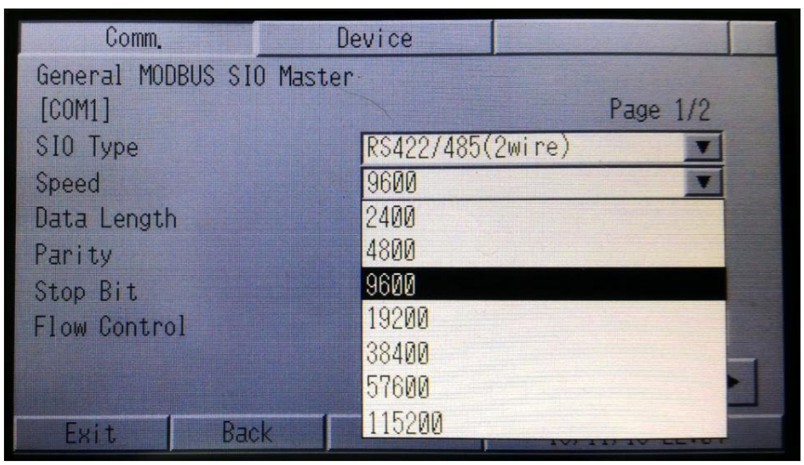
Touch the **Modbus-IDA** section to display communication details, such as baud rate.



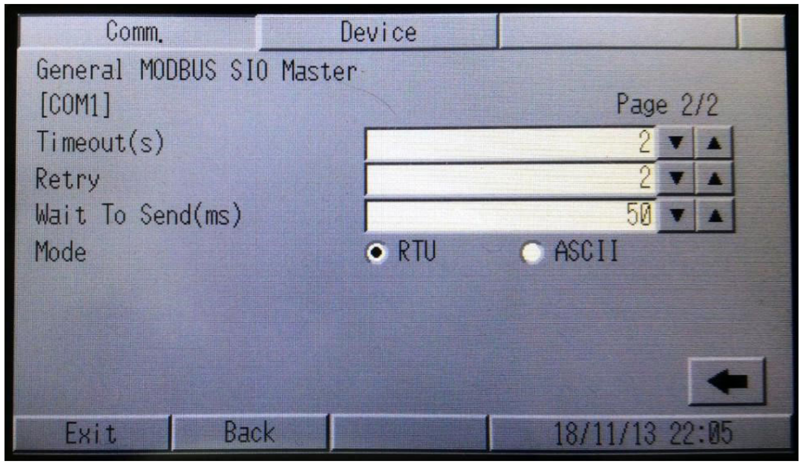
The screen below shows the display's communication settings: connection type (SIO Type), baud rate (Speed), data length, parity, stop bits, and flow control. The settings shown below are the device's default communication settings.



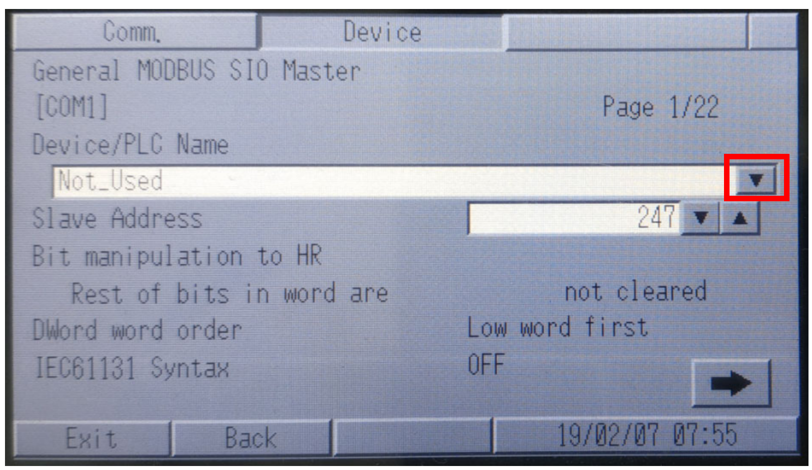
If the display is offline, you can use this screen to set the correct connection. For example, if you need to correct the baud rate, touch the arrow in the Speed field and select the Baud rate you want to use (the display's default Baud rate is 9600).



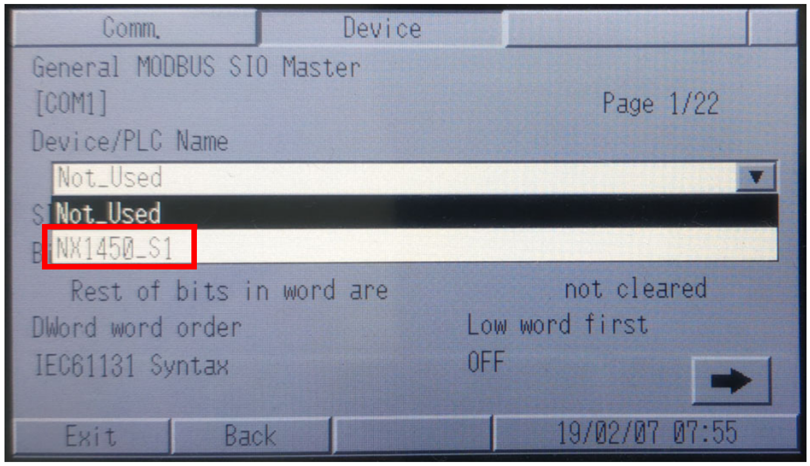
Touch the arrow button at the bottom right of the screen to display additional settings: Timeouts (the number of allowable timeouts in communication), Retry (the number if times the display should try again to communicate with the meter), Wait to Send ms (the number of ms the display should wait before sending data to the meter, and Mode (the protocol being used - Modbus RTU or ASCII - the default is Modbus RTU). The settings shown are the firmware's default settings.



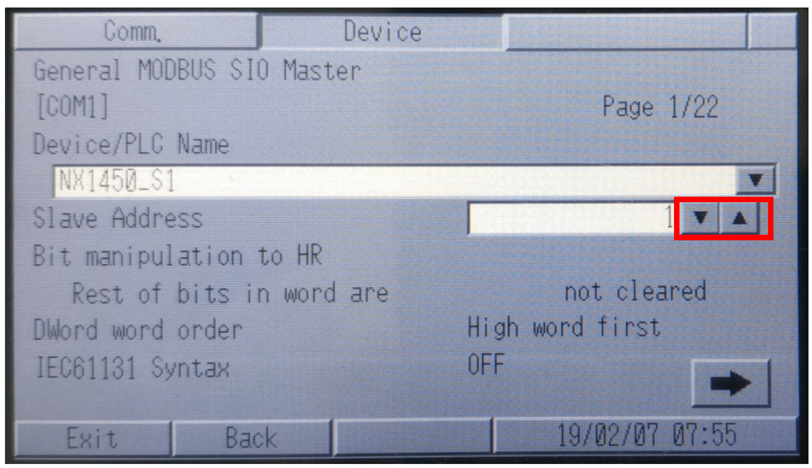
Touch the **Device** tab to view the connected meter information. If the meter is not connected, you will see the screen below, with **Not_Used** in the **Device/PLC Name** field. Click the arrow in the field to display the meter to connect to.



The meter's name - NX1450_S1- is displayed, as shown in the example screen below. Select the meter by touching its name

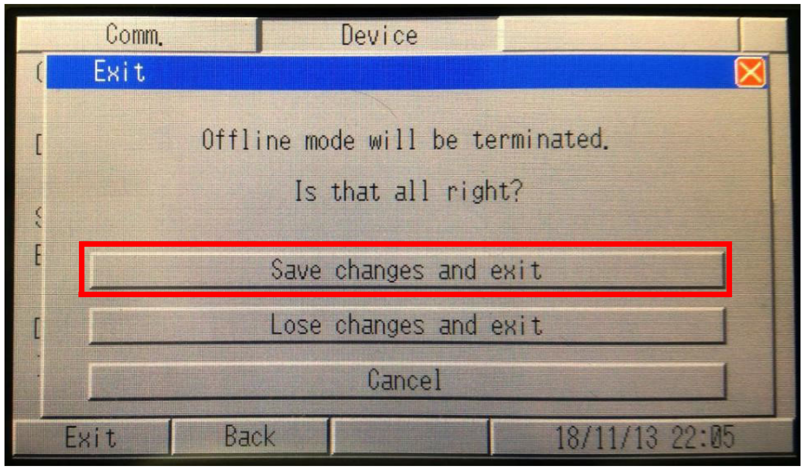


The meter is now shown in the **Device/PLC Name** field.



If the meter is at a different Modbus address (**Slave Address** field), you can change the Modbus address by touching the arrow in the field and selecting the number you need.

Touch **Exit** when you are finished with the settings. You will see the screen shown below.



To save your changes, touch **Save Changes and exit**. The display will reset and attempt to connect to the meter using the settings you programmed.

5.3.4 Updating the Display Firmware

To check the current firmware version of your display, refer to *Display Version (for P70N)* on page 5–52. To upgrade the display firmware. contact the GE Technical Support team.

Multilin EPM 9700

Chapter 6: Transformer Loss Compensation

This chapter explains the Transformer Loss Compensation implemented in the EPM 9700 meter. See B.1 *Transformer Line/Loss Compensation* on page B–1 for a detailed explanation of Transformer Loss Compensation.

6.1 EPM Meter Transformer Loss Compensation

- Performs calculations on each phase of the meter for every measurement taken. Unbalanced loads are accurately handled.
- Calculates numerically, eliminating the environmental effects that cause inaccuracies in electromechanical compensators.
- Performs Bidirectional Loss Compensation.
- Requires no additional wiring; the compensation occurs internally.
- Imposes no additional electrical burden when performing Loss Compensation.

Loss Compensation is applied to 1 second per phase Watt/VAR readings and, because of that, affects all subsequent readings based on 1 second per phase Watt/VAR readings. This method results in loss compensation being applied to the following quantities:

- Total Power
- Demands, per Phase and Total (Thermal, Block (Fixed) Window, Rolling (Sliding) Window and Predictive Window)
- Maximum and Minimum Demands
- Energy Accumulations
- KYZ Output of Energy Accumulations

The EPM 9700 meter provides compensation for active and reactive power quantities by performing numerical calculations. The factors used in these calculations are derived by clicking the TLC Calculator button on the Transformer Loss screen of the Device Profile, to open the TLC Calculator. The GE Communicator software allows you to enable Transformer Loss Compensation for Losses due to Copper and Iron, individually or simultaneously. Losses can either be added to or subtracted from measured readings.

Loss compensation values must be calculated based on the meter installation. As a result, transformer loss values must be normalized to the meter by converting the base voltage and current and taking into account the number of elements used in the metering installation. For three-element meters, the installation must be normalized to the phase-to-neutral voltage and the phase current; in two-element meters the installation must be normalized to the phase-to-phase voltage and the phase current. This process is described in the following sections.

6.1.1 Loss Compensation in Three Element Installations

Loss compensation is based on the loss and impedance values provided on the transformer manufacturer's test report. A typical test report will include at least the following information:

- Manufacturer
- Unit Serial Number
- Transformer MVA Rating (Self-Cooled)
- Test Voltage
- No Load Loss Watts
- Load Loss Watts (or Full Load Loss Watts)
- % Exciting Current @ 100% voltage
- % Impedance

The transformer MVA rating is generally the lowest VA rating (the self-cooled or OA rating) of the transformer winding. The test voltage is generally the nominal voltage of the secondary or low voltage winding. For three-phase transformers these values will typically be the three-phase rating and the phase-to-phase voltage. All of the test measurements are based on these two numbers. Part of the process of calculating the loss compensation percentages is converting the transformer loss values based on the transformer ratings to the base used by the meter.

Correct calculation of loss compensation also requires knowledge of the meter installation. In order to calculate the loss compensation settings you will need the following information regarding the meter and the installation:

- Number of meter elements
- Potential Transformer Ratio (PTR)
- Current Transformer Ratio (CTR)
- Meter Base Voltage
- Meter Base Current

This section is limited to application of EPM 9700 meters to three-element metering installations. As a result, we know that:

- Number of metering elements = 3
- Meter Base Voltage = 120 Volts
- Meter Base Current = 5 Amps

Multilin EPM 9700

Chapter 7: Time-of-Use Function

7.1 Introduction

In response to both higher energy costs and concern for energy conservation (oftentimes spurred on by governmental regulations), many utilities have adopted strategies for load management. Time of Use (TOU) metering is one of these strategies. TOU is a means of accumulating usage during specified time periods with the purpose of billing with different rates for the different periods; for example, off-peak versus on-peak usage, and weekday versus weekend usage. So, a TOU usage structure takes into account both the quantity of energy used and the time at which it was consumed. TOU metering by utilities lets them charge a higher rate for electricity used when it is more expensive to produce and distribute, i.e., a Peak Demand period. In this way the utility tries to reward usage during lower demand periods and curtail usage during higher demand periods, by charging more or less for equivalent energy use.

The EPM 9700 meter's TOU function, available with the GE Communicator software application, lets you set up a TOU profile to meet your application needs. It has been developed to offer a variety of programmable rate structures, for maximum flexibility. Once programmed, the EPM 9700 meter's TOU function accumulates data based on the time-scheme you programmed into the meter. See the figure on the next page for a graphical representation of TOU.

See Chapter 15 of the *GE Communicator Instruction Manual* for details on programming the EPM 9700 meter TOU profile and retrieving TOU data.

Time of Use

Energy use is binned according to the time it is used, so that it can be billed for appropriately.

To set up the bins (that is, the rates), you can use:

Seasons 1-4

Months 1-12

Type of Days (Weekend/Weekday/Holiday)

Time of Day Bins (Rates)

For Example: Off-Peak=Lowest Energy Usage Cost
On-Peak=Highest Energy Usage Cost
Shoulder Peak=Middle Energy Usage Cost

TOU example: Season One, Month 1

Weekdays
Off Peak 12 am-7:59am
On Peak 8 am - 5:59pm
Shoulder Peak 6 pm - 7:59 pm
Off Peak 8 pm-11:59pm

Weekends
Off Peak 12 am-11:59pm

Holidays
Off Peak 12 am-11:59pm

Monday: the day's usage is binned as shown below:

Energy Used: **12am-7:59 am** **8am-5:59pm** **6pm-7:59pm** **8pm-11:59pm**

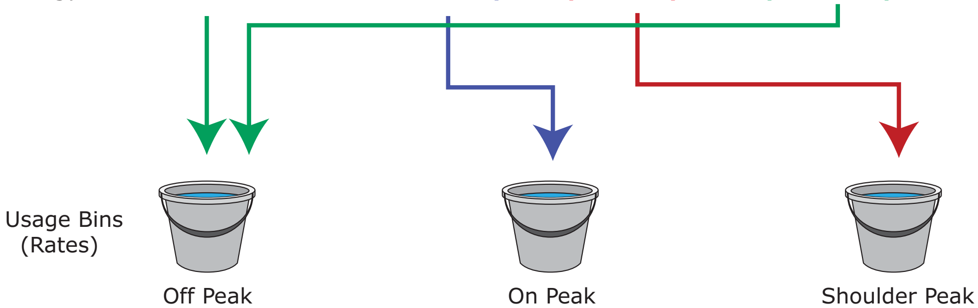


Figure 7-1: Time of Use

7.2 EPM 9700 Meter TOU Profile

An EPM 9700 meter's TOU profile sets the parameters for TOU data accumulation into rate bins. Features of the meter's TOU implementation include:

- The meter uses a perpetual TOU scheme, so you only need to set up the TOU profile once and then you can apply it to all subsequent years.
- You can save the TOU profile as a file and easily import it into any other EPM 9000 series meters that you have.
- You can set up to 16 daily schedules, e.g., Weekday, Weekend, or Holiday, or any type of daily schedule you need.
- You can set up to four Season types, which can also be customized as daily or weekly schedules.
- You can set up to 12 Month types.
- Season and month end time can be customized as needed.
- The meter has 38 available accumulators for TOU; 16 accumulators can be tracked in a TOU profile.

7.3 TOU Prior Season and Month

The EPM 9700 meter stores accumulations for the prior season and the prior month. When the end of a billing period is reached, the current season or month is stored as the prior data. The registers are then cleared and accumulations resume, using the next set of TOU schedules and register assignments from the TOU profile. Prior and current accumulations to date are always available.

7.4 Updating, Retrieving and Replacing the TOU Profile

GE Communicator software retrieves the TOU Profile from the EPM 9700 meter or from the computer's hard drive for review and edit. Accumulations do not stop during TOU profile updates, but once you have made your changes and updated the meter, the meter performs a self-read and the current month and season data blocks are moved to the prior data blocks, and the current data blocks and all accumulator "buckets" are cleared. See the *GE Communicator Instruction Manual* for instructions on updating the TOU profile.

7.5 Daylight Savings and Demand

To enable Daylight Savings Time for the meter: from the Device Profile menu click **General Settings > Time Settings**. In the Time Settings screen, click **Auto DST,** which sets Daylight Savings Time automatically (for the United States only). You can also select User Defined and enter the desired dates for Daylight Savings Time. See the *GE Communicator Instruction Manual* for instructions.

To set Demand intervals: from the Device Profile menu click **Revenue and Energy Settings > Demand Integration Intervals** and set the desired intervals. See the *GE Communicator Instruction Manual* for instructions.

To set Cumulative Demand Type, from the Device Profile menu click **Revenue and Energy Settings > Cumulative Demand Type** and select Block or Rolling Window Average. See the *GE Communicator Instruction Manual* for instructions.

Multilin EPM 9700

Chapter 8: IEC 61000-4-30/EN 50160 Reporting

The EPM 9700 meter has IEC 61000-4-30 Class A, Edition 3 Power Quality Compliance analysis for Flicker and other power quality measurements. This chapter explains how to program the meter, how to view polling screens, and how to view reports, for these power quality monitoring and reporting features. See B.2 *IEC 61000-4-30/EN 50160 Reporting* on page B–3, for additional information on these features.

The accuracy table for parameters measured by IEC 61000-4-30 Class A Edition 3 is shown in the table below:

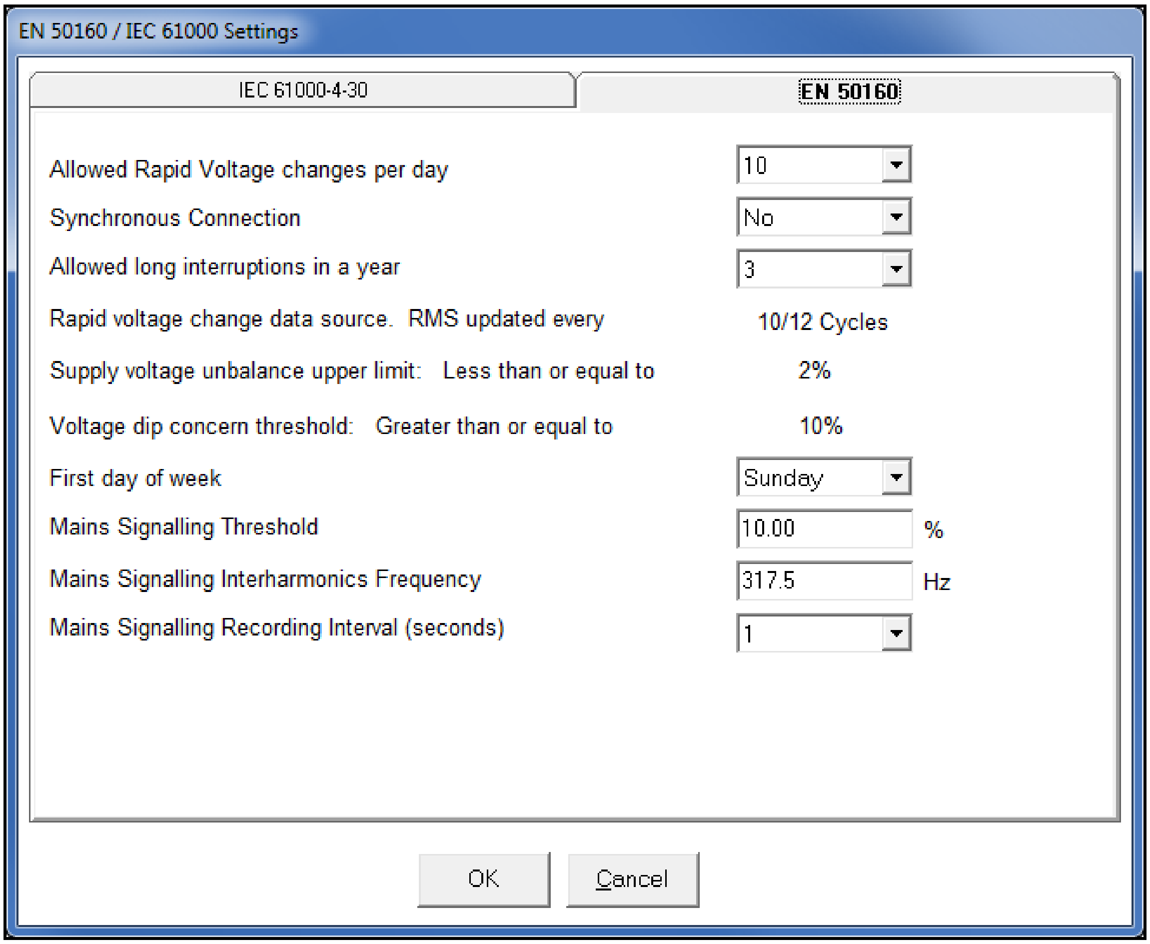
Parameter	Accuracy	Range
Frequency	0.001 Hz (10 s)	(42.5 to 69.5) Hz
Voltage/Current Unbalance	±0.15%	0.5% to 5% u2 0.5% to 5% u0
Harmonics/Interharmonic subgrouping	±2.5%	10% to 200% of Class 3 of IEC61000-2-4
Voltage Sag/Swell Duration Depth	 1/2 cycle ±0.2%	 4.97 hour maximum 10% to 200% of Udin
Interruption duration	1/2 cycle	4.97 hour maximum
Rapid Voltage Change (RVC) Duration Umax Uss	 1/2 cycle ±0.2% ±0.2%	 4.97 hour maximum 10% to 200% of Udin 10% to 200% of Udin
Mains Signalling Voltage	±5% Um Um ≥ 1% of Unom ±0.05% Unom Um ≤ 1% of Unom	10% to 200% of Class 3 of IEC61000-2-4
Overdeviation and Underdeviation	±0.2% (cycle reading)	10% to 200% of Udin
Flicker	0.5 of reading	0.2 to 10 of Pst
Real Time Clock	±3.5ppm	(-25 to +70) ^{o}C
Timestamp (IRIG synch)	0.1 ms	

8.1 EN 50160/IEC 61000-4-30 Settings

NOTE

Since the EN 50160 reporting has specific requirements for programming, it is recommended that you refer to the IEC 61000-4-30 2008 standard when making settings for the meter.

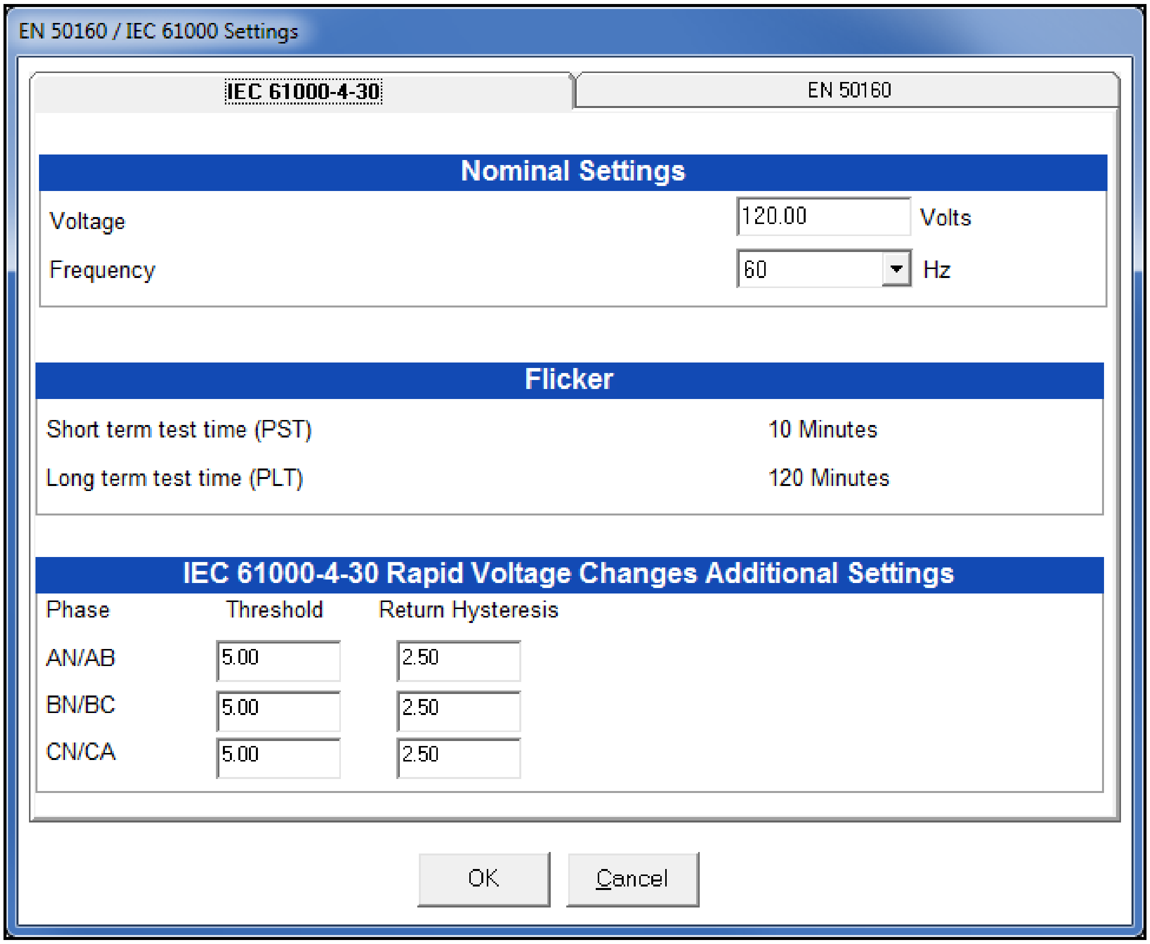
1. From the Device Profile screen double-click on the EN50160/IEC 61000-4-30 Flicker line. You will see the following screen, which has two tabs.



2. The initial tab is the EN 50160 tab. Some of the fields are display only and cannot be changed. You can select the following settings from their pull-down menus:
   - **Allowed Rapid Voltage changes per day:** this field determines how many rapid voltage variations are allowed before they are considered a fault condition, and reported - select between 1 and 50.
   - **Synchronous Connection:** this field specifies whether the system has a synchronous connection to another system - select Yes or No.
   - **Allowed long interruptions in a year:** this field determines how many long voltage interruptions per year are allowed, before they are considered a fault, and reported - select between 1 and 100.

- **Rapid Voltage Change Data Source, RMS updated every (10/12) cycles:** this setting can't be changed.
- **Supply voltage unbalance upper limit:** Less than or equal to (2%): this setting can't be changed.
- **Voltage dip concern threshold:** Greater than or equal to (10%): this setting can't be changed.
- **First day of the week:** for the report, select Sunday or Monday as the first day of the week.
- Mains Signaling Threshold:
  This setting and the next one (Mains Signaling Interharmonics Threshold Frequency) are for the Mains Signaling voltage, which is a burst of signals (often at a non-harmonic frequency) that remotely control industrial equipment, energy meters, and other devices. In this setting, enter the pass thresholds for the Mains signaling voltage (this is a percentage); e.g., if you set the threshold at 99.00, 99% or better will be considered a pass and anything less than 99% will be considered a fail.
- Mains Signaling Interharmonics Threshold Frequency: enter the interharmonic frequency for the test. When this interharmonic exceeds the detection threshold, reporting is made. See the IEC 61000-4-30 standard's Section 5.10.1 for more details on this setting.
- Mains Signaling Recording Interval (seconds): if your meter supports IEC 61000- 4-30 Edition 3, you can select an interval (from 1 to 120 seconds) for recording - (not all meters support this).

3. Click the IEC-61000-4-30 tab.



4. Enter:
   - **Voltage:** enter the Nominal voltage.
   - **Frequency (50 or 60Hz):** this field is used to calculate the harmonics and interharmonics associated with the set fundamental frequency. Select the frequency from the pull-down menu.
5. Short Term Test Time and Long Term Test Time are display only and cannot be changed.
6. IEC 61000-4-30 Rapid Voltage Change Additional Settings: for meters that support Edition 3, you can set a Threshold (the % of the voltage Full Scale for each channel) and Return Hysteresis (the % of the voltage Full Scale for each channel) per phase AN/AB, BN/BC, and CN/CA.

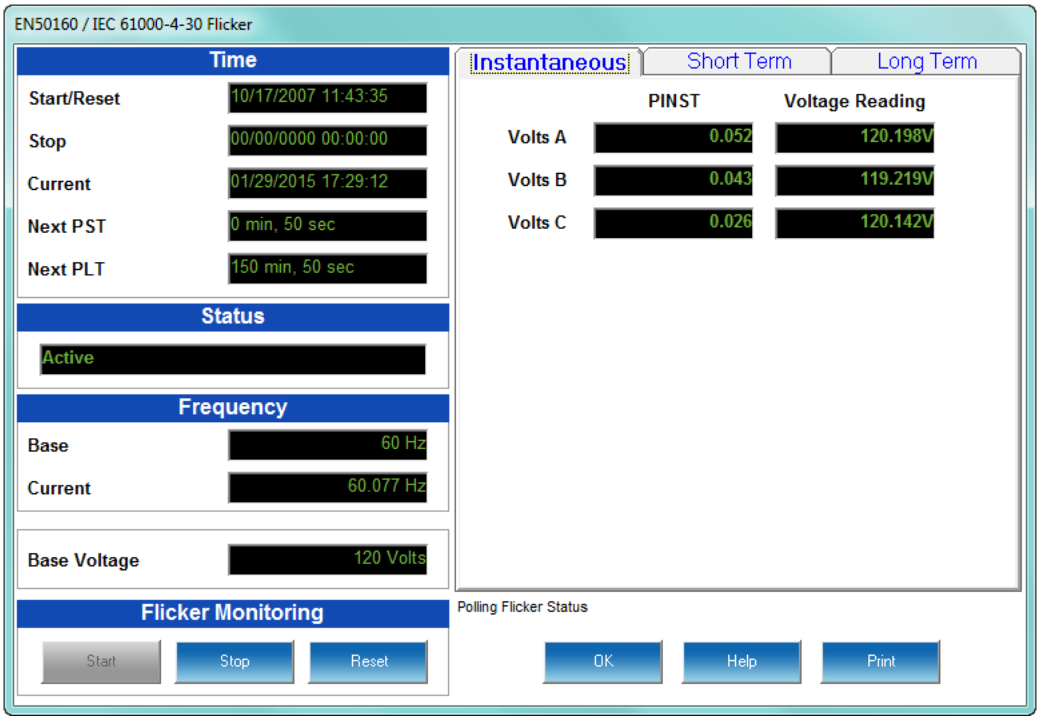
NOTE

- The default for the Threshold value is 3% and the default for the Hysteresis Value is 1.5%.
- Make sure that the Threshold setting does not exceed the Dip/Swell threshold settings; and that the Hysteresis does not exceed the Threshold settings.

7. When all changes have been entered, click **OK** to return to the main Device Profile screen. For any changes to take effect, you must click the Update Device button to send the new profile to the meter. Note that Flicker is discussed in detail in the *GE Communicator Instruction Manual*.

8.2 Flicker Polling Screen

1. From the GE Communicator application's Title bar, select **Real-Time Poll>Power Quality and Alarms>Flicker**. You will see the screen shown below.



Main screen:

This section describes the Main Screen functions. These functions are found on the left side of the screen.

Time

- Reset is the time when Flicker was reset. A Reset of Flicker causes the Max/Min values to be cleared and restarts the Flicker Pst and Plt timers.
- Current is the current clock time.
- Next Pst is the countdown time to when the next Pst value is available.
- Next Plt is the countdown time to when the next Plt value is available.

Status

- This screen indicates the current status: Active = On.

Frequency

- Base is the operating frequency (50 or 60 Hz) selected in the EN50160 Flicker screen (see 8.1 *EN 50160/IEC 61000-4-30 Settings* on page 8–2).

- Current is the real-time frequency measurement of the applied voltage.

Base Voltage

- This field shows the normalized voltage for the selected frequency (230 V for 50 Hz or 120 V for 60 Hz).

Flicker Monitoring

- Clicking on **Reset** causes the Max/Min values to be cleared and restarts the Flicker Pst and Plt timers.

Use the tabs at the top of the screen to navigate to the Instantaneous, Short Term, and Long Term Readings views, shown on the right side of the screen.

Instantaneous Readings

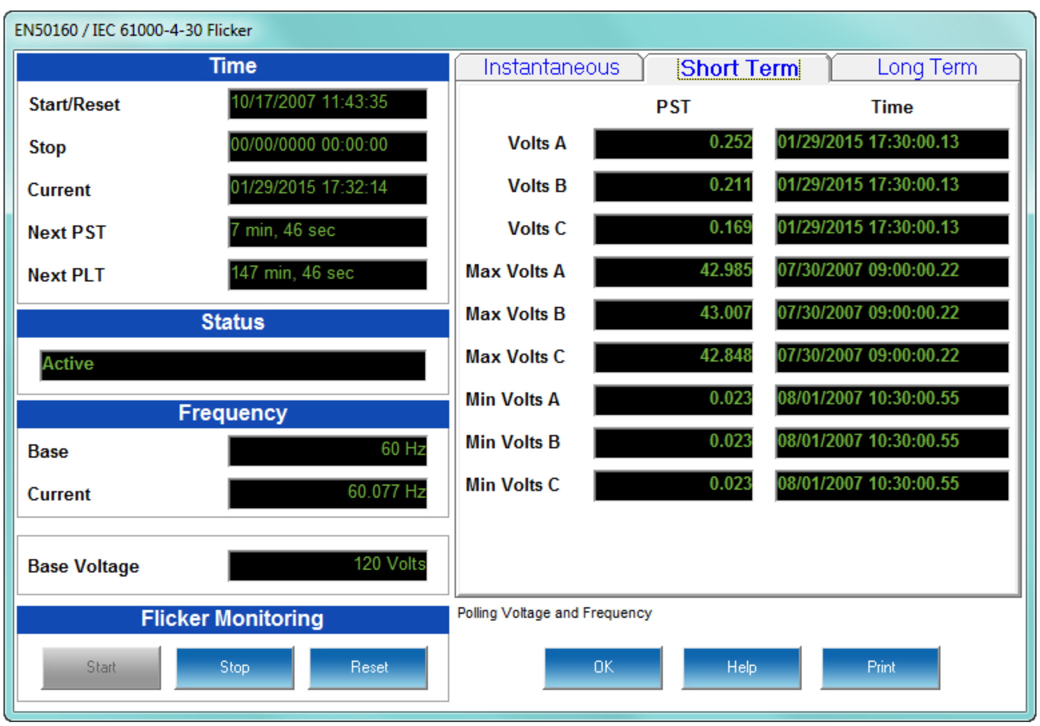
NOTE

The Instantaneous view is the default of this screen. (See the screen pictured on the previous page.) If you are in the Short or Long Term views, click on the Instantaneous tab to display this view.

- The PU values, Pinst for Voltage Inputs V A, V B and V C are displayed here and are continuously updated. The corresponding Current Voltage values for each channel are displayed for reference.

Short Term Readings

Click on the Short Term tab to access a screen containing three groups of Pst readings (shown below).



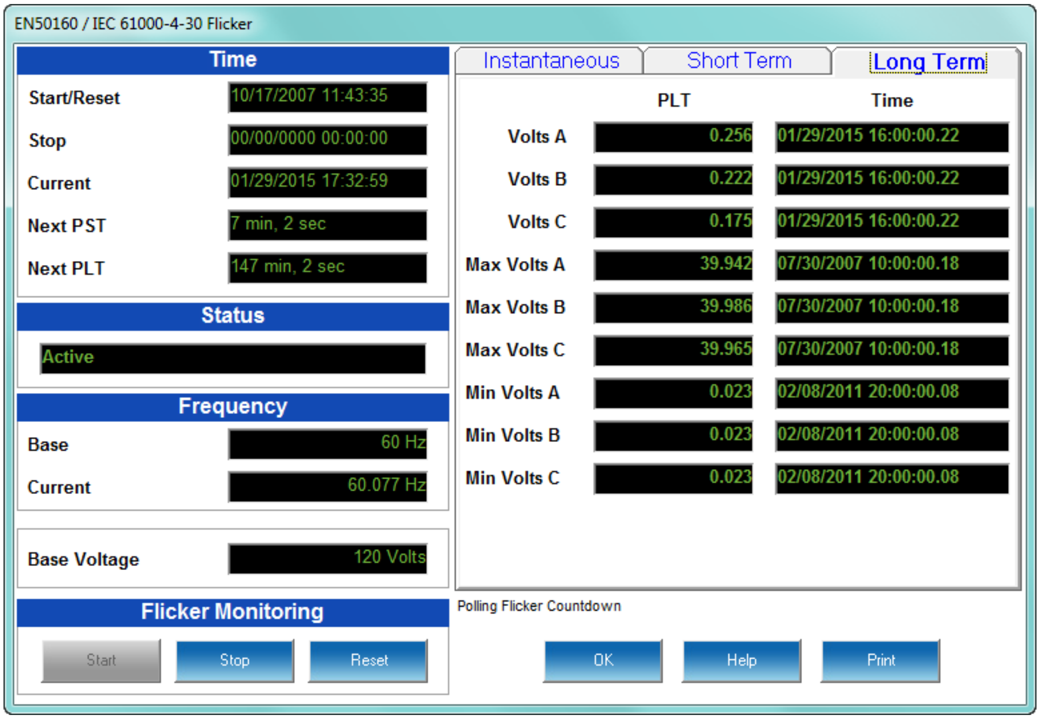
Pst readings displayed:

- Current Pst values for V A, V B and V C and the time of computation
- Current Pst Max values for V A, V B and V C since the last reset and the time of the last reset

- Current Pst Min values for V A, V B and V C since the last reset and the time of the last reset

Long Term Readings

Click on the Long Term tab to access a screen containing three groups of Plt readings (shown below).



Plt readings displayed:

- Current Plt values for V A, V B and V C and the time of computation
- Current Plt Max values for V A, V B and V C since the last reset and the time of the last reset
- Current Plt Min values for V A, V B and V C since the last reset and the time of the last reset

Click **OK** to exit the EN50160/IEC 61000-4-30 Flicker Polling screen; click **Print** to print all of the Readings views.

8.3 Logging and Analysis

The EPM 9700 meter logs Flicker values automatically in the EN 50160 10 Minute log. By default, Pst and Plt values are entered into the log every 10 minutes. All values can be downloaded to the Log Viewer where they are available for graphing or export to another program, such as Excel. All Flicker values are predefined and cannot be changed. Refer to the *GE Communicator Instruction Manual* for additional instructions concerning the Flicker log.

NOTE

A full week of logging is necessary before an EN 50160/IEC 61000-4-30 report for analysis can be created.

1. To download the log, from the GE Communicator application's **Main** screen, either click **Logs > Retrieve Logs from Device(s)** from the Title bar or click the **Retrieve Logs** icon from the Icon bar. You will see the screen shown below.

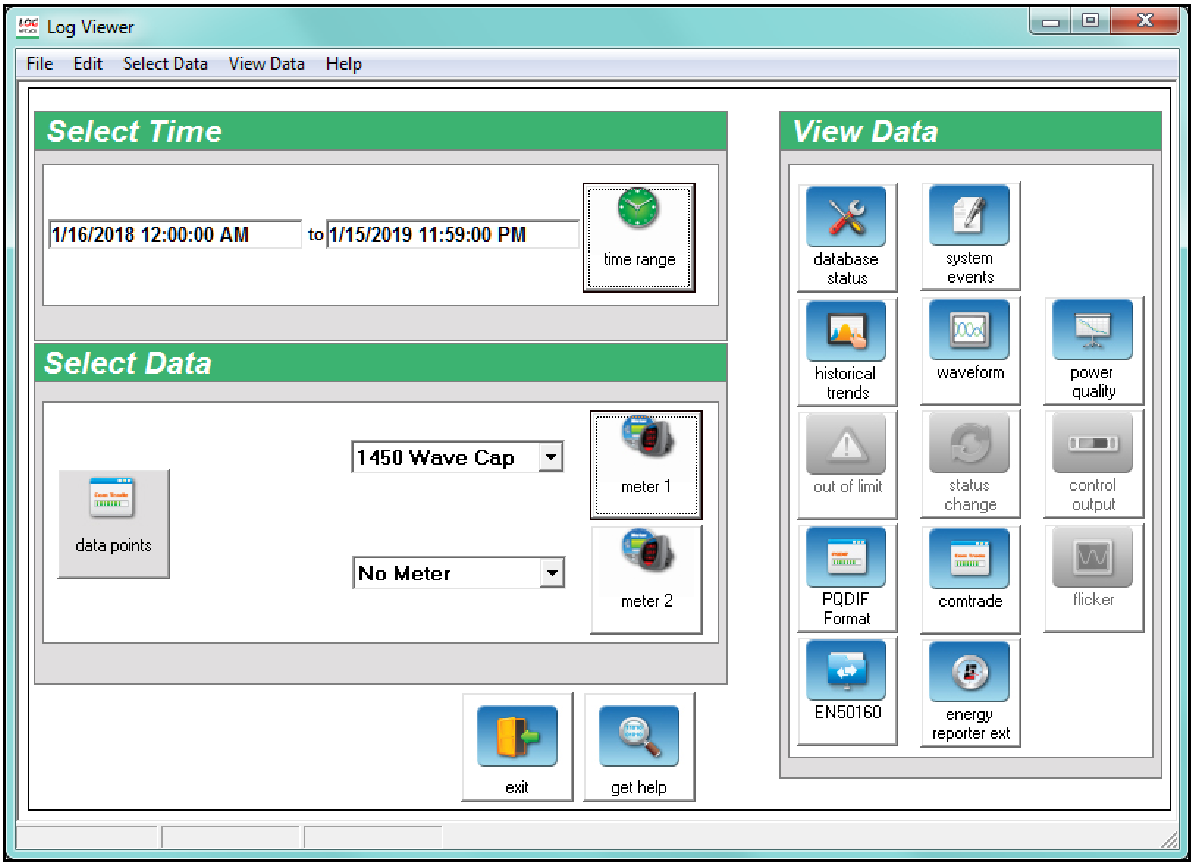
Log Status for 0177962133__0000000177962133

Log	Memory Used (%)	Records	Maximum Records	Newest Record	Oldest Record	Select	Status
Historical Core	14.7%	2415	16384	2019/07/29 15:15:00	2019/07/03 11:00:00	☐	Available
Historical 1	14.8%	2418	16384	2019/07/29 15:15:00	2019/07/03 11:15:00	☐	Available
Historical 2	14.7%	2406	16384	2019/07/29 15:15:00	2019/07/03 14:15:00	☐	Available
Historical 3	14.8%	2418	16384	2019/07/29 15:15:00	2019/07/03 11:15:00	☐	Available
Historical 4	14.8%	2418	16384	2019/07/29 15:15:00	2019/07/03 11:15:00	☐	Available
Historical 5	14.8%	2418	16384	2019/07/29 15:15:00	2019/07/03 11:15:00	☐	Available
Historical 6	14.8%	2418	16384	2019/07/29 15:15:00	2019/07/03 11:15:00	☐	Available
Historical 7	0.0%	0	16384			☐	Not Available
Historical 8	0.0%	0	16384			☐	Not Available
Event Triggered	0.0%	0	16384			☐	Not Available
System Event	8.7%	5673	65536	2019/07/29 14:32:31	2019/05/10 13:59:21	☐	Available
Digital Inputs	0.0%	0	16384			☐	Not Available
Limits	100.0%	16384	16384	2019/07/29 15:27:00	2019/07/10 03:57:00	☐	Available
Power Quality	100.0%	16384	16384	2019/07/29 15:27:00	2019/07/13 06:03:00	☐	Available
Waveform	100.0%	1365	1365	2019/07/29 15:27:00	2019/07/28 06:26:59	☐	Available
Flicker	0.0%	0	16384			☐	Not Available

2. Click on the Select box in line with the EN 50160 10 Minute log.

3. Click **Start** to begin retrieving the logs. GE Communicator software retrieves the selected logs and automatically creates a database for you. Pop-ups confirm the retrieval and conversion.

4. The Log Viewer opens.



5. Your meter is displayed next to Meter 1. If you want to view EN 50160/IEC 61000-4-30 information for a specific time range, e.g., for the last month only, click the Time Range button and select the range you want. See Chapter 19 in the *GE Communicator Instruction Manual* for detailed instructions on setting time range and other aspects of the Log Viewer.
6. Click the **EN 50160** button.
7. The screen that is displayed lists all of the weeks for which data has been collected, within the date range specified in the Log Viewer Main screen. Information provided includes:
   - Start/End Time of Week
   - Device Name
   - Nominal Frequency / Voltage
   - Pass / Fail Value for each component
8. Click on a week to select it and click the **Graph** button at the bottom of the screen. The EN 50160/IEC 61000-4-30 report is generated and opens on your PC. See the *GE Communicator Instruction Manual* for more information on the EN 50160/ IEC 61000-4-30 report.
9. To see Flicker values, from the main Log Viewer screen, click the Flicker icon.

The values and the associated time stamps (when the values occurred) are displayed in a grid box. Use the buttons at the bottom of the screen to create a graph or export the data to another program.

- Graphed values include Pst and Plt V A, V B and V C.

8.4 Polling through a Communication Port

The Pinst, Pst, Pst Max, Pst Min, Plt, Plt Max, Plt Min values can be polled through the Communications Port. Refer to the EPM 9700 meters' Modbus and DNP Mapping manuals for register assignments and data definitions.

8.5 Log Viewer

1. Open Log Viewer by selecting the Open Logs icon from GE Communicator application’s Icon bar.
2. Using the menus at the top of the screen, select a meter, time ranges and values to access.
3. Click the Flicker icon.

   The values and the associated time stamps (when the values occurred) are displayed in a grid box. Use the buttons at the bottom of the screen to create a graph or export the data to another program.
4. Graphed values include Pst and Plt V A, V B and V C.

8.6 Performance Notes

Pst and Plt average time are synchronized to the clock (e.g. for a 10 minute average, the times will occur at 0, 10, 20, etc.). The actual time of the first average can be less than the selected period to allow for initial clock synchronization.

If the wrong frequency is chosen (e.g. 50 Hz selection for a system operating at 60 Hz), Flicker will still operate but the computed values will not be valid. Therefore, you should select the frequency setting with care.

User settings are stored. If Flicker is on and power is removed from the meter, Flicker will still be on when power returns. This can cause gaps in the logged data.

The Max and Min values are stored, and are not lost if the unit is powered down.

Flicker meets the requirements of IEC 61000-4-15 and former IEC 868. Refer to those specifications for more details, if needed. Meters with the EN50160 option also meet the EN50160 conformance standards for Flicker. Refer to the *CGE Communicator Instruction Manual* for additional information.

Operation is at 230 V for 50 Hz and 120 V for 60 Hz as per specification. If the input voltage is different, the system will normalize it to 230 V or 120 V for computational purposes.

8.7 EN 50160 Report Setting (EPM 9700 meter with Software option B)

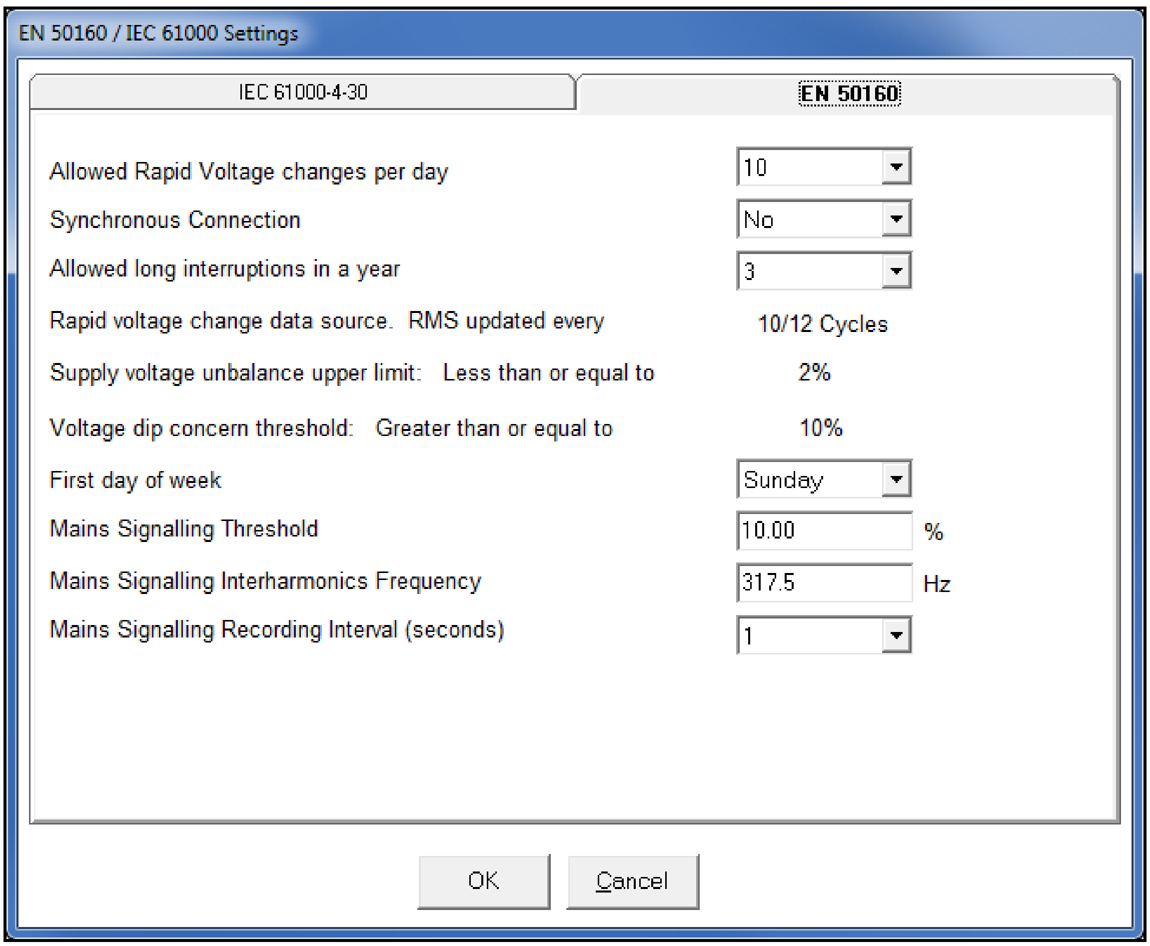
If your EPM 9700 meter is equipped with Software option B, you have access to the EN 50160 Compliance reporting function, as well as to Flicker measurement.

NOTE

Since the EN 50160 reporting has specific requirements for programming, GE recommends that you refer to the IEC 61000-4-30 2008 standard when making settings for the meter.

8.7.1 EN 50160 Configuration

1. Select the Profile icon from GE Communicator application's Icon bar.
2. From the Device Profile screen, double-click **Power Quality and Alarm Settings > EN50160/IEC 61000-4-30**.
3. Click the EN50160 tab.



4. The EPM 9700 meter has a pre-configured log which stores associated values every 10 minutes.
5. Make the following selections:

a. Allowed Rapid Voltage changes per day: select the acceptable number of Rapid Voltage Fluctuations per day.

b. Synchronous Connection: select YES for a system with a synchronous connection to another system, NO if there is no such synchronous connection.

c. Allowed long interruptions in a year: select the acceptable number of long interruptions in a year.

d. Rapid Voltage Change Data Source, RMS updated every (10/12) cycles: this setting can't be changed.

e. Supply voltage unbalance upper limit: Less than or equal to (2%): this setting can't be changed.

f. Voltage dip concern threshold: Greater than or equal to (10%): this setting can't be changed.

g. irst day of the week: select the day you want for the report's first day of the week.

h. Mains Signaling Threshold: This setting and the next one (Mains Signaling Interharmonics Threshold Frequency) are for the Mains Signaling voltage, which is a burst of signals (often at a non-harmonic frequency) that remotely control industrial equipment, energy meters, and other devices. In this setting, enter the pass thresholds for the Mains signaling voltage (this is a percentage); e.g., if you set the threshold at 99.00, 99% or better will be considered a pass and anything less than 99% will be considered a fail.

i. Mains Signaling Interharmonics Threshold Frequency: enter the interharmonic frequency for the test. When this interharmonic exceeds the detection threshold, reporting is made. See the IEC 61000-4-30 standard's Section 5.10.1 for more details on this setting.

6. Click **OK**.

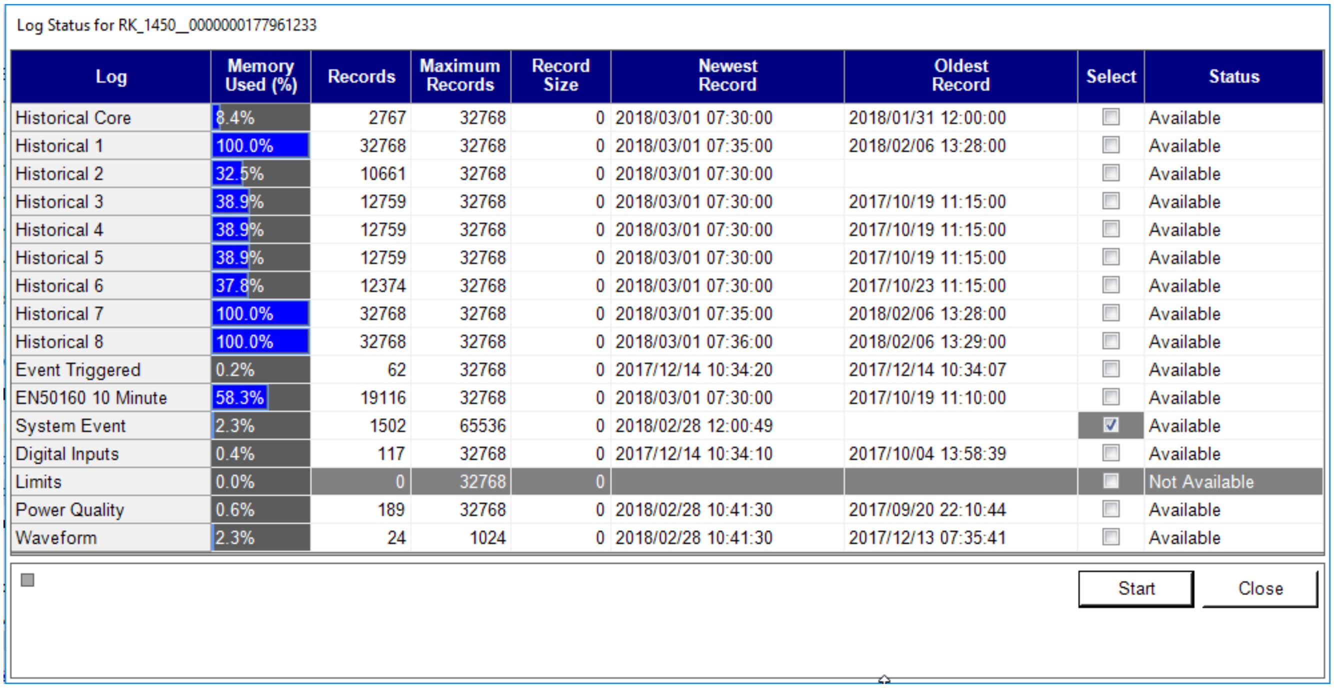
7. Click **Update Device** to send the new settings to the meter and return to the Main screen.

8.7.2 EN 50160/IEC 61000-4-30 Analysis

NOTE

A full week of logging is necessary before an EN50160/IEC 61000-4-30 analysis can be created.

1. From the GE Communicator application toolbar, click **Logs > Retrieve Logs from Device(s)** or click the **Retrieve Logs** icon. You will see the screen shown below.



Log Status for RK_1450__0000000177961233

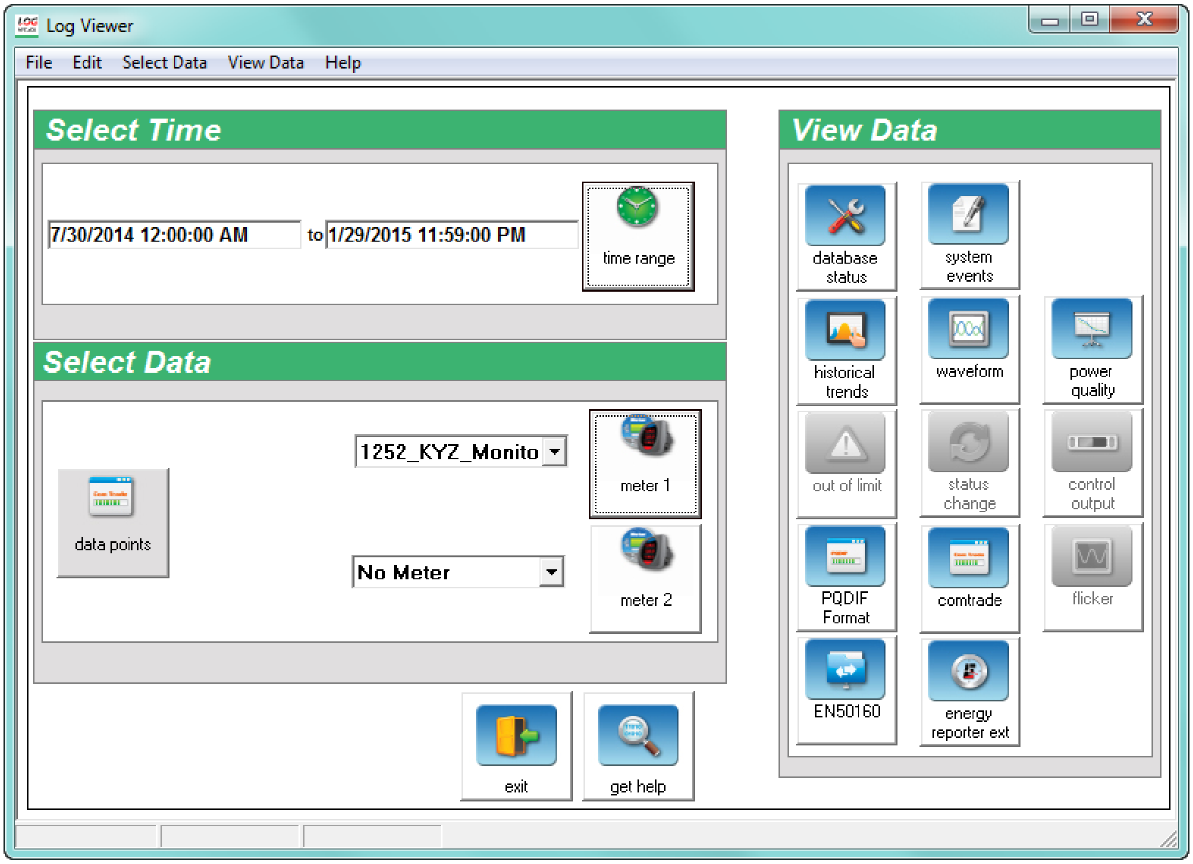
Log	Memory Used (%)	Records	Maximum Records	Record Size	Newest Record	Oldest Record	Select	Status
Historical Core	8.4%	2767	32768	0	2018/03/01 07:30:00	2018/01/31 12:00:00	☐	Available
Historical 1	100.0%	32768	32768	0	2018/03/01 07:35:00	2018/02/06 13:28:00	☐	Available
Historical 2	32.5%	10661	32768	0	2018/03/01 07:30:00		☐	Available
Historical 3	38.9%	12759	32768	0	2018/03/01 07:30:00	2017/10/19 11:15:00	☐	Available
Historical 4	38.9%	12759	32768	0	2018/03/01 07:30:00	2017/10/19 11:15:00	☐	Available
Historical 5	38.9%	12759	32768	0	2018/03/01 07:30:00	2017/10/19 11:15:00	☐	Available
Historical 6	37.8%	12374	32768	0	2018/03/01 07:30:00	2017/10/23 11:15:00	☐	Available
Historical 7	100.0%	32768	32768	0	2018/03/01 07:35:00	2018/02/06 13:28:00	☐	Available
Historical 8	100.0%	32768	32768	0	2018/03/01 07:36:00	2018/02/06 13:29:00	☐	Available
Event Triggered	0.2%	62	32768	0	2017/12/14 10:34:20	2017/12/14 10:34:07	☐	Available
EN50160 10 Minute	58.3%	19116	32768	0	2018/03/01 07:30:00	2017/10/19 11:10:00	☐	Available
System Event	2.3%	1502	65536	0	2018/02/28 12:00:49		☑	Available
Digital Inputs	0.4%	117	32768	0	2017/12/14 10:34:10	2017/10/04 13:58:39	☐	Available
Limits	0.0%	0	32768	0			☐	Not Available
Power Quality	0.6%	189	32768	0	2018/02/28 10:41:30	2017/09/20 22:10:44	☐	Available
Waveform	2.3%	24	1024	0	2018/02/28 10:41:30	2017/12/13 07:35:41	☐	Available

Start Close

2. Click on the Select box in line with the EN 50160 10 Minute log.

3. Click **Start** to begin retrieving the logs. GE Communicator software retrieves the selected logs and automatically creates a database for you. Pop-ups confirm the retrieval and conversion.

4. The Log Viewer opens.



5. Your meter is displayed next to Meter 1. If you want to view EN 50160/IEC 61000-4-30 information for a specific time range, e.g., for the last month only, click the Time Range button and select the range you want. See the *GE Communicator Instruction Manual* for detailed instructions on setting time range and other aspects of the Log Viewer.

6. Click the EN50160 button.

7. The screen that is displayed lists all of the weeks for which data has been collected, within the date range specified in the Log Viewer's Main screen. Information provided includes:
   - Start/End Time of Week
   - Device Name
   - Nominal Frequency / Voltage
   - Pass / Fail Value for each component

8. Click on a week to select it and click the Graph button at the bottom of the screen. The EN 50160/IEC 61000-4-30 report is generated and opens on your PC. See the *GE Communicator Instruction Manual* for more information on the EN 50160/ IEC 61000-4-30 report.

Multilin EPM 9700

Chapter 9: Ethernet Communication

9.1 Overview

The EPM 9700 meter has two Ethernet network communication ports: a standard RJ45 Ethernet port and a standard Fiber Optic Ethernet port. The standard RJ45 and Fiber Optic ports allow a EPM 9700 meter to communicate with multiple PCs simultaneously. The RJ45 jack and the Fiber Optic connections are both located on the front of the meter. This chapter explains these network options and gives instructions for setting them up.

Each Ethernet port supports up to 16 Modbus TCP/IP connections, with up to 28 total Modbus TCP/IP connections for the two ports; and 2 DNP connections per port (1 TCP and 1 UDP). Either one or both of the Ethernet ports can be configured to send email on an alarm condition and both offer port control. Note that when the email feature is enabled for both Ethernet ports, by default the first port is used to send the email. If that port's email fails, then the second port is used.

9.2 RJ45 Port

The EPM 9700 meter's Ethernet port conforms to the IEEE 802.3, 10BaseT and 100BaseT specifications using unshielded twisted pair (UTP) wiring.

The EPM 9700 meter's Ethernet port:

- Adheres to IEEE 802.3 Ethernet standard using TCP/IP
- Utilizes simple and inexpensive 10/100BaseT wiring and connections
- Plugs into your network using built-in RJ45 jack
- Is programmable to any IP address, subnet mask and gateway requirements

The RJ45 port allows multiple simultaneous connections (via LAN) to the EPM meter, allowing multiple users running GE Communicator software to access the meter concurrently.You can access the meter with SCADA, MV90 and RTU simultaneously.

NOTE

The EPM 9700 meter's Ethernet ports do not support network bonding and teaming. If two Ethernet ports are being used, they must be in different subnet domains.

9.2.1 Network Connection

Use standard RJ45 10/100BaseT cable to connect with the EPM meter. Insert the RJ45 line into the RJ45 Port on the face of an EPM 9700 meter. The RJ45 port's default IP address is 10.0.0.1. The switch under the RJ45 port should be set to FIXED to connect to the meter using the default IP address. To change the port's IP address, use the following steps and then move the switch to PROG before connecting to the meter using the new IP address: (Refer to the *GE Communicator Instruction Manual* for more detailed instructions.)

1. From the Device Profile screen, double-click **General Settings> Communications**, then double-click on any of the ports. The Communications Settings screen opens.
2. In the Network Settings section enter the following data. (Consult your System Administrator if you do not know this information.)

   IP Address:

   Subnet Mask:

   Default Gateway:
3. Click **OK** to return to the Device Profile screen.

Once the above parameters have been set, GE Communicator software connects via the network using a Device Address of "1" and the assigned IP Address when you follow these steps (remember to set the RJ45 switch to PROG if you have changed the IP address for the port to something other than the default IP address):

1. Open the GE Communicator application.
2. Click the **Connect** icon in the icon tool bar. The Connect screen opens.
3. Click the Network button at the top of the screen. Enter the following information:

   Device Address: 1

   Host: IP Address

   Network Port: 502

   Protocol: Modbus TCP
4. Click the **Connect** button at the bottom of the screen. GE Communicator software connects to the meter via the network.

NOTE

Refer to the note in4.2 *Communication Basics* on page 4–3 if you forget, or don't know, the RJ45 port's programmed IP address.

If the Ethernet link speed drops after initial power up of the meter or a restart, disconnect and then reconnect the Ethernet cable.

9.3 Fiber Optic Port

Port#6 is 100Base-FX fiber in ST connector, that supports a 1300 nm 2 km multimode fiber link connection. The fiber port utilizes its own MAC and IP address, so it can be used on a separate network from the RJ45 Ethernet port.

9.3.1 Network Connection

Connect a Fiber Optic cable to the meter's Fiber Optic port.

9.4 WebView Energy Dashboard

The EPM 9700 meter's Ethernet ports support the GE WebView Energy Dashboard, which is an HTML-based application that lets you view meter information over any standard Web browser. The EPM 9700 meter default webpages can be viewed by Internet Explorer, Firefox, Chrome, and Safari web browsers. They can be viewed on PCs, tablet computers and smart phones.

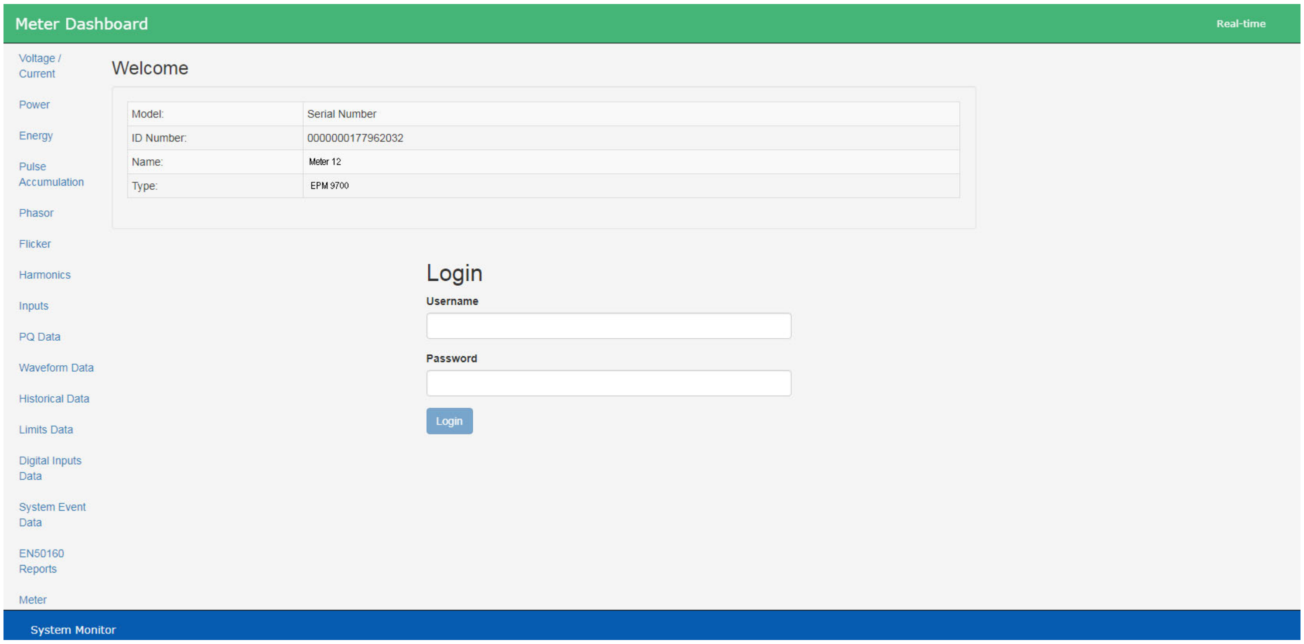
The default webpages provide real-time readings of the meter's voltage, current, power, energy, power quality, pulse accumulations and high speed digital inputs, as well as additional meter information, alarm/email information and diagnostic information. You can also upgrade the meter's firmware through the webpages. You can customize the default webpages - see the *GE Communicator Instruction Manual* for instructions on setting up the WebView Energy Dashboard and customizing webpages. Following is information on accessing the default webpages.

9.4.1 Viewing Webpages

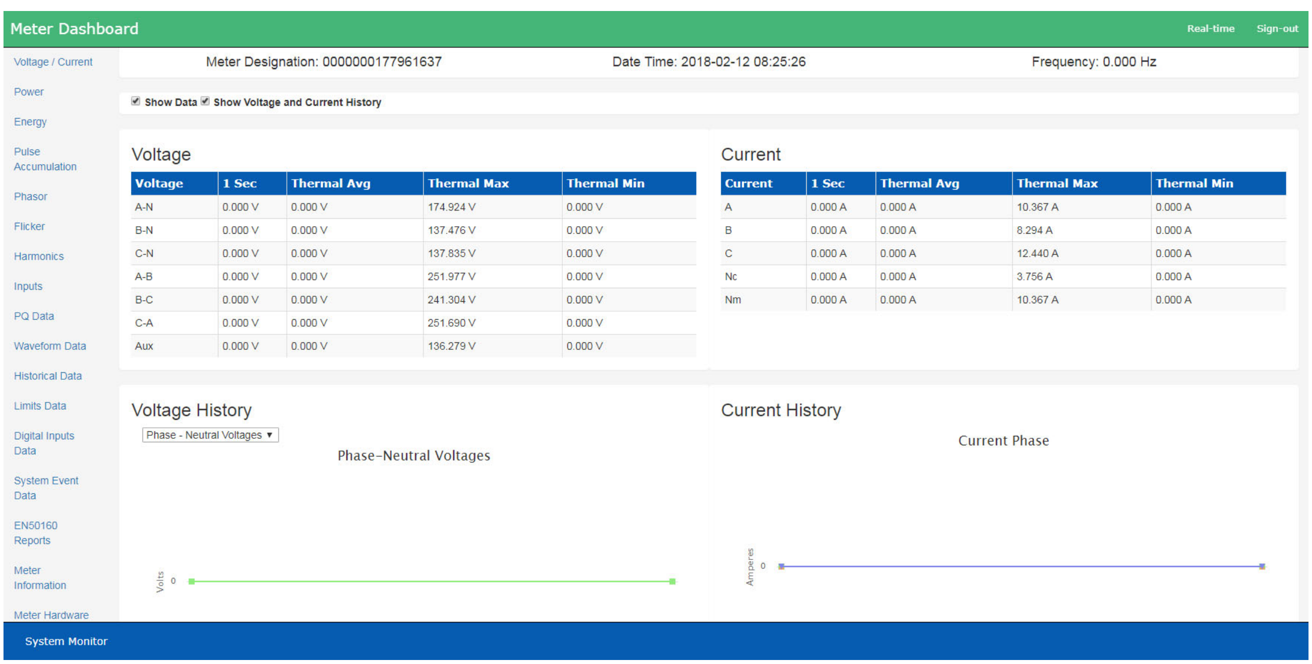
1. Open a Web browser on your PC, tablet computer or smart phone.
2. Type the Ethernet card's IP address in the address bar, preceded by "http://".

   For example: http://10.0.0.1
3. If security is enabled for the meter, you will see the Meter Dashboard displaying the Welcome webpage.
   - You will have to log in with the correct username and password in order to access any of the other webpages, except for Meter Information, Meter Hardware, and System Monitor, which you do not need to log in to view.

- If a webpage times out, the Login webpage is redisplayed. Note that the user's timeout period is set up in Security, using GE Communicator software. Refer to the *GE Communicator Instruction Manual* for instructions.



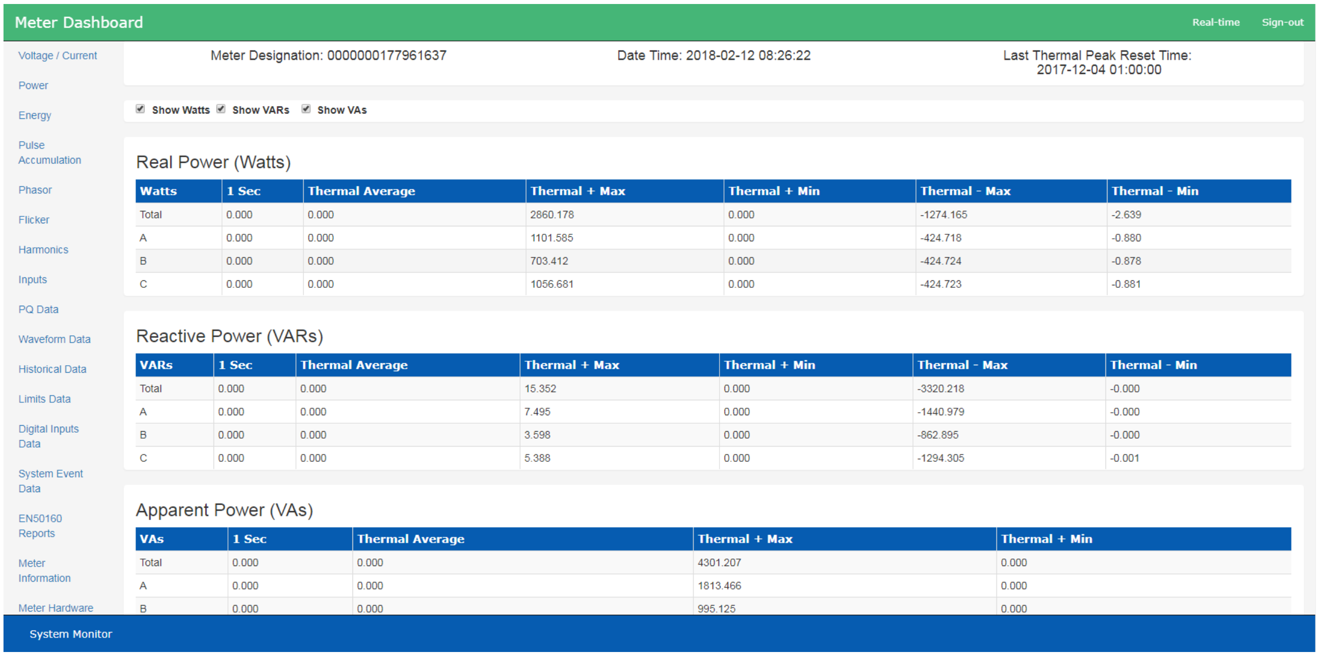
4. If security is not enabled, or if you log in with correct credentials, you will see the Voltage and Current webpage. The webpage shows graphics of voltage and current history, as well as the voltage and current readings.



- You can view this webpage any time by clicking **Real-time** at the top right of the webpage.

- If security is enabled for the meter, you will see **Sign-in** at the top right of the webpage. Click it to open the Login webpage (see previous page). You may want to do this if you have access to a higher level security, e.g., to perform actions not permitted by the current login.

5. To view power readings, click **Power** on the left side of the webpage. You will see the webpage shown below. Scroll to see all of the information.



Real Power (Watts)

Watts	1 Sec	Thermal Average	Thermal + Max	Thermal + Min	Thermal - Max	Thermal - Min
Total	0.000	0.000	2860.178	0.000	-1274.165	-2.639
A	0.000	0.000	1101.585	0.000	-424.718	-0.880
B	0.000	0.000	703.412	0.000	-424.724	-0.878
C	0.000	0.000	1056.681	0.000	-424.723	-0.881

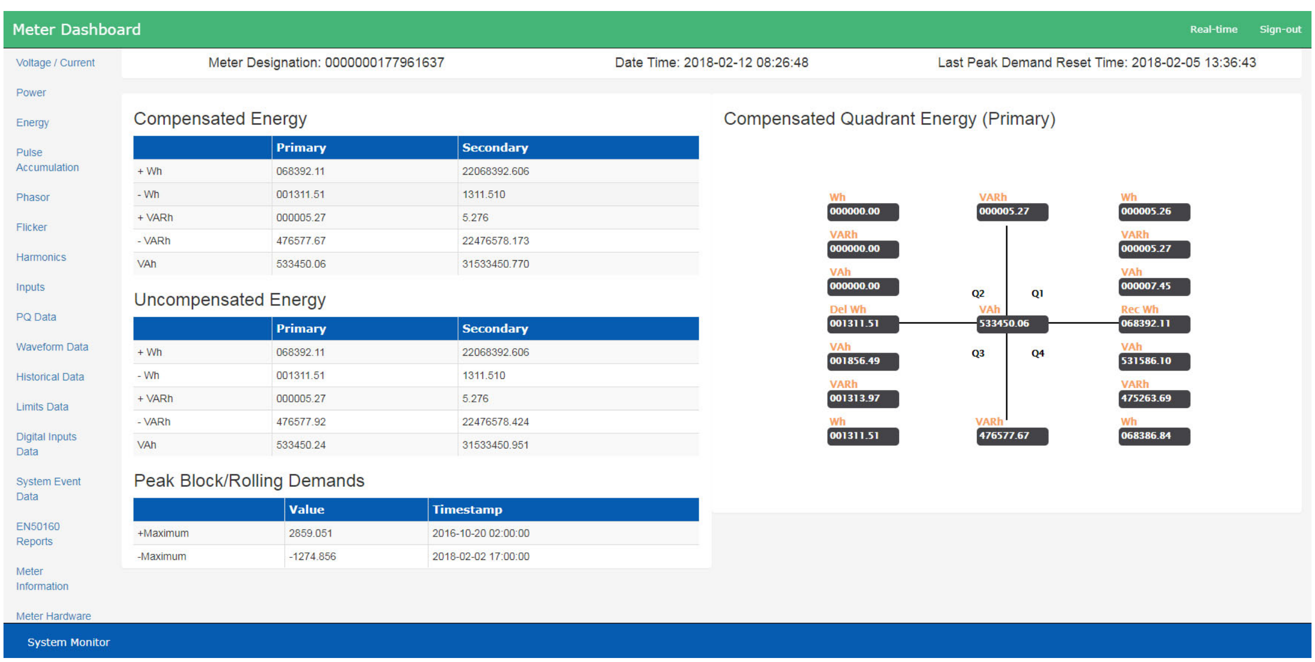
Reactive Power (VARs)

VARs	1 Sec	Thermal Average	Thermal + Max	Thermal + Min	Thermal - Max	Thermal - Min
Total	0.000	0.000	15.352	0.000	-3320.218	-0.000
A	0.000	0.000	7.495	0.000	-1440.979	-0.000
B	0.000	0.000	3.598	0.000	-862.895	-0.000
C	0.000	0.000	5.388	0.000	-1294.305	-0.001

Apparent Power (VAs)

VAs	1 Sec	Thermal Average	Thermal + Max	Thermal + Min
Total	0.000	0.000	4301.207	0.000
A	0.000	0.000	1813.466	0.000
B	0.000	0.000	995.125	0.000

6. To view energy readings, click **Energy** on the left side of the webpage. You will see the webpage shown below. Scroll to see all of the information.



Compensated Energy

	Primary	Secondary
+ Wh	068392.11	22068392.606
- Wh	001311.51	1311.510
+ VARh	000005.27	5.276
- VARh	476577.67	22476578.173
VAh	533450.06	31533450.770

Uncompensated Energy

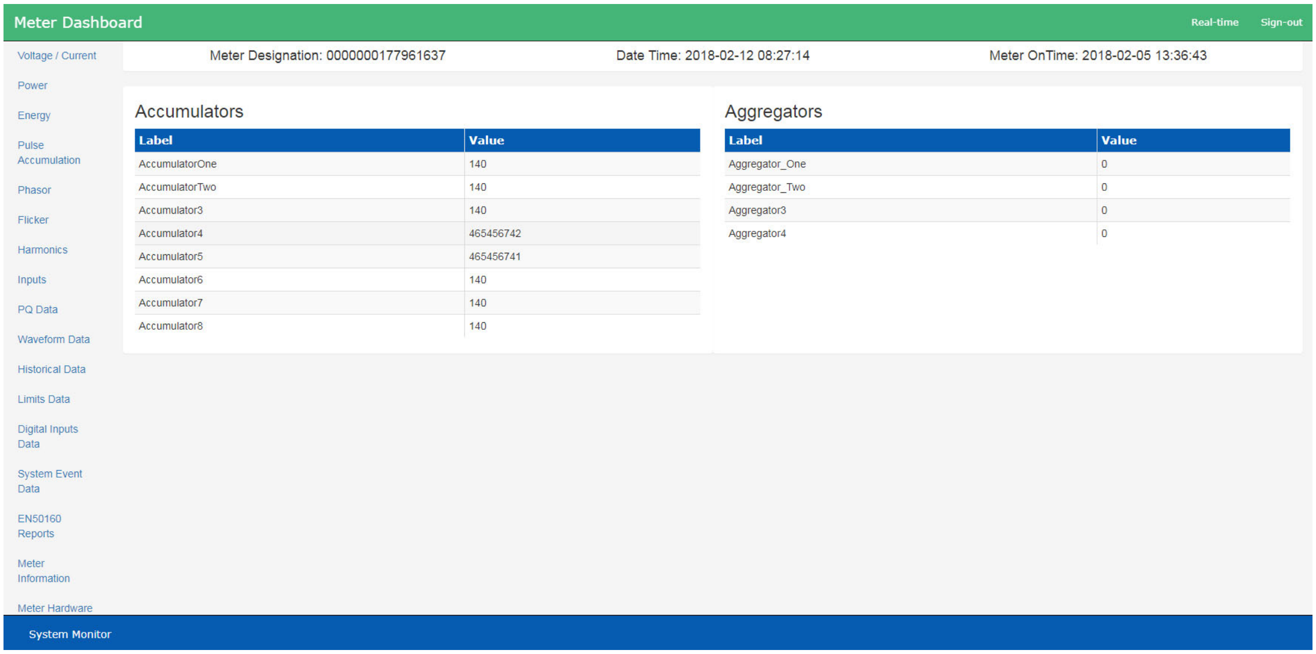
	Primary	Secondary
+ Wh	068392.11	22068392.606
- Wh	001311.51	1311.510
+ VARh	000005.27	5.276
- VARh	476577.92	22476578.424
VAh	533450.24	31533450.951

Peak Block/Rolling Demands

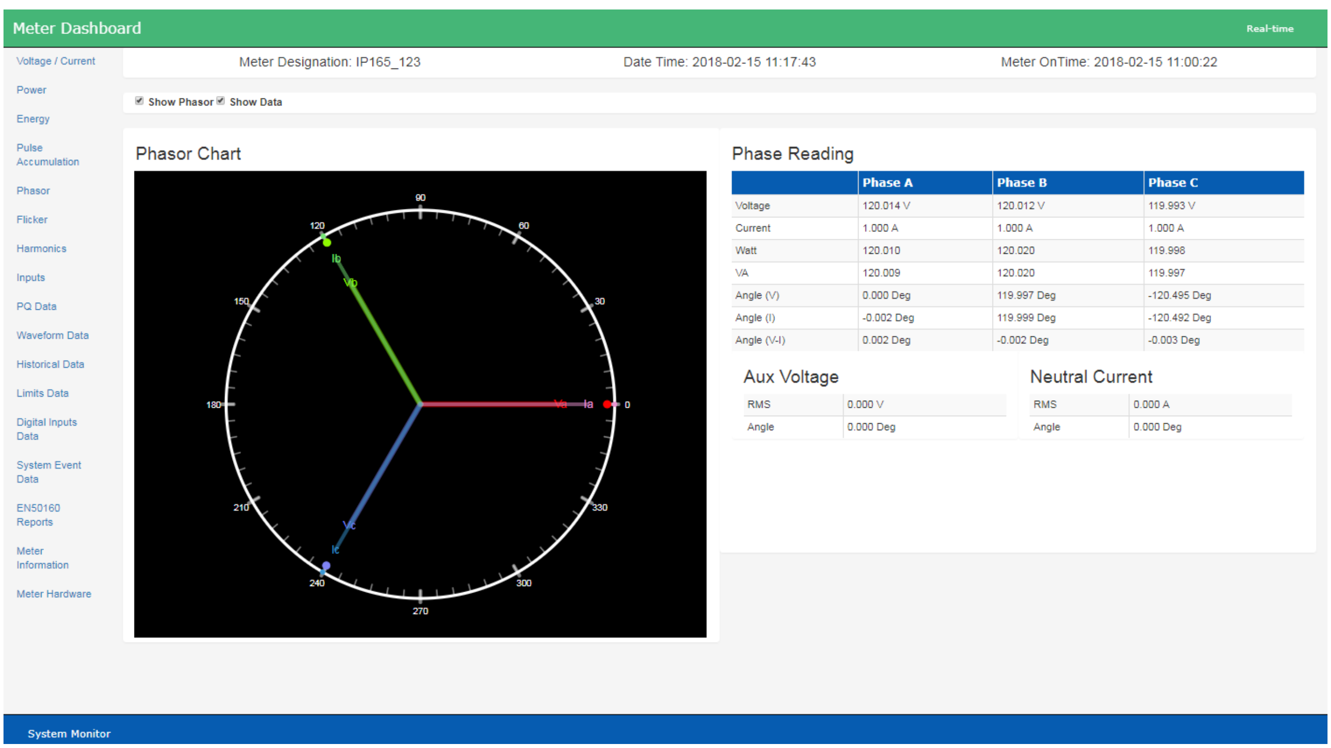
	Value	Timestamp
+Maximum	2859.051	2016-10-20 02:00:00
-Maximum	-1274.856	2018-02-02 17:00:00

Compensated Quadrant Energy (Primary)

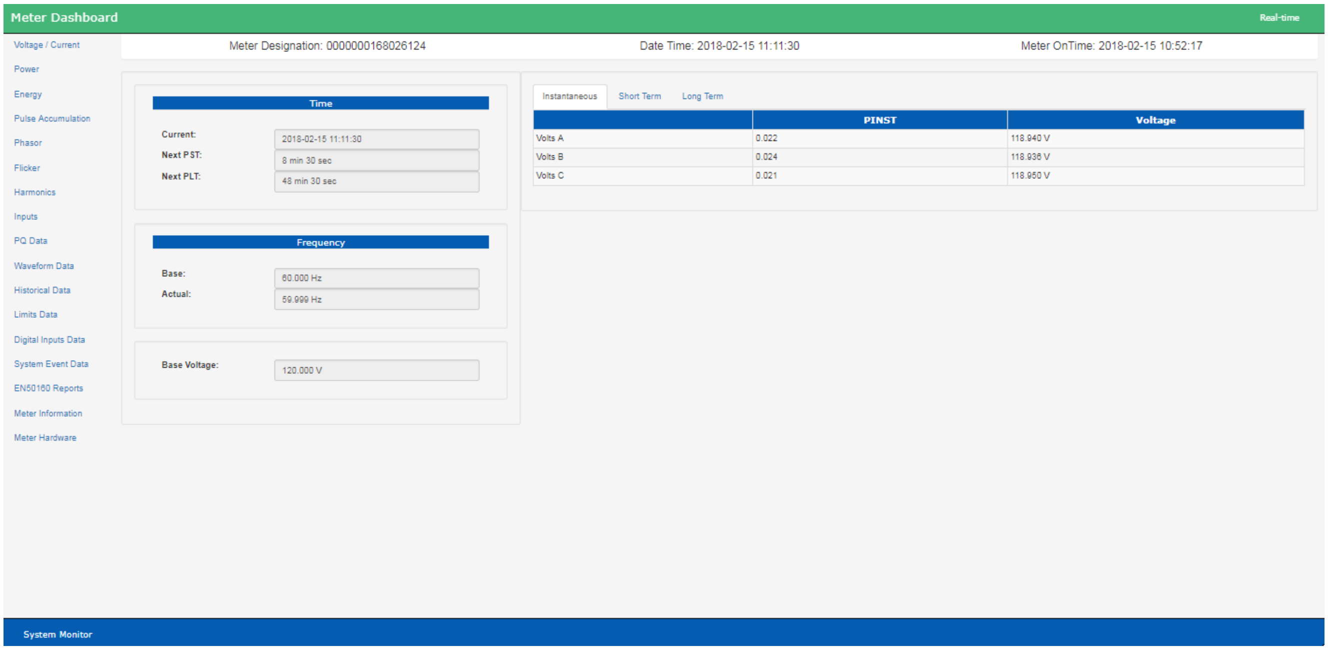
7. To view pulse accumulations/aggregator information, click **Pulse Accumulation** on the left side of the webpage.



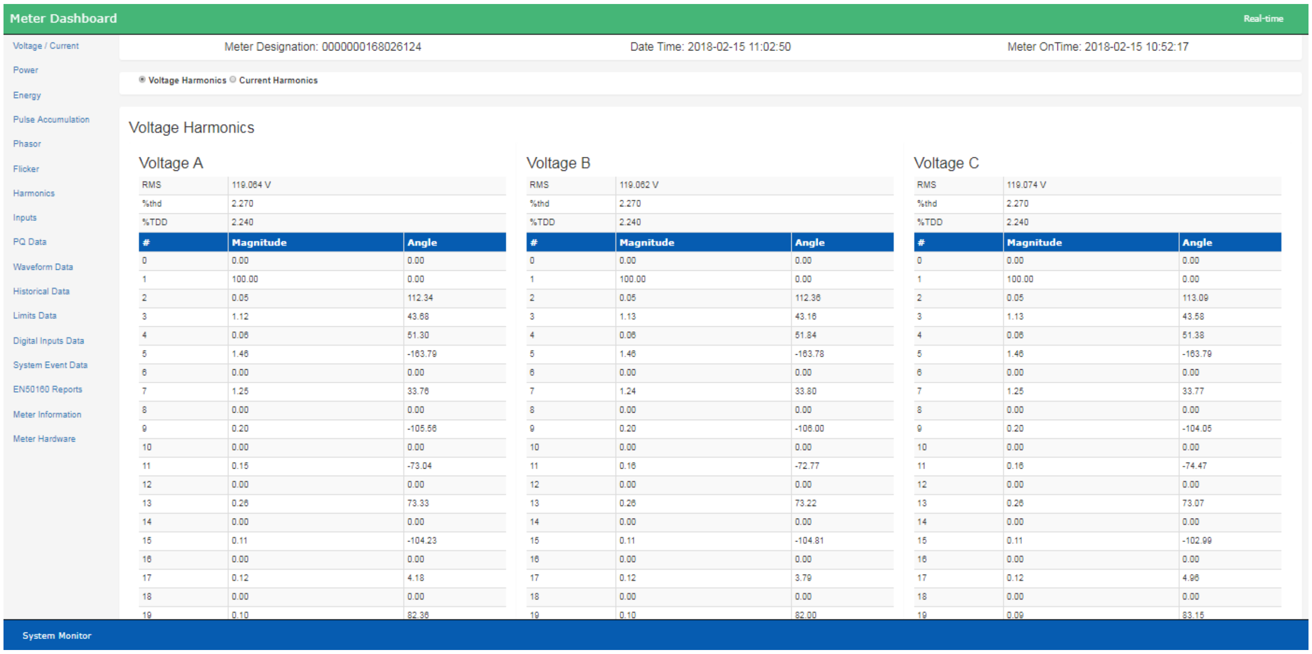
8. To view phasor data, click **Phasor** on the left side of the webpage. You will see the webpage shown below, showing a phasor diagram and phasor readings.



9. To view Flicker data, click **Flicker** on the left side of the webpage.


Meter Dashboard
Real-time
Voltage / Current
Power
Energy
Pulse Accumulation
Phasor
Flicker
Harmonics
Inputs
PQ Data
Waveform Data
Historical Data
Limits Data
Digital Inputs Data
System Event Data
EN50160 Reports
Meter Information
Meter Hardware
Meter Designation: 0000000168026124
Date Time: 2018-02-15 11:11:30
Meter OnTime: 2018-02-15 10:52:17
Time
Current: 2018-02-15 11:11:30
Next PST: 8 min 30 sec
Next PLT: 48 min 30 sec
Frequency
Base: 60.000 Hz
Actual: 59.999 Hz
Base Voltage: 120.000 V
Instantaneous
Short Term
Long Term
PINST
Voltage
Volts A 0.022 118.940 V
Volts B 0.024 118.936 V
Volts C 0.021 118.950 V
System Monitor

10. To view harmonic magnitudes information, click **Harmonics** on the left side of the webpage. You will see the webpage shown below.



Voltage A

RMS	119.064 V
%thd	2.270
%TDD	2.240

#	Magnitude	Angle
0	0.00	0.00
1	100.00	0.00
2	0.05	112.34
3	1.12	43.68
4	0.06	51.30
5	1.46	-163.79
6	0.00	0.00
7	1.25	33.76
8	0.00	0.00
9	0.20	-105.56
10	0.00	0.00
11	0.15	-73.04
12	0.00	0.00
13	0.26	73.33
14	0.00	0.00
15	0.11	-104.23
16	0.00	0.00
17	0.12	4.18
18	0.00	0.00
19	0.10	82.36

Voltage B

RMS	119.062 V
%thd	2.270
%TDD	2.240

#	Magnitude	Angle
0	0.00	0.00
1	100.00	0.00
2	0.05	112.36
3	1.13	43.16
4	0.06	51.84
5	1.46	-163.78
6	0.00	0.00
7	1.24	33.80
8	0.00	0.00
9	0.20	-106.00
10	0.00	0.00
11	0.16	-72.77
12	0.00	0.00
13	0.26	73.22
14	0.00	0.00
15	0.11	-104.81
16	0.00	0.00
17	0.12	3.79
18	0.00	0.00
19	0.10	82.00

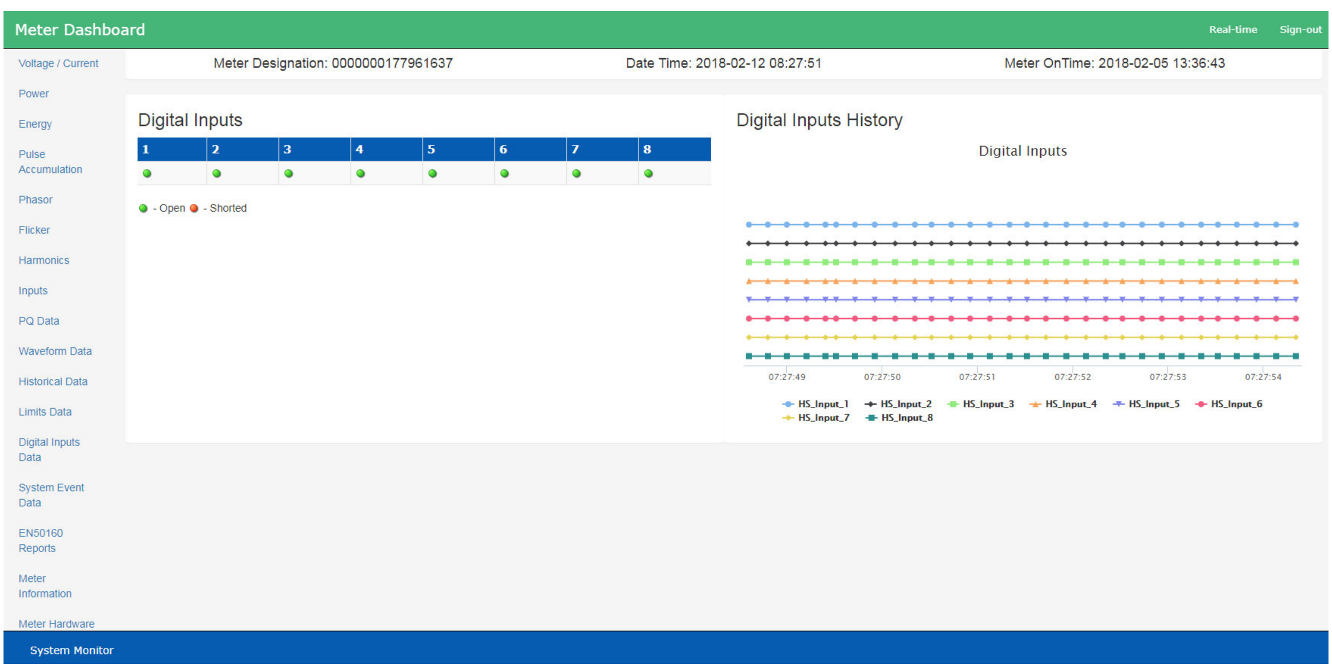
Voltage C

RMS	119.074 V
%thd	2.270
%TDD	2.240

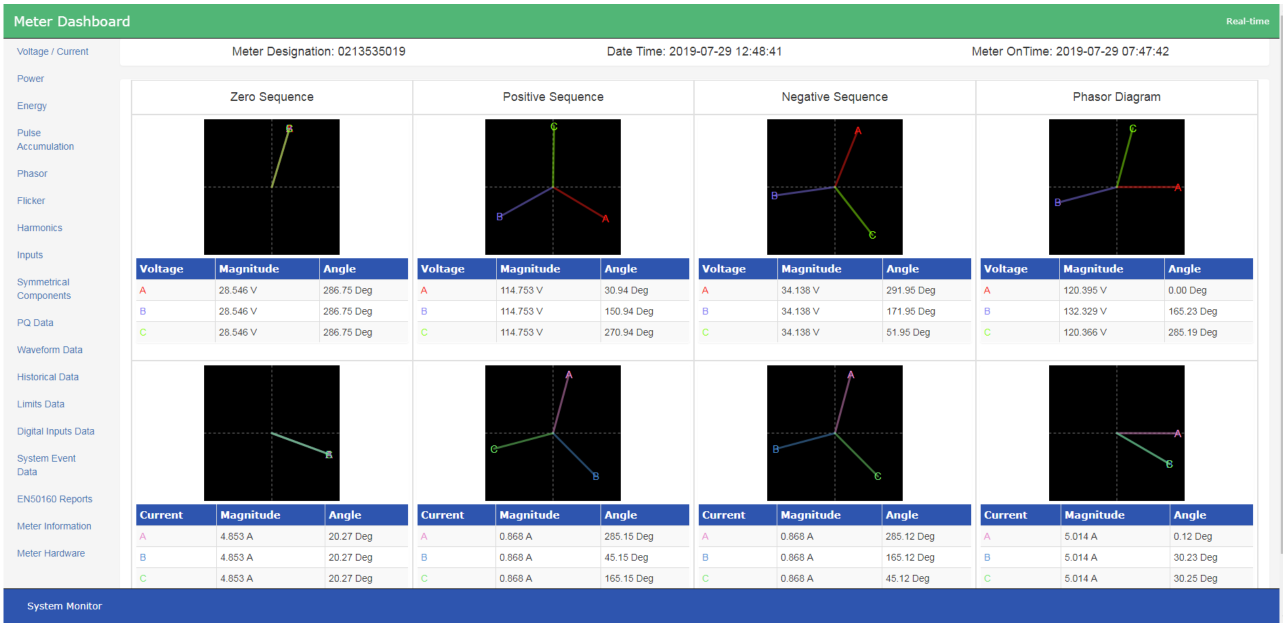
#	Magnitude	Angle
0	0.00	0.00
1	100.00	0.00
2	0.05	113.09
3	1.13	43.58
4	0.06	51.38
5	1.46	-163.79
6	0.00	0.00
7	1.25	33.77
8	0.00	0.00
9	0.20	-104.05
10	0.00	0.00
11	0.16	-74.47
12	0.00	0.00
13	0.26	73.07
14	0.00	0.00
15	0.11	-102.99
16	0.00	0.00
17	0.12	4.96
18	0.00	0.00
19	0.09	83.15

- You can see harmonics for voltage or current by selecting the radio button for either, at the top left of the webpage.
- Scroll to see all of the available data.

11. To view readings for the meter's digital inputs, click **Inputs** on the left side of the webpage. You will see the webpage shown below, showing digial input states, and history in a graph.

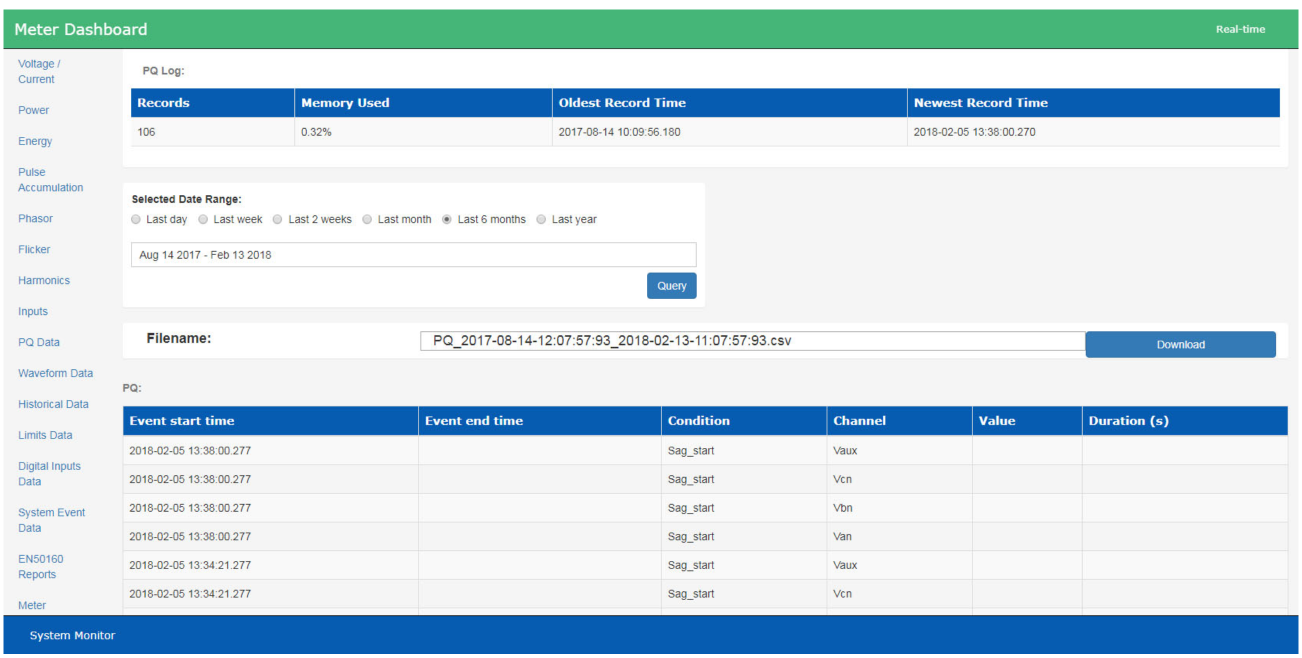


12. To view symmetrical components, click Symmetrical Components on the left side of the webpage.



This page shows the real time positive, negative, zero sequence, and phasor diagrams and magnitude and angle measurements for the voltage and current.

13. To view the PQ Log data, click **PQ data** on the left side of the webpage.

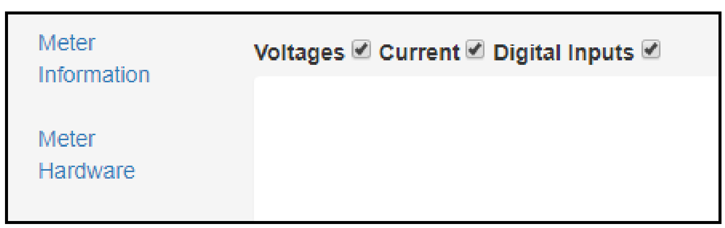


- Information about the PQ log is listed at the top of the webpage: number of records in the log, the amount of memory used the oldest and newest record time stamps.

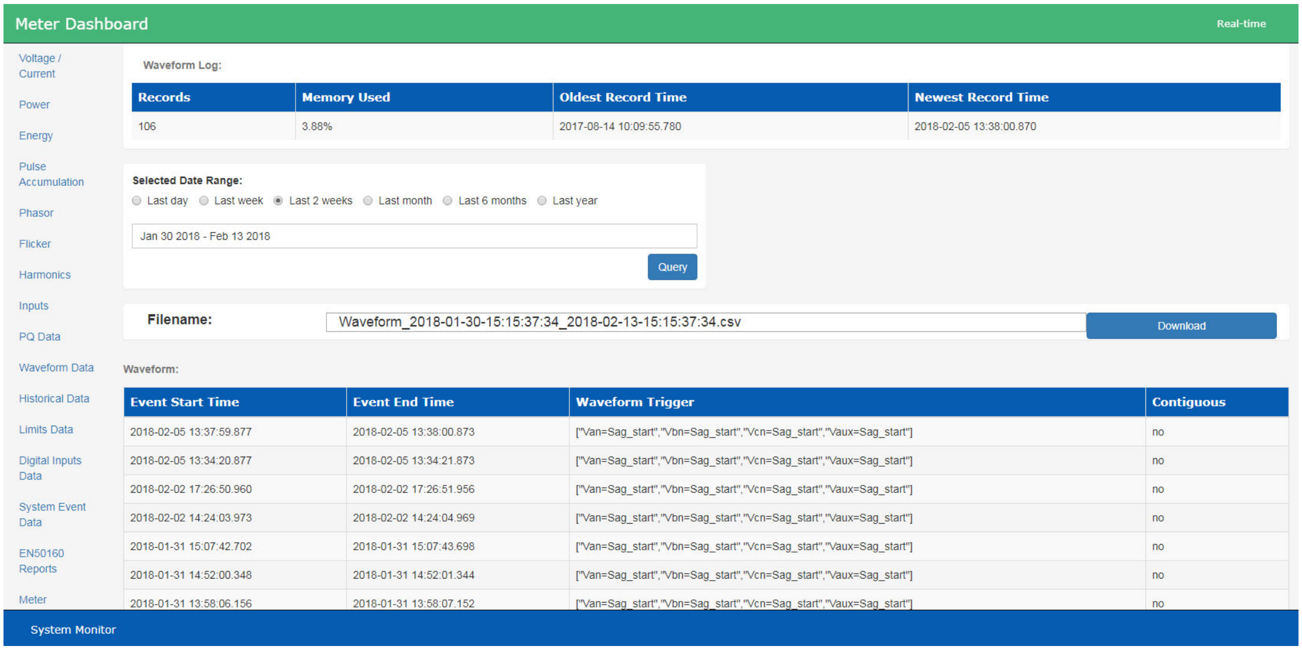
- Select the date range you want and click **Query**.
- Click **Download** to create a .csv file of the log - you can change the filename if you want.
- The PQ events are listed in the lower part of the screen - scroll to see all of the events.
- Click on an event to see details and its waveform.

Once you are viewing an event, you can use the Next button to go to the next event in the log, or the Back button to return to the previous event in the log.

You can select to see waveforms for voltages, and/or currents, and also to see the state of the digital inputs while the waveform was being recorded. Use the checkboxes to select what you want to see, and scroll to see all of the data.

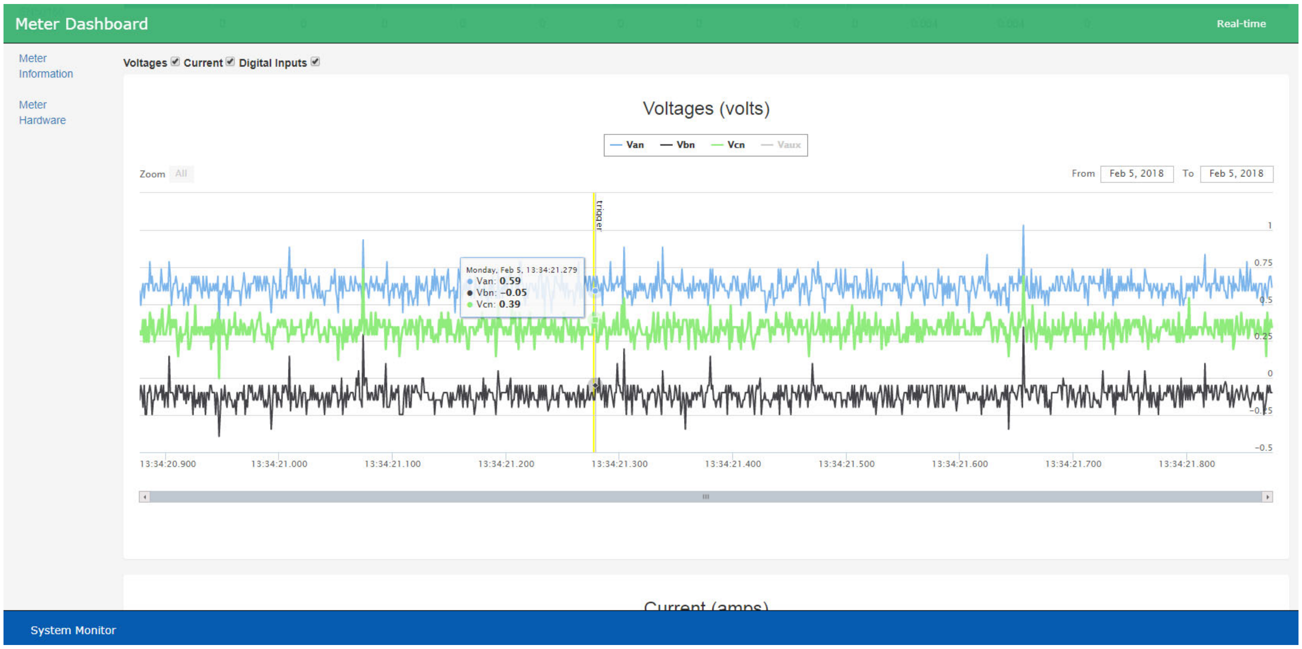


14. To see waveform recordings, click **Waveform Data** on the left side of the webpage.



- Information about the Waveform log is listed at the top of the webpage: number of records in the log, the amount of memory used the oldest and newest record time stamps.
- Select the date range you want and click **Query**.
- Click **Download** to create a .csv file of the log - you can change the filename if you want.
- The waveform records are listed in the lower part of the screen - scroll to see all of the waveforms.

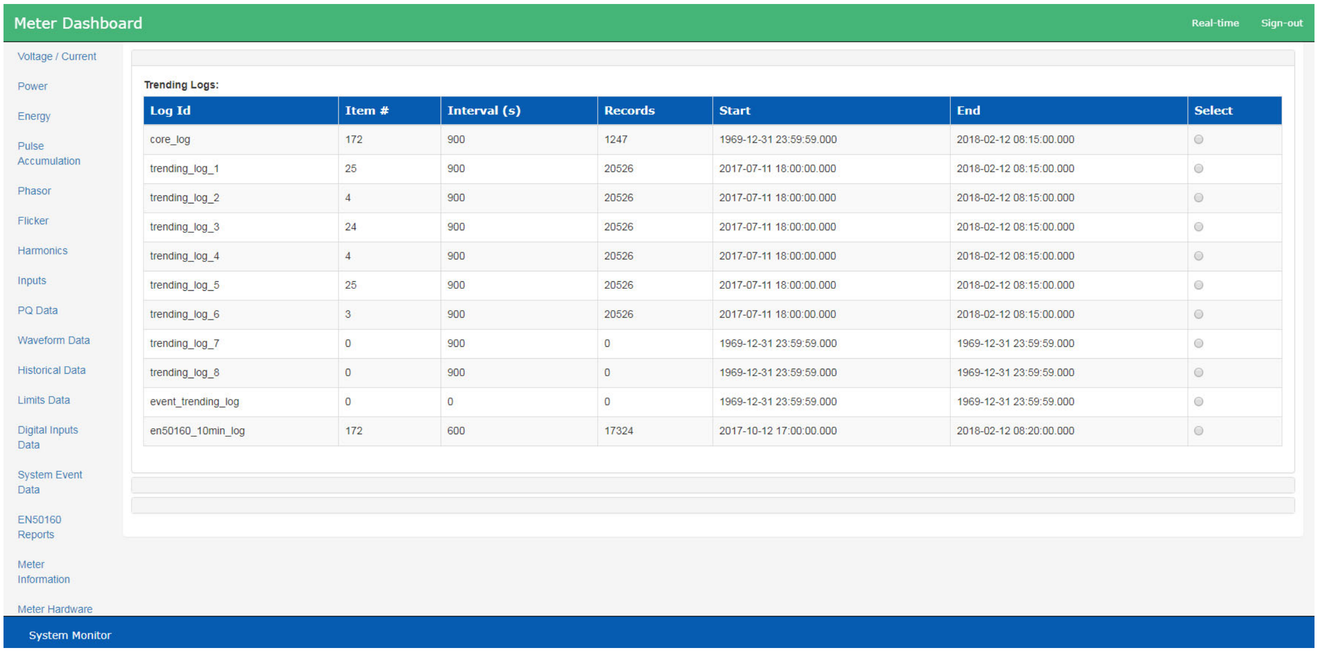
Click on a waveform event to see the waveform detail.



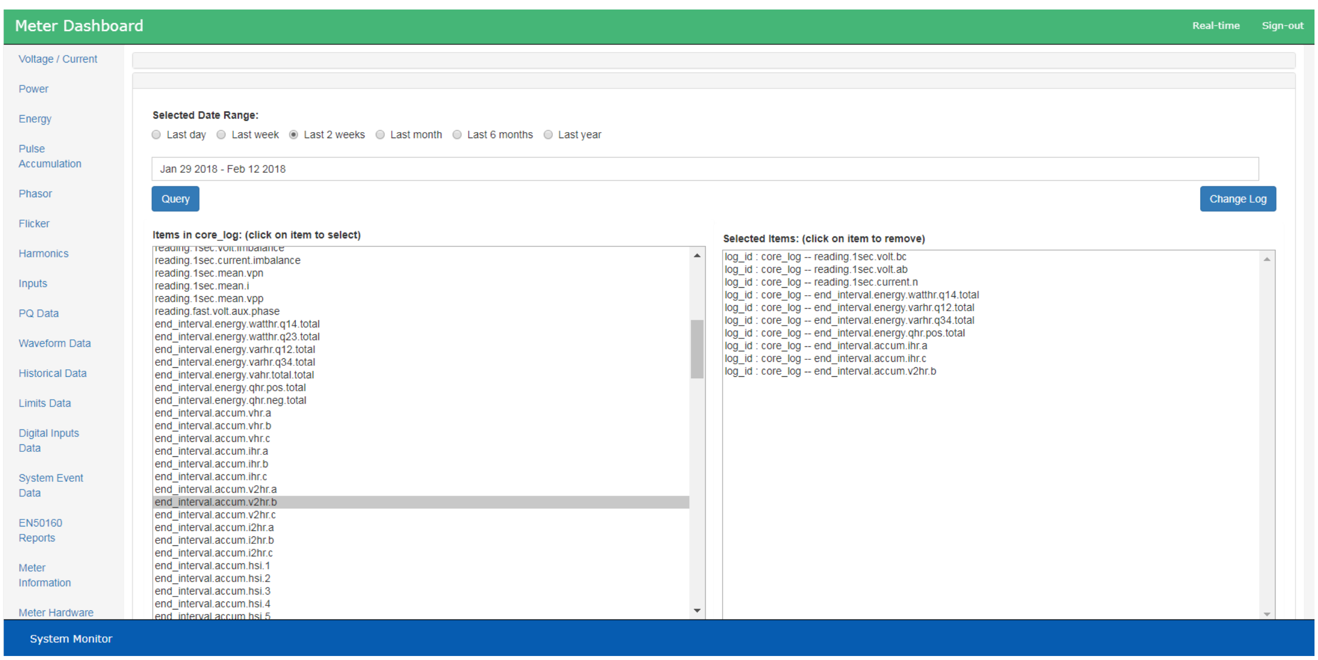
You can select to see waveforms for voltages, and/or currents, and also to see the state of the digital inputs while the waveform was being recorded. Use the checkboxes to select what you want to see, and scroll to see all of the data.

Once you are viewing a waveform event, you can use the Next button to go to the next event in the log, or the Back button to return to the previous event in the log.

15. To view historical, trending data for the meter, click **Historical Data** on the left side of the webpage. You will see the webpage shown below.

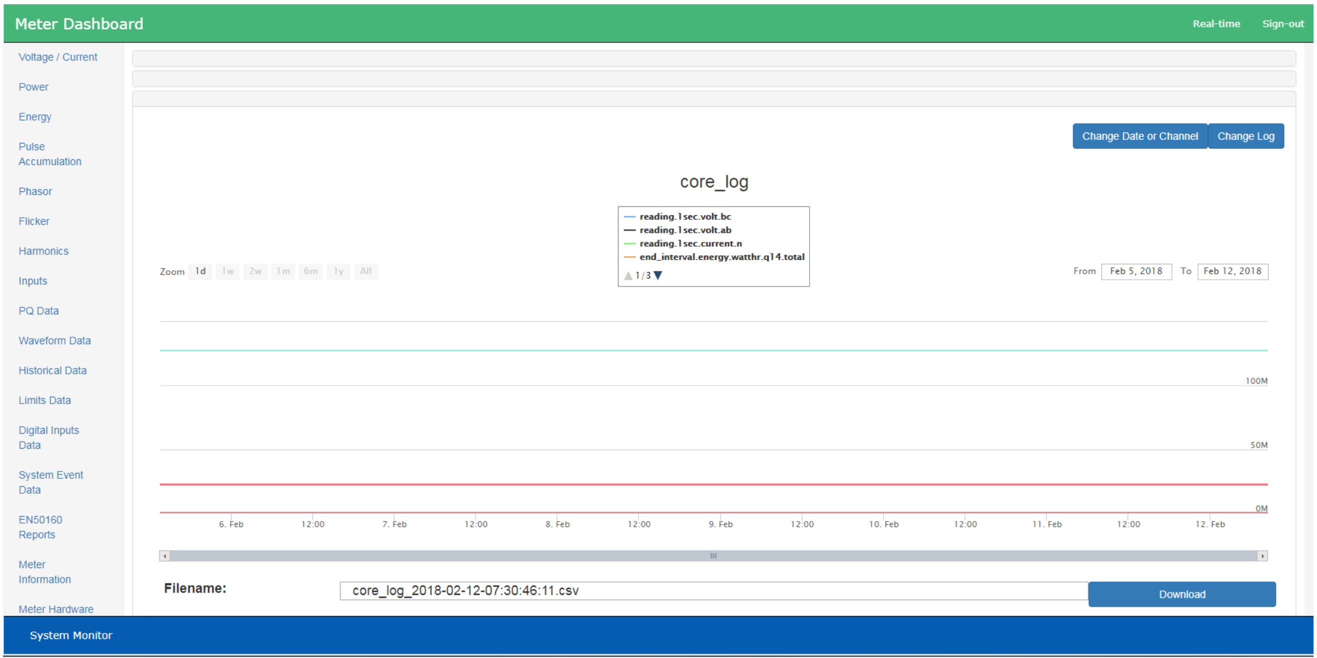


- Select one of the listed logs to view, by clicking the **Select** button next to it.

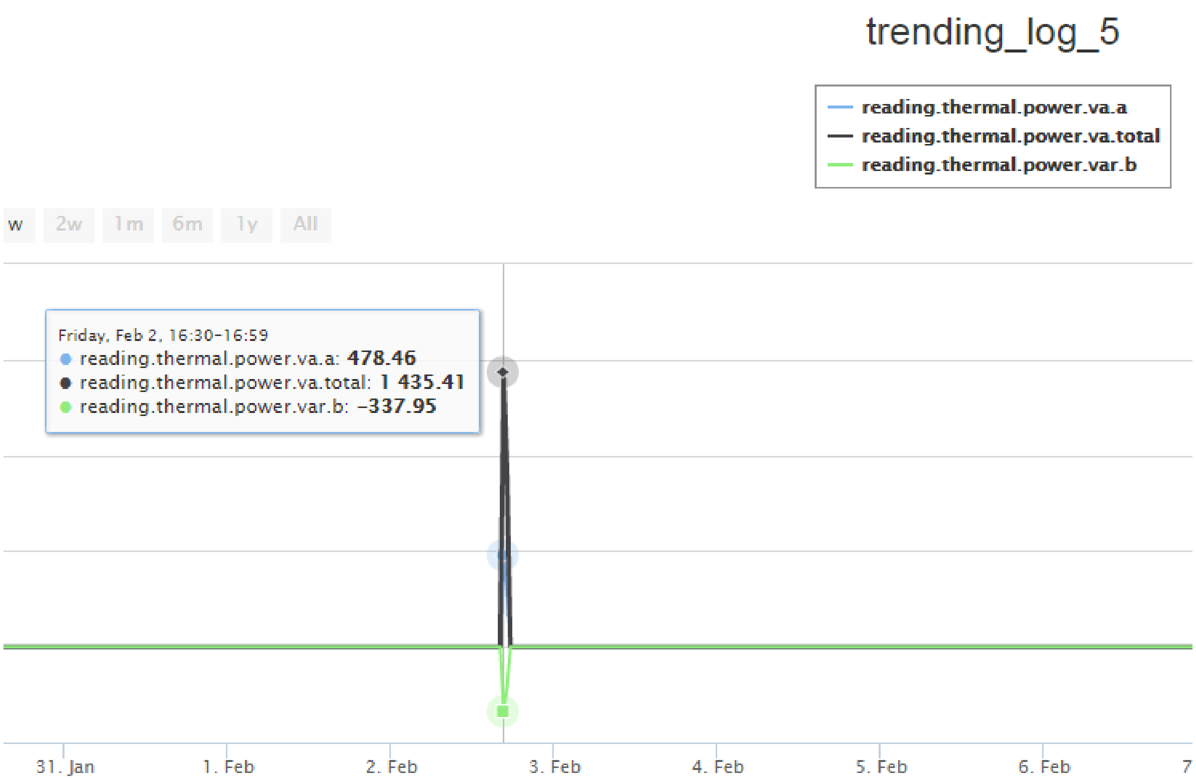


- Select the date range and data points you want to view.
- Select Query to view the selected log data, or Change Log to select a different log to view.

The data channels are shown in the graph.

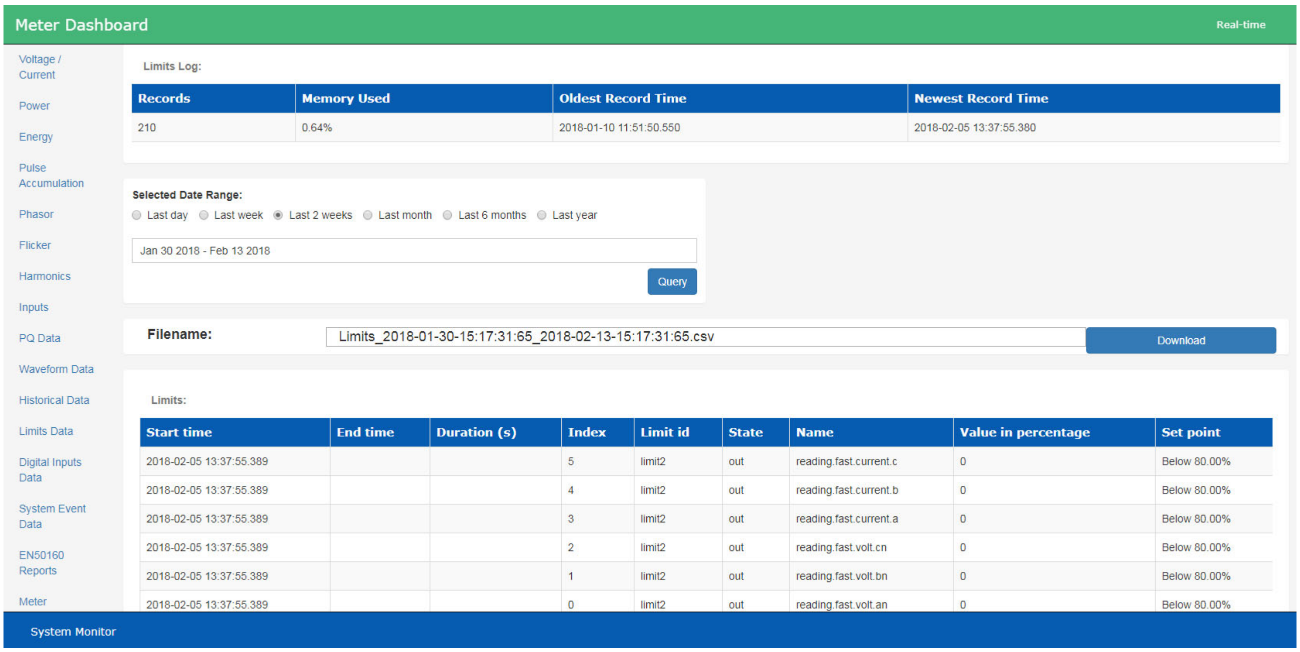


- You can click on a point in the graph to see the readings for that time stamp. See the example, below.



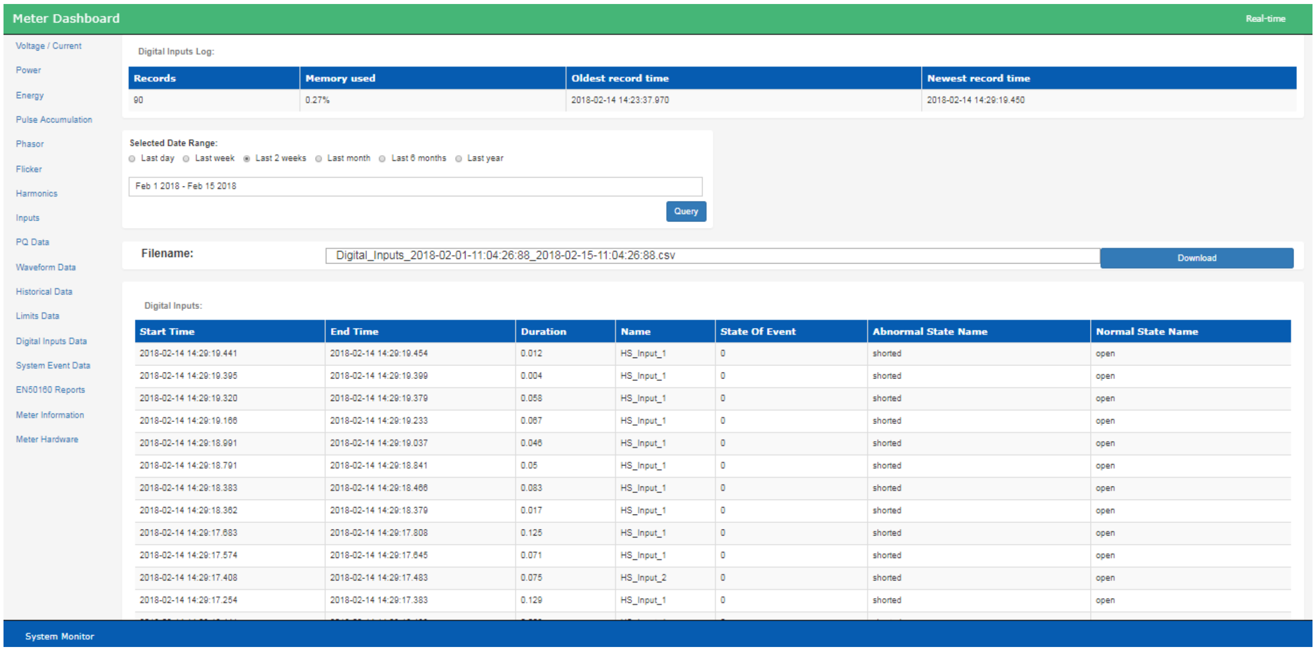
- Click **Download** to create a .csv file of the log - you can change the filename if you want.
- To select another date range and/or other data channels from this log, click **Change Date or Channel**.
- To see data for another log, click **change Log**.

16. To see Limits/Alarm log data, click **Limits** on the left side of the webpage.



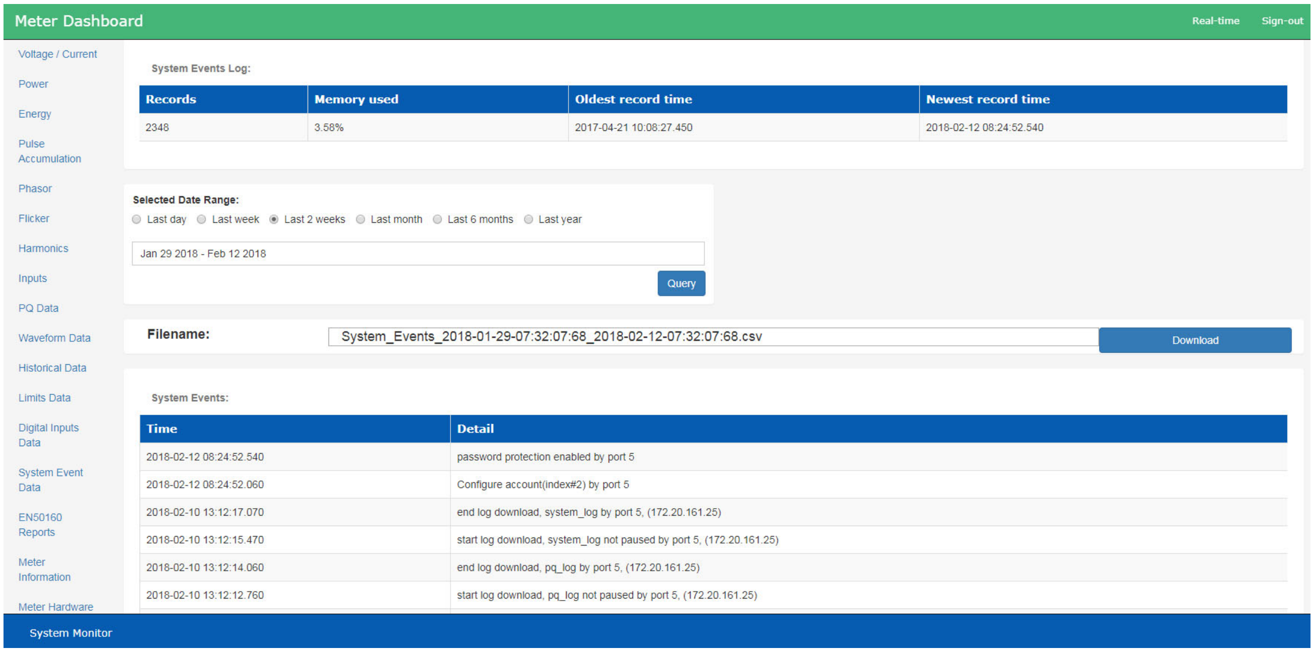
- Information about the Limits log is listed at the top of the webpage: number of records in the log, the amount of memory used the oldest and newest record time stamps.
- Select the date range you want and click **Query**.
- Click **Download** to create a .csv file of the log - you can change the filename if you want.
- The limits/alarm events are listed in the lower part of the screen - scroll to see all of the events.

17. To see the Digital Inputs log data, click **Digital Inputs Data** on the left side of the webpage.



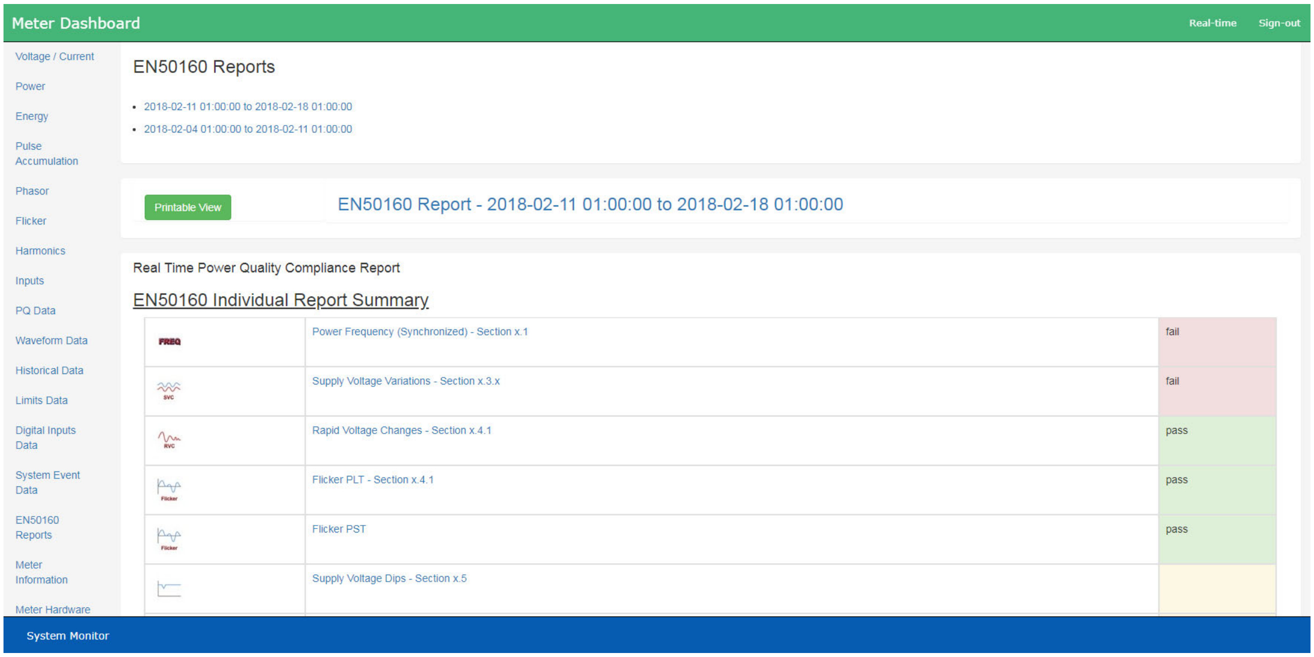
- Information about the Digital Inputs log is listed at the top of the webpage: number of records in the log, the amount of memory used the oldest and newest record time stamps.
- Select the date range you want and click **Query**.
- Click **Download** to create a .csv file of the log - you can change the filename if you want.
- The digital inputs data is listed in the lower part of the screen - scroll to see all of the events.

18. To see System Events log data, click **System Event Data** on the left side of the webpage.

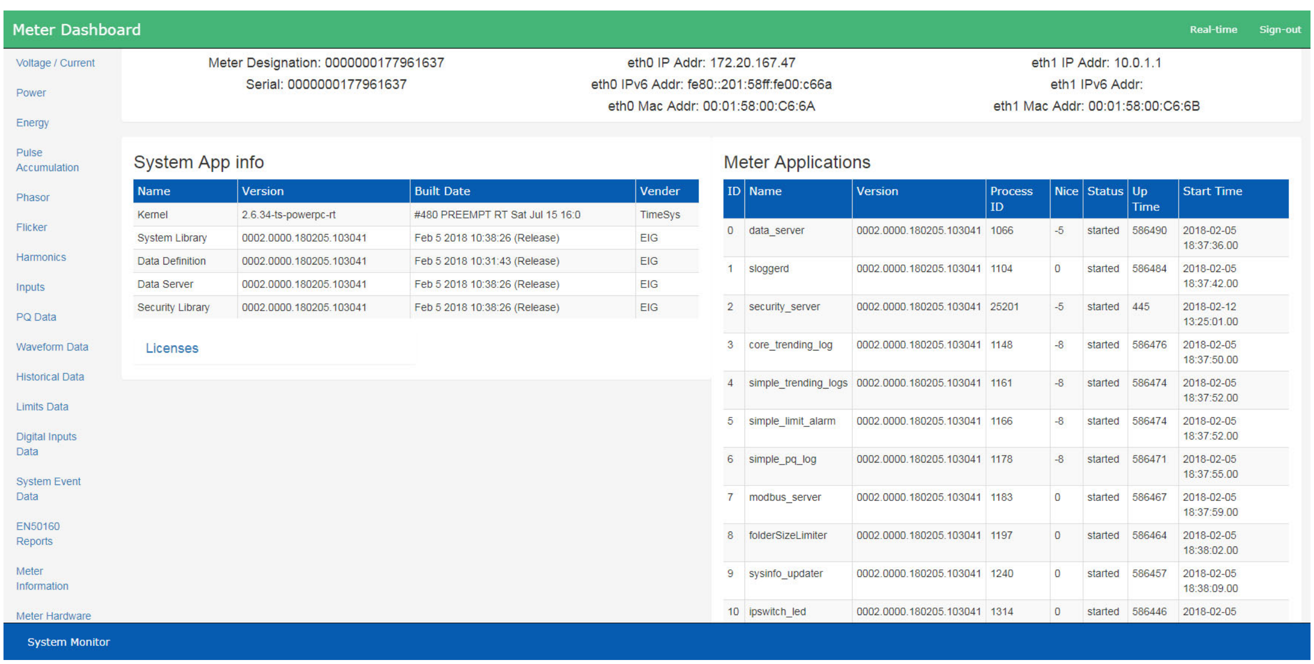


- Information about the System events log is listed at the top of the webpage: number of records in the log, the amount of memory used the oldest and newest record time stamps.
- Select the date range you want and click **Query**.
- Click **Download** to create a .csv file of the log - you can change the filename if you want.
- The system events are listed in the lower part of the screen - scroll to see all of the events.

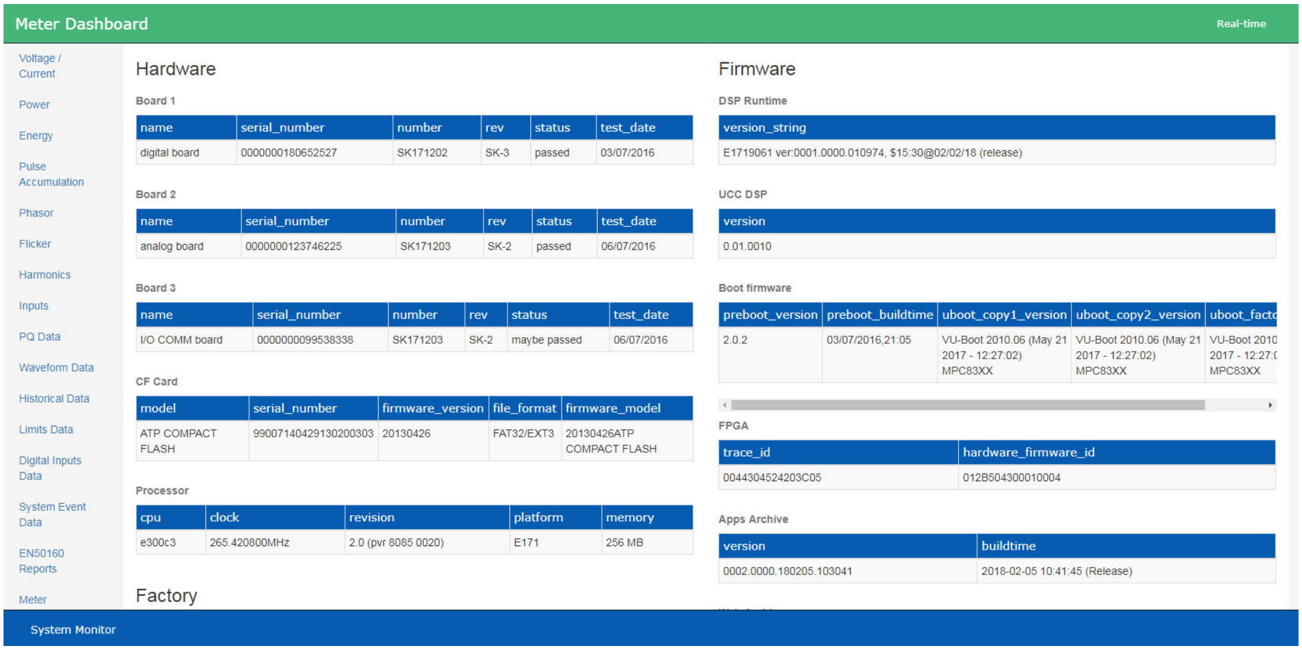
19. To see EN 50160 PQ Report data, click **Reports** on the left side of the webpage. Scroll to see all of the data.



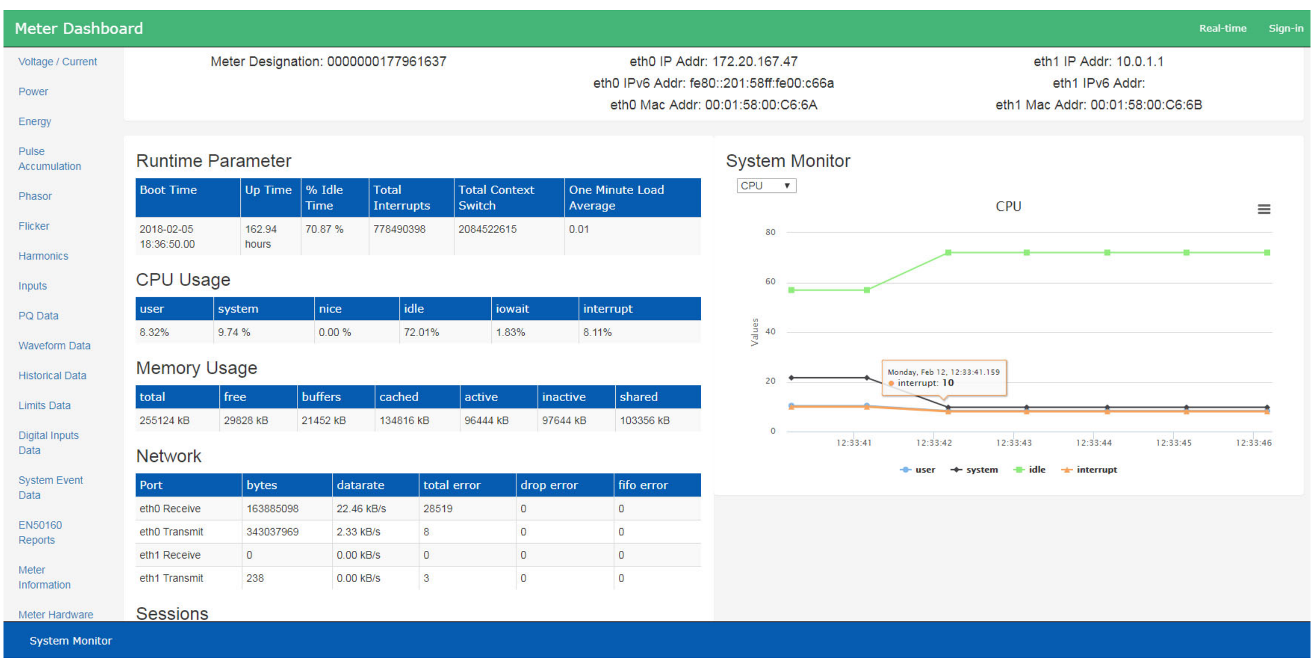
20. To view general meter information, click **Meter Information** on the left side of the webpage. You will see the webpage shown below. It lists the meter's system application and other applications details. Click licenses to see the software licenses.



21. To see details of the meter's hardware, firmware, and factory settings, click **Meter Hardware** on the left side of the webpage. Scroll to see all of the data.



22. To view status information for the meter's processors, click **System Monitor** at the bottom of any of the webpages. Scroll to see all of the information.



Multilin EPM 9700

Chapter 10: Optional I/O

10.1 Hardware Overview

All EPM External I/O modules have the following components:

- Female RS485 Side Port: use to connect to another module's male RS485 side port.
- Male RS485 Side Port: use to connect to the EPM 9700 Meter's Port 3 or 4 or to another module's female RS485 side port.
- I/O Port: used for functions specific to the type of module; size and pin configuration vary depending on type of module.
- Reset Button: Press and hold for three seconds to reset the module's baud rate to 57600 and its address to 247 for 30 seconds.
- LEDs: when flashing, signal that the module is functioning.
- Mounting Brackets MBIO (MBIO00000): used to secure one or more modules to a flat surface. Comes with 2 DIN rail mounting clips.

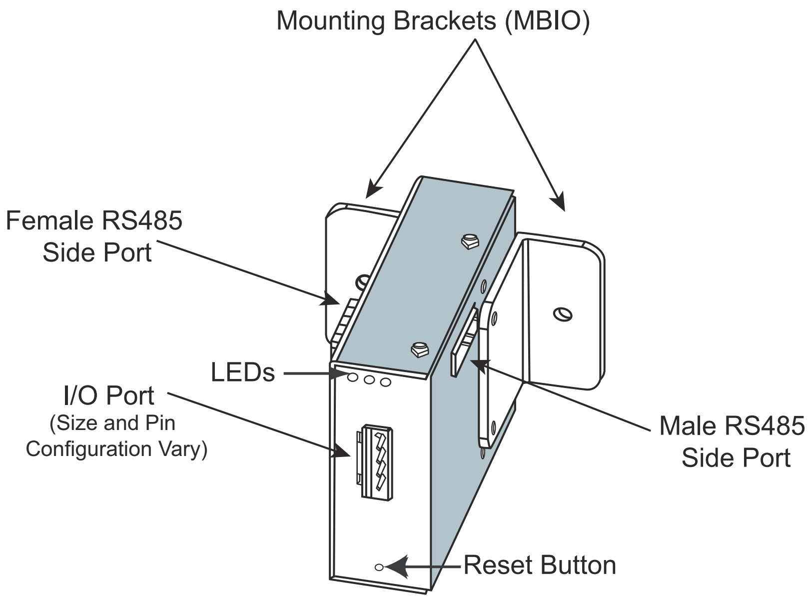
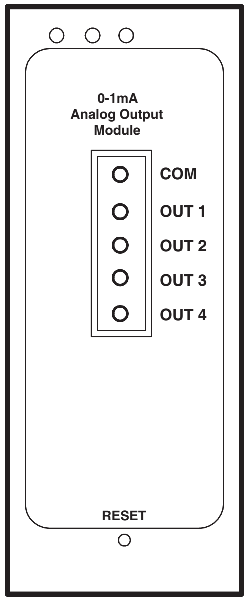


Figure 10-1: I/O Module Components

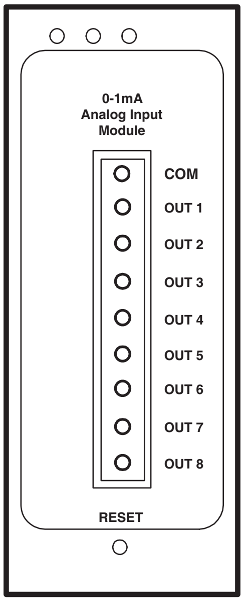
10.1.1 Port Overview

All EPM I/O Modules have ports through which they interface with other devices. The port configurations are variations of the four types shown below.

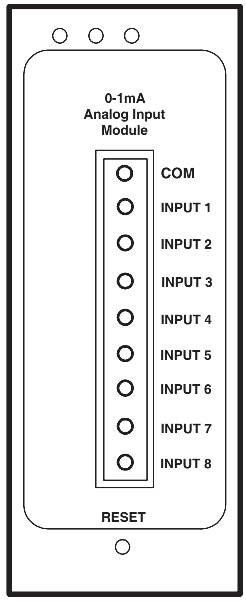
Four Analog Outputs
(0-1mA and 4-20mA)



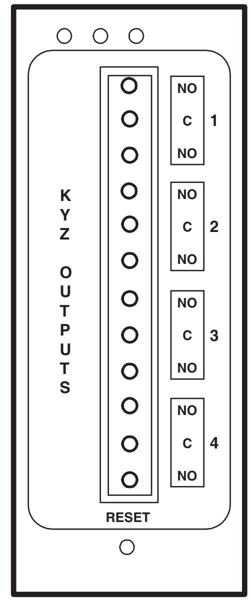
Eight Analog Outputs
(0-1mA and 4-20mA)



Eight Analog Inputs
(0-1mA, 0-20mA, 0-5 VDC,
0-10 VDC) or Eight Status Inputs



Four Relay Outputs
or Four KYZ Pulse Outputs



10.2 RS485 Connection to External I/O Modules

- Six feet of RS485 cable harness is supplied. Insert one end of the cable into Port 3 or Port 4 of the EPM 9700 meter.
- Insert the other end of the cable into the I/O module's female RS485 side port (see Figure 10.1). The connectors fit only one way into the ports.
- Use the male RS485 side port to attach another I/O module. The EPM 9700 meter can power up to four connected I/O modules using (15–20) V DC at (50–200) mA. Refer to 10.3 *Steps to Determine Power Needed* on page 10–4, to determine if you must use a separate power source (for example, PSIO) to supply added power to the group. See 10.3.1 *Power Source for I/O Modules* on page 10–5, for information on the PSIO. RS485 communication is viable for up to 4000 feet (1219 meters). However, if your cable length exceeds 200 feet, use the remote power supply and:

    1. Connect the + and - terminals on the EPM 9700 meter to the + and - terminals of the female RS485 port. Connect the shield to the shield (S) terminal. The (S) terminal on the EPM 9700 meter is used to reference the meter's port to the same potential as the source. It is not an earth-ground connection. **You must also connect the shield to earth-ground at one point.**
    2. Provide termination resistors at each end, connected to the + and - lines. RT is approximately 120 Ohms. See RT EXPLANATION in 4.5 *RS485 Communication* on page 4–6.

10.3 Steps to Determine Power Needed

Available power for all ports of the EPM 9700 meter is 12 VA.

1. Refer to the tables on the next two pages to determine the VA Ratings for I/O modules and displays.
2. Add together the VA Ratings for all I/O modules and displays in use.
3. Compare available power to power needed to determine if you must use an additional power source.

NOTE

GE recommends the PSIO 12 V power source if the I/O module VA rating exceeds the EPM 9700 specification. See 10.3.1 *Power Source for I/O Modules* on page 10–5, for information and usage instructions.

I/O Module Factory Settings and VA Ratings			
Model#	Module	Address	VA Rating
1mAON4	+/- 0-1 mA, 4 Analog Outputs	128	2.7 VA
1mAON8	+/- 0-1 mA, 8 Analog Outputs	128	3.2 VA
20mAON4	4-20 mA, 4 Analog Outputs	132	5.0 VA
20mAON8	4-20 mA, 8 Analog Outputs	132	8.5 VA
8AI1	+/- 0-1 mA, 8 Analog Inputs	136	2.3 VA
8AI2	4-20 mA, 8 Analog Inputs	140	2.3 VA
8AI3	+/- 0-5 V DC, 8 Analog Inputs	144	2.3 VA
8AI4	+/- 0-10 VDC, 8 Analog Inputs	148	2.3 VA
4RO1	4 Latching Relay Outputs	156	2.7 VA
4PO1	4 KYZ Pulse Outputs	160	2.7 VA
8DI1	8 Status Inputs (Wet/Dry)	164	1.0 VA

As the table above shows, all I/O modules are shipped pre-programmed with a baud rate of 57600 and addresses. For programming instructions, refer to the *GE Communicator Instruction Manual*.

See 4.5.2 *RS485 Connection to an External Display* on page 4–8 for the external displays' VA Ratings.

If you are using a PSIO (for 125 V AC/DC input) or PB1 your maximum VA is 12.

10.3.1 Power Source for I/O Modules

The EPM 9700 can supply power to a limited number of I/O Modules and external displays. For more modules, you must use an external power source, such as the GE PSIO (12V). See 10.3 *Steps to Determine Power Needed* on page 10–4 to determine power needed.

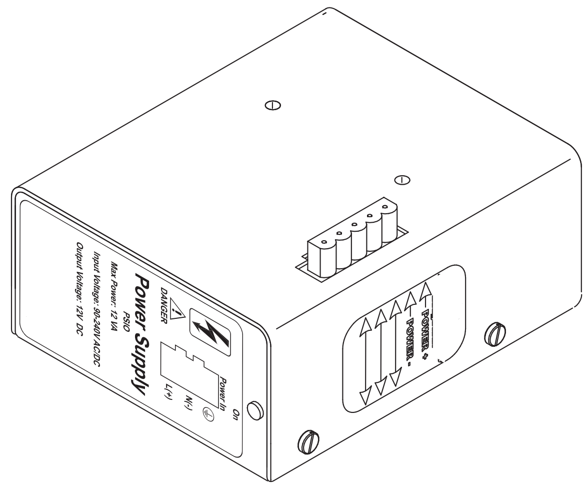


Figure 10-2: PSIO Power Supply Side View, Showing Male RS485 Port

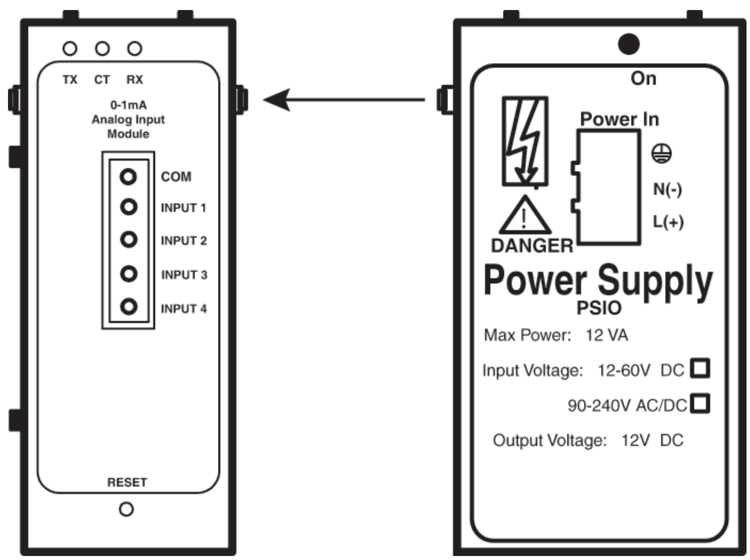


Figure 10-3: Power Flow from PSIO to I/O Module

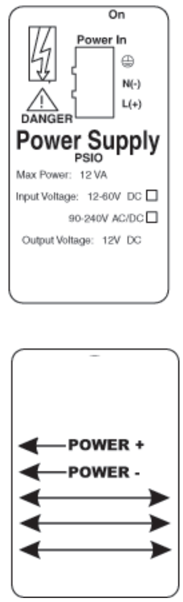


Figure 10-4: PSIO Side and Top Labels (Labels are Red and White)

10.3.2 Using the PSIO with Multiple I/O Modules

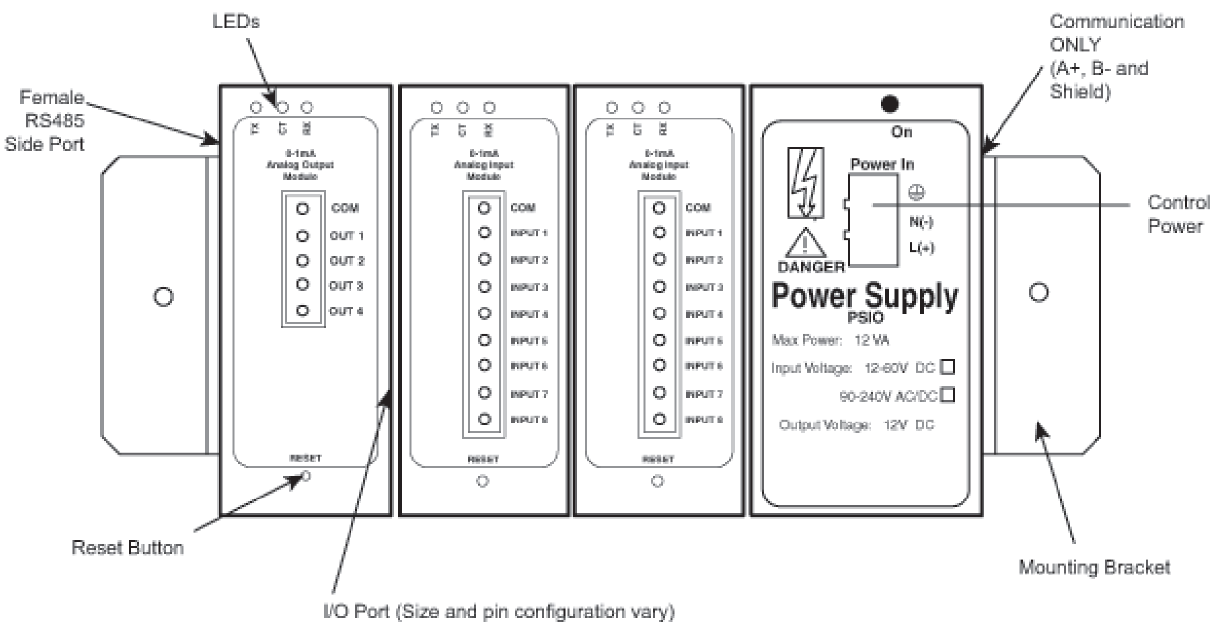


Figure 10-5: PSIO Used with Multiple I/O Modules

NOTE

As shown, the PSIO must be to the right of I/O Modules when viewing the front label.

10.4 Steps for Attaching Multiple I/O Modules

1. Each I/O module in a group must be assigned a unique address. See the *GE Communicator Instruction Manual* for details on configuring and programming the I/O Modules.
2. Determine how many power sources (such as the PSIO) are needed for the number of modules in use. See 10.3 *Steps to Determine Power Needed* on page 10–4 for details.
3. I/O modules can be mounted using either of two methods. The first method is using the mounting brackets provided, to attach directly to a panel. The second method is to attach the Din Rail clips to the mounting brackets to connect the I/O modules to a DIN rail mounting system.
4. Starting with the left module and using a slotted screwdriver, fasten the first I/O module to the left mounting bracket of the MBIO mounting brackets kit. The left mounting bracket is the one with the PEM. Fasten the internal screw tightly into the left mounting bracket.
5. Slide the female RS485 port into the male RS485 side port to connect the next I/O module to the left module. Fasten together enough to grab but do not tighten, yet.
6. Combine the modules together, one by one.
7. Attach the PSIO (power supply) to the right of the group of I/O Modules it is supplying with power.

NOTE

The PB1 can also be used as a Low Voltage Power Supply. It must be mounted separately. The PB1 should be ordered with a 12V output for this application.

8. Once you have combined all the I/O modules and power supplies together for the group, fasten tightly. This final tightening will lock the whole group together as a unit.
9. Attach the right Mounting Bracket to the right side of the group using the small Phillips head screws provided.
10. If not mounting on a DIN rail, mount the group of modules on a secure, flat surface. This procedure will insure that all modules stay connected securely.
11. The MBIO mounting brackets kit comes with 2 DIN rail mounting clips and an 8mm screw and lock washer for each clip. The clips let you easily mount the connected I/O modules (or a single I/O module between two brackets) on a DIN rail. See the following figure.

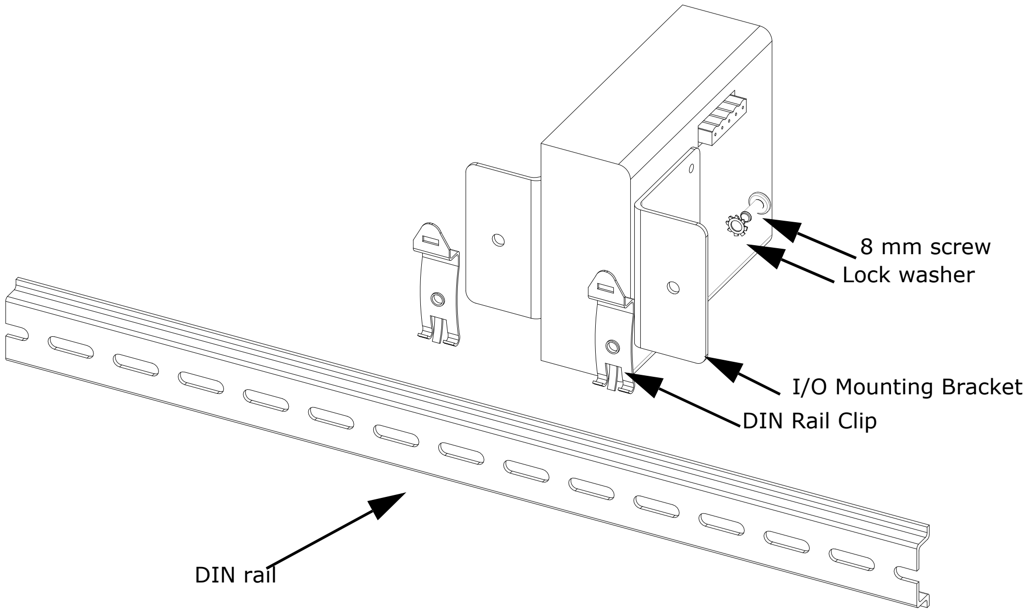


Figure 10-6: Figure 10.6: Mounting the Brackets on a DIN Rail

To use the DIN rail mounting clips:

1. From the front of either bracket, insert the screw into the lock washer and through the hole, and screw it into the clip using an appropriate screwdriver. Note that the clip should be positioned as shown above, with the indented side facing the back.
2. Repeat step a for the second bracket.
3. Hook the bottom of the clips around the bottom of the DIN rail and then push the top of the clips forward so that they fit over the top of the DIN rail. See the figure below.

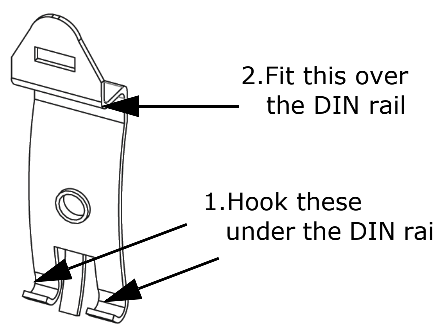


Figure 10-7: Detail of DIN Rail Mounting Clip

10.5 Factory Settings and Default Settings

Factory Settings:

All EPM 9700 I/O Modules are shipped with a preset address and a baud rate of 57600. See following sections for I/O Module addresses.

Default Settings:

Sometimes a problem prevents an I/O module from running in its Normal mode. Problems preventing normal operation are as follows:

- EEPROM Failure
- Failure of Communication Settings Checksum
- Failure of Programmable Settings Checksum
- Invalid Communications Settings
- Invalid Programmable Settings:
    - An Address outside the range of 1-247
    - A Baud Rate not supported by the device
- Reset Switch triggered during Initialization
- Any modification to the Programmable Settings
- Calibration Mode (Analog Input/Output Module)
- Test Output Mode (Analog Input/Output Module)

When an I/O Module cannot run in Normal Mode, it will still run in Default Mode. If there is a communication problem (or if you are unsure of a module's address and baud rate), press and hold the RESET button for 3 seconds: the module will reset to a default address of 247 at 57600 baud rate for 30-seconds. This enables you to interrogate the I/O using the GE Communicator software; see the *GE Communicator Instruction Manual* for instructions.

When the I/O module is operating in Default Mode, the following happens:

- The device runs a 30-second timer. This timer is reloaded with every valid request received.
- If the timer runs out, the device will reset.
- The commands used in Normal Mode will be ignored when received.
- Bits in the Device Status Registers reflect this state and the reason(s) for the state.
- The device will start in Normal Mode after reset, if nothing prevents it from doing so.

10.6 Analog Transducer Signal Output Modules

Analog Transducer Signal Output Module Specifications	
Model Numbers	1mAON4: 4-channel analog output 0±1mA
	1mAON8: 8-channel analog output 0±1mA
	20mAON4: 4-channel analog output 4-20mA
	20mAON8: 8-channel analog output 4-20mA
Accuracy	0.1% of Full Scale
Scaling	Programmable
Communication	RS485, Modbus RTU
	Programmable Baud Rates: 4800, 9600, 19200, 38400, 57600
Power Requirement	12-20 VDC @50-200mA; EPM 9700 supports up to two I/O modules without need for PSIO power supply.
Operating Temperature	(-20 to +70)^{o} C/(-4 to +158)^{o} F
Maximum Load Impedance	0±1mA: 10k Ohms; 4-20mA: 500 Ohms
Factory Settings	Modbus Address: 1mAON4: 128; 1mAON8: 128; 20mAON4: 132; 20mAON8: 132
	Baud Rate: 57600
	Transmit Delay Time: 0
Default Settings (Reset Button)	Modbus Address: 247
	Baud Rate: 57600
	Transmit Delay Time: 20ms

10.6.1 Overview

The Analog Transducer Signal Output Modules (0±1mA or 4–20mA) are available in either a 4- or 8-channel configuration. Maximum registers per request, read or write, is 17 registers.

The EPM 9700 meter supplies power for up to two connected Analog Output modules. See 10.2 *RS485 Connection to External I/O Modules* on page 10–3, for power and communication details. Refer to 10.3 *Steps to Determine Power Needed* on page 10–4 to determine if you must use an additional power source, such as the GE PSIO.

All outputs share a single common point. This is also an isolated connection (from ground).

10.6.2 Normal Mode

Normal Mode is the same for the 0-1mA and the 4-20mA Analog Output Modules except for the number of processes performed by the modules.

Both devices:

1. Accept new values through communication.
2. Output current loops scaled from previously accepted values.

   The 0-1mA module includes one more process in its Normal Mode:

3. Read and average the A/D and adjust values for Process 2 above.

   The device will operate with the following default parameters:

Address: 247 (F7H)

Baud Rate: 57600 Baud

Transmit Delay Time: 20 ms

Normal Operation is prevented by a number of occurrences. See 10.5 *Factory Settings and Default Settings* on page 10–9, for details.

10.7 Analog Input Modules

Analog Input Module Specifications	
Model Numbers	8AI1: 8-channel analog input 0±1 mA
	8AI2: 8-channel analog input 0±20 mA
	8AI3: 8-channel analog input 0±5 VDC
	8AI4: 8-channel analog input 0±10 VDC
Accuracy	0.25% of Full Scale
Scaling	Programmable
Communication	RS485, Modbus RTU
	Programmable Baud Rates: 4800, 9600, 19200, 38400, 57600
Power Requirement	12-20 VDC @50-200 mA; EPM 9700 supports up to four I/O modules without need for PSIO power supply.
Operating Temperature	(-20 to +70)^{o} C/(-4 to +158)^{o} F
Maximum Load Impedance	0±1mA: 10k Ohms; 4-20mA: 500 Ohms
Factory Settings	Modbus Address: 8AI1: 136; 8AI2: 140; 8AI3: 144; 8AI4: 148
	Baud Rate: 57600
	Transmit Delay Time: 0
Default Settings (Reset Button)	Modbus Address: 247
	Baud Rate: 57600
	Transmit Delay Time: 20 ms

10.7.1 Overview

The Analog Input Modules (0±1 mA, 0±20 mA, 0±5 VDC and 0±10 VDC) are available in 8-channel format. Maximum registers per request, read or write, is 17 registers.

The EPM 9700 meter supplies power for up to 4 connected Analog Input modules. See 10.2 *RS485 Connection to External I/O Modules* on page 10–3, for power and communication details. Refer to 10.3 *Steps to Determine Power Needed* on page 10–4 to determine if you must use an additional power source, such as the GE PSIO.

All inputs share a single common point. This is also an isolated connection (from ground).

10.7.2 Normal Mode

In Normal Mode, the Input Module:

1. Reads and averages the A/D and adjusts values for process 2.
2. Calculates the percentage of Input Value.

NOTE

The percentage value of the Input is stored in Input Value Registers (Registers 04097-04104).

The device will operate with the following default parameters:

Address: 247 (F7H)

Baud Rate: 57600 Baud

Transmit Delay Time: 20 ms

Normal Operation is prevented by a number of occurrences. See 10.5 *Factory Settings and Default Settings* on page 10–9, for details.

10.8 Digital Dry Contact Relay Output (Form C) Module

Digital Dry Contact Relay Output Module Specifications	
Model Number	4RO1: 4 latching relay outputs
Contact Type	Changeover (SPDT)
Relay Type	Mechanically latching
Communication	RS485, Modbus RTU
	Programmable Baud Rates: 4800, 9600, 19200, 38400, 57600
Power Requirement	2.0 W max @ 12-20 VDC
Operating Temperature	(-20 to +70)^{o} C/(-4 to +158)^{o} F
Switching Voltage	AC 250V / DC 30V
Switching Power	1250VA / 150W
Switching Current	5A
Mechanical Life	5 x 10^{7} switching operations
Electrical Life	10^{5} switching operations at rated current
Factory Settings	Modbus Address: 156
	Baud Rate: 57600
	Transmit Delay Time: 0
Default Settings (Reset Button)	Modbus Address: 247
	Baud Rate: 57600
	Transmit Delay Time: 20 ms

10.8.1 Overview

The Relay Output Module consists of four Latching Relay Outputs. In Normal Mode, the device accepts commands to control the relays. Relay output modules are triggered by limits programmed with the GE Communicator software. See the *GE Communicator Instruction Manual* for details on programming limits.

The EPM 9700 meter supplies power for up to 4 connected Relay Output modules. See 10.2 *RS485 Connection to External I/O Modules* on page 10–3, for power and communication details. Refer to 10.3 *Steps to Determine Power Needed* on page 10–4 to determine if you must use an additional power source, such as the GE PSIO.

Each latching relay will hold its state in the event of a power loss.

10.8.2 Communication

Maximum registers per request, read or write, is 4 registers.

The device will operate with the following default parameters:

Address: 247 (F7H)

Baud Rate: 57600 Baud

Transmit Delay Time: 20 ms

Some situations will cause the device to operate with the above Default Parameters. See 10.5 *Factory Settings and Default Settings* on page 10–9, for details of Default Mode.

10.8.3 Normal Mode

Normal Mode consists of one process: the device accepts new commands to control the relays.

10.9 Digital Solid State Pulse Output (KYZ) Module

Digital Solid State Pulse Output Module Specifications	
Model Number	4PO1
Communication	RS485, Modbus RTU
	Programmable Baud Rates: 4800, 9600, 19200, 38400, 57600
Power Requirement	12-20 VDC @50-200 mA; EPM 9450/9650 support up to four modules
Operating Temperature	(-20 to +70)^{o} C/(-4 to +158)^{o} F
Voltage Rating	Up to 300 VDC
Commands Accepted	Read and Write with at least 4 registers of data per command
Memory	256 Byte IC EEPROM for storage of programmable settings and non-volatile memory
Factory Settings	Modbus Address: 160
	Baud Rate: 57600
	Transmit Delay Time: 0
Default Settings (Reset Button)	Modbus Address: 247
	Baud Rate: 57600
	Transmit Delay Time: 20 ms

10.9.1 Overview

The KYZ Pulse Output Modules have 4 KYZ Pulse Outputs and accept Read and Write Commands with at least 4 registers of data per command. Digital Solid State Pulse Output (KYZ) Modules are user programmed to reflect VAR-hours, Watt-hours, or VA-hours.

The EPM 9700 meter supplies power for up to 4 connected KYZ Pulse Output modules. See 10.2 *RS485 Connection to External I/O Modules* on page 10–3, for power and communication details. Refer to 10.3 *Steps to Determine Power Needed* on page 10–4 to determine if you must use an additional power source, such as the GE PSIO.

NC = Normally Closed; NO = Normally Open; C = Common.

10.9.2 Communication

Maximum registers per request, read or write, is 4 registers.

The device will operate with the following Default Mode Parameters. See 10.5 *Factory Settings and Default Settings* on page 10–9, for details.

Address: 247 (F7H)

Baud Rate: 57600 Baud

Transmit Delay Time: 20 ms

10.9.3 Normal Mode

Energy readings are given to the device frequently. The device generates a pulse at each channel after a certain energy increase.

Normal Operation consists of three processes:

1. The first process accepts writes to registers 04097 - 04112. Writes can be up to four registers long and should end on the fourth register of a group (register 04100, or registers 04103-04112 or registers 04109-04112). These writes can be interpreted as two-byte, four-byte, six-byte or eight-byte energy readings. The reception of the first value for a given channel provides the initial value for that channel. Subsequent writes will increment the Residual for that channel by the difference of the old value and the new value. The previous value is then replaced with the new value. Attempting to write a value greater than the programmed Rollover Value for a given channel is completely ignored and no registers are modified. If the difference is greater than half of the programmed Rollover Value for a given channel, the write does not increment the Residual but does update the Last Value. Overflow of the Residual is not prevented.
2. The second process occurs in the main loop and attempts to decrement the Residual by the Programmed Energy/Pulse Value. If the Residual is greater than the Programmed Energy/Pulse Value and the Pending Pulses Value for that channel has not reached the maximum limit, then Residual is decremented appropriately and the Pending Pulses is incremented by two, signifying two more transitions and one more pulse.
3. The third process runs from a timer which counts off pulse widths from the Programmable Minimum Pulse Width Values. If there are Pulses Pending for a channel and the delay has passed, then the Pulses Pending is decremented for that channel and the Output Relay is toggled.

   Operation Indicator (0000H = OK, 1000H = Problem):

   Bit 1:1 = EEPROM Failure

   Bit 2:1 = Checksum for Communications Settings bad

   Bit 3:1 = Checksum for Programmable Settings bad

   Bit 4:1 = 1 or more Communications Settings are invalid

   Bit 5:1 = 1 or more Programmable Settings are invalid

   Bit 6:1 = 1 or more Programmable Settings have been modified

   Bit 7:1 = Forced Default by Reset Value

   Bit 15:1 = Normal Operation of the device is disabled

10.10 Digital Status Input Module

Digital Status Input Module Specifications	
Model Number	8DI1
Communication	RS485, Modbus RTU
	Programmable Baud Rates: 4800, 9600, 19200, 38400, 57600
Power Requirement	12-20 VDC @50-200 mA; EPM 9450/9650 support up to four modules
Operating Temperature	(-20 to +70)^{o} C/(-4 to +158)^{o} F
Voltage Rating	Up to 300 VDC
Detection	Wet/Dry, Auto-detect
Memory	256 Byte I^2C EEPROM for storage of programmable settings and non-volatile memory
Factory Settings	Modbus Address: 164
	Baud Rate: 57600
	Transmit Delay Time: 0
Default Settings (Reset Button)	Modbus Address: 247
	Baud Rate: 57600
	Transmit Delay Time: 20 ms

10.10.1 Overview

The Digital Status Input Module is used either for additional status detect or for accumulating pulses from external equipment, such as power meters, water meters, etc.

The EPM 9700 meter supplies power for up to 4 connected Digital Status Input modules. See 10.2 *RS485 Connection to External I/O Modules* on page 10–3, for power and communication details. Refer to 10.3 *Steps to Determine Power Needed* on page 10–4 to determine if you must use an additional power source, such as the GE PSIO.

10.10.2 Communication

Maximum registers per request, read or write, is 4 registers.

The device will operate with the following Default Mode Parameters. See 10.5 *Factory Settings and Default Settings* on page 10–9, for details.

Address: 247 (F7H)

Baud Rate: 57600 Baud

Transmit Delay Time: 20 ms

10.10.3 Normal Mode

The device polls the inputs at 100Hz (once every 10 ms), debouncing the inputs and incrementing the Transition Accumulators for each channel as appropriate.

The inputs are represented by Channel 1 in the LSB through Channel 8 in the MSB of the low order byte of the register.

Multilin EPM 9700

Appendix A: Three-Phase Power Measurement

This introduction to three-phase power and power measurement is intended to provide only a brief overview of the subject. The professional meter engineer or meter technician should refer to more advanced documents such as the EEI Handbook for Electricity Metering and the application standards for more in-depth and technical coverage of the subject.

A.1 Three Phase System Configurations

Three-phase power is most commonly used in situations where large amounts of power will be used because it is a more effective way to transmit the power and because it provides a smoother delivery of power to the end load. There are two commonly used connections for three-phase power, a wye connection or a delta connection. Each connection has several different manifestations in actual use.

When attempting to determine the type of connection in use, it is a good practice to follow the circuit back to the transformer that is serving the circuit. It is often not possible to conclusively determine the correct circuit connection simply by counting the wires in the service or checking voltages. Checking the transformer connection will provide conclusive evidence of the circuit connection and the relationships between the phase voltages and ground.

A.2 Wye Connection

The wye connection is so called because when you look at the phase relationships and the winding relationships between the phases it looks like a Y. The figure depicts the winding relationships for a wye-connected service. In a wye service the neutral (or center point of the wye) is typically grounded. This leads to common voltages of 208/120 and 480/277 (where the first number represents the phase-to-phase voltage and the second number represents the phase-to-ground voltage).

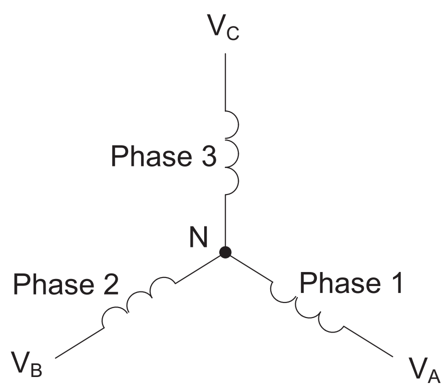


Figure A-1: Three-phase Wye Winding

The three voltages are separated by 120° electrically. Under balanced load conditions the currents are also separated by 120°. However, unbalanced loads and other conditions can cause the currents to depart from the ideal 120° separation. Three-phase voltages and currents are usually represented with a phasor diagram. A phasor diagram for the typical connected voltages and currents is shown in the next figure.

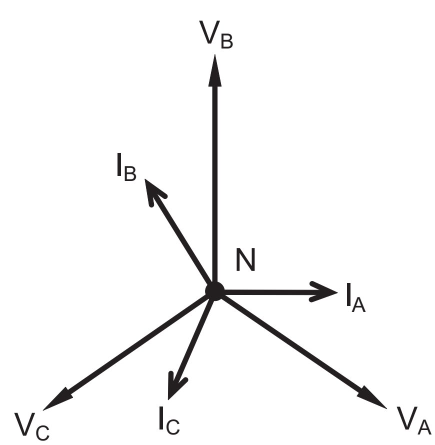


Figure A-2: Phasor Diagram Showing Three-phase Voltages and Currents

The phasor diagram shows the 120° angular separation between the phase voltages. The phase-to-phase voltage in a balanced three-phase wye system is 1.732 times the phase-to-neutral voltage. The center point of the wye is tied together and is typically grounded. The table shows the common voltages used in the United States for wye-connected systems.

Table A.1: Common Phase Voltages on Wye Services

Phase to Ground Voltage	Phase to Phase Voltage
120 volts	208 volts
277 volts	480 volts
2,400 volts	4,160 volts
7,200 volts	12,470 volts
7,620 volts	13,200 volts

Usually a wye-connected service will have four wires: three wires for the phases and one for the neutral. The three-phase wires connect to the three phases (as shown in the first figure). The neutral wire is typically tied to the ground or center point of the wye.

In many industrial applications the facility will be fed with a four-wire wye service but only three wires will be run to individual loads. The load is then often referred to as a delta-connected load but the service to the facility is still a wye service; it contains four wires if you trace the circuit back to its source (usually a transformer). In this type of connection the phase to ground voltage will be the phase-to-ground voltage indicated in Table A.1, even though a neutral or ground wire is not physically present at the load. The transformer is the best place to determine the circuit connection type because this is a location where the voltage reference to ground can be conclusively identified.

A.3 Delta Connection

Delta-connected services may be fed with either three wires or four wires. In a three-phase delta service the load windings are connected from phase-to-phase rather than from phase-to-ground. The figure shows the physical load connections for a delta service.

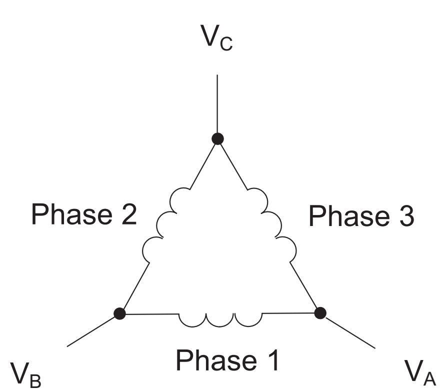


Figure A-3: Three-phase Delta Winding Relationship

In this example of a delta service, three wires will transmit the power to the load. In a true delta service, the phase-to-ground voltage will usually not be balanced because the ground is not at the center of the delta.

The next figure shows the phasor relationships between voltage and current on a three-phase delta circuit.

In many delta services, one corner of the delta is grounded. This means the phase to ground voltage will be zero for one phase and will be full phase-to-phase voltage for the other two phases. This is done for protective purposes.

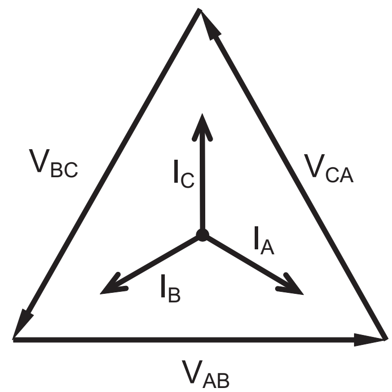


Figure A-4: Phasor Diagram, Three-Phase Voltages and Currents, Delta-Connected

Another common delta connection is the four-wire, grounded delta used for lighting loads. In this connection the center point of one winding is grounded. On a 120/240 volt, four-wire, grounded delta service the phase-to-ground voltage would be 120 volts on two phases and 208 volts on the third phase. Figure A.5 shows the phasor diagram for the voltages in a three-phase, four-wire delta system.

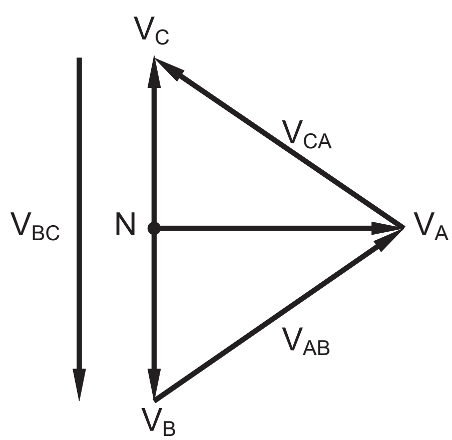


Figure A-5: Phasor Diagram Showing Three-phase Four-Wire Delta-Connected System

A.4 Blondel's Theorem and Three Phase Measurement

In 1893 an engineer and mathematician named Andre E. Blondel set forth the first scientific basis for polyphase metering. His theorem states:

If energy is supplied to any system of conductors through N wires, the total power in the system is given by the algebraic sum of the readings of N wattmeters so arranged that each of the N wires contains one current coil, the corresponding potential coil being connected between that wire and some common point. If this common point is on one of the N wires, the measurement may be made by the use of N-1 Wattmeters.

The theorem may be stated more simply, in modern language:

In a system of N conductors, N-1 meter elements will measure the power or energy taken provided that all the potential coils have a common tie to the conductor in which there is no current coil.

Three-phase power measurement is accomplished by measuring the three individual phases and adding them together to obtain the total three phase value. In older analog meters, this measurement was accomplished using up to three separate elements. Each element combined the single-phase voltage and current to produce a torque on the meter disk. All three elements were arranged around the disk so that the disk was subjected to the combined torque of the three elements. As a result the disk would turn at a higher speed and register power supplied by each of the three wires.

According to Blondel's Theorem, it was possible to reduce the number of elements under certain conditions. For example, a three-phase, three-wire delta system could be correctly measured with two elements (two potential coils and two current coils) if the potential coils were connected between the three phases with one phase in common.

In a three-phase, four-wire wye system it is necessary to use three elements. Three voltage coils are connected between the three phases and the common neutral conductor. A current coil is required in each of the three phases.

In modern digital meters, Blondel's Theorem is still applied to obtain proper metering. The difference in modern meters is that the digital meter measures each phase voltage and current and calculates the single-phase power for each phase. The meter then sums the three phase powers to a single three-phase reading.

Some digital meters measure the individual phase power values one phase at a time. This means the meter samples the voltage and current on one phase and calculates a power value. Then it samples the second phase and calculates the power for the second phase. Finally, it samples the third phase and calculates that phase power. After sampling all three phases, the meter adds the three readings to create the equivalent three-phase power value. Using mathematical averaging techniques, this method can derive a quite accurate measurement of three-phase power.

More advanced meters actually sample all three phases of voltage and current simultaneously and calculate the individual phase and three-phase power values. The advantage of simultaneous sampling is the reduction of error introduced due to the difference in time when the samples were taken.

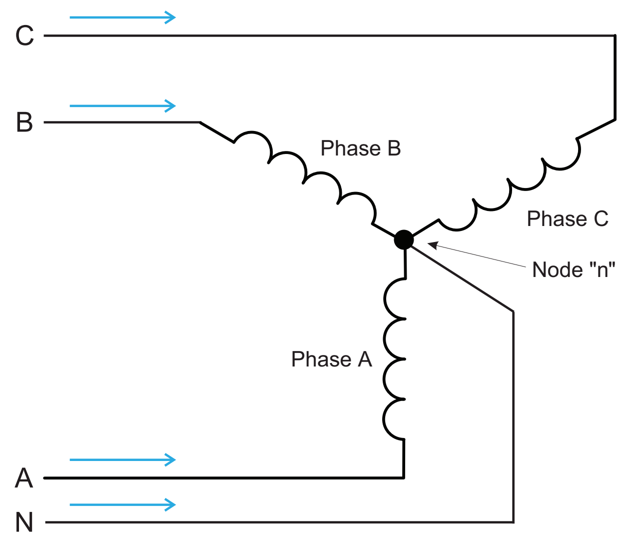


Figure A-6: Three-Phase Wye Load Illustrating Kirchoff's Law and Blondel's Theorem

Blondel's Theorem is a derivation that results from Kirchoff's Law. Kirchoff's Law states that the sum of the currents into a node is zero. Another way of stating the same thing is that the current into a node (connection point) must equal the current out of the node. The law can be applied to measuring three-phase loads. Figure A.6 shows a typical connection of a three-phase load applied to a three-phase, four-wire service. Kirchoff's Law holds that the sum of currents A, B, C and N must equal zero or that the sum of currents into Node "n" must equal zero.

If we measure the currents in wires A, B and C, we then know the current in wire N by Kirchoff's Law and it is not necessary to measure it. This fact leads us to the conclusion of Blondel's Theorem- that we only need to measure the power in three of the four wires if they are connected by a common node. In the circuit of Figure A.6 we must measure the power flow in three wires. This will require three voltage coils and three current coils (a three-element meter). Similar figures and conclusions could be reached for other circuit configurations involving Delta-connected loads.

A.5 Power, Energy and Demand

It is quite common to exchange power, energy and demand without differentiating between the three. Because this practice can lead to confusion, the differences between these three measurements will be discussed.

Power is an instantaneous reading. The power reading provided by a meter is the present flow of watts. Power is measured immediately just like current. In many digital meters, the power value is actually measured and calculated over a one second interval because it takes some amount of time to calculate the RMS values of voltage and current. But this time interval is kept small to preserve the instantaneous nature of power.

Energy is always based on some time increment; it is the integration of power over a defined time increment. Energy is an important value because almost all electric bills are based, in part, on the amount of energy used.

Typically, electrical energy is measured in units of kilowatt-hours (kWh). A kilowatt-hour represents a constant load of one thousand watts (one kilowatt) for one hour. Stated another way, if the power delivered (instantaneous watts) is measured as 1,000 watts and the load was served for a one hour time interval then the load would have absorbed one kilowatt-hour of energy. A different load may have a constant power requirement of 4,000 watts. If the load were served for one hour it would absorb four kWh. If the load were served for 15 minutes it would absorb ¼ of that total or one kWh.

Figure A.7 shows a graph of power and the resulting energy that would be transmitted as a result of the illustrated power values. For this illustration, it is assumed that the power level is held constant for each minute when a measurement is taken. Each bar in the graph will represent the power load for the one-minute increment of time. In real life the power value moves almost constantly.

The data from Figure A.7 is reproduced in Table A.2 to illustrate the calculation of energy. Since the time increment of the measurement is one minute and since we specified that the load is constant over that minute, we can convert the power reading to an equivalent consumed energy reading by multiplying the power reading times 1/60 (converting the time base from minutes to hours).

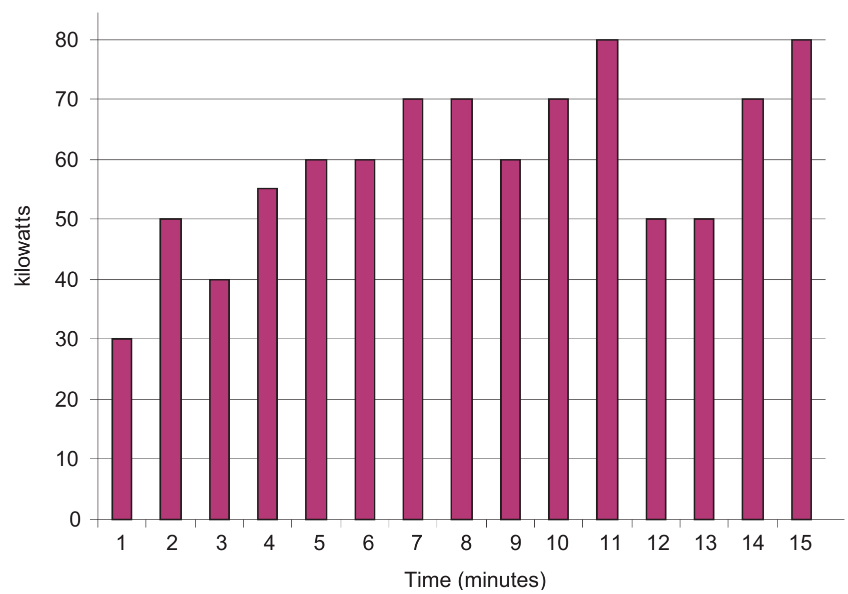


Figure A-7: Power Use over Time

Table A.2: Power and Energy Relationship over Time

Time Interval (minute)	Power (kW)	Energy (kWh)	Accumulated Energy (kWh)
1	30	0.50	0.50
2	50	0.83	1.33
3	40	0.67	2.00
4	55	0.92	2.92
5	60	1.00	3.92
6	60	1.00	4.92
7	70	1.17	6.09

Table A.2: Power and Energy Relationship over Time

Time Interval (minute)	Power (kW)	Energy (kWh)	Accumulated Energy (kWh)
8	70	1.17	7.26
9	60	1.00	8.26
10	70	1.17	9.43
11	80	1.33	10.76
12	50	0.83	12.42
13	50	0.83	12.42
14	70	1.17	13.59
15	80	1.33	14.92

As in Table A.2, the accumulated energy for the power load profile of Figure A.7 is 14.92 kWh.

Demand is also a time-based value. The demand is the average rate of energy use over time. The actual label for demand is kilowatt-hours/hour but this is normally reduced to kilowatts. This makes it easy to confuse demand with power, but demand is not an instantaneous value. To calculate demand it is necessary to accumulate the energy readings (as illustrated in Figure A.7) and adjust the energy reading to an hourly value that constitutes the demand.

In the example, the accumulated energy is 14.92 kWh. But this measurement was made over a 15-minute interval. To convert the reading to a demand value, it must be normalized to a 60-minute interval. If the pattern were repeated for an additional three 15-minute intervals the total energy would be four times the measured value or 59.68 kWh. The same process is applied to calculate the 15-minute demand value. The demand value associated with the example load is 59.68 kWh/hr or 59.68 kWd. Note that the peak instantaneous value of power is 80 kW, significantly more than the demand value.

Figure A.8 shows another example of energy and demand. In this case, each bar represents the energy consumed in a 15-minute interval. The energy use in each interval typically falls between 50 and 70 kWh. However, during two intervals the energy rises sharply and peaks at 100 kWh in interval number 7. This peak of usage will result in setting a high demand reading. For each interval shown the demand value would be four times the indicated energy reading. So interval 1 would have an associated demand of 240 kWh/hr. Interval 7 will have a demand value of 400 kWh/hr. In the data shown, this is the peak demand value and would be the number that would set the demand charge on the utility bill.

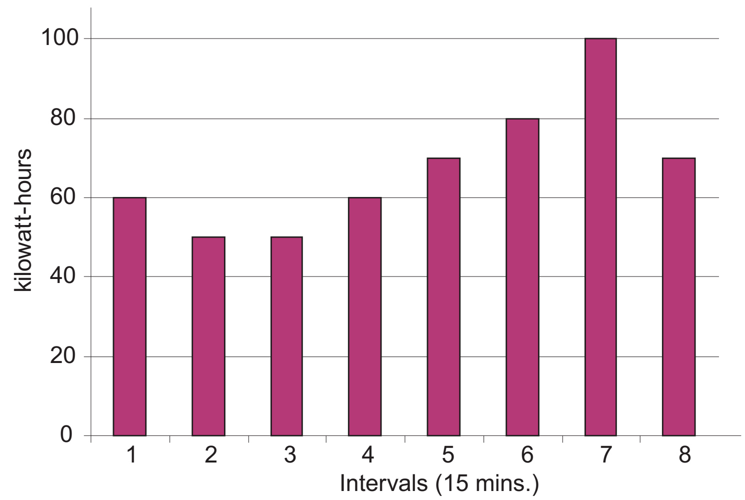


Figure A-8: Energy Use and Demand

As can be seen from this example, it is important to recognize the relationships between power, energy and demand in order to control loads effectively or to monitor use correctly.

A.6 Reactive Energy and Power Factor

The real power and energy measurements discussed in the previous section relate to the quantities that are most used in electrical systems. But it is often not sufficient to only measure real power and energy. Reactive power is a critical component of the total power picture because almost all real-life applications have an impact on reactive power. Reactive power and power factor concepts relate to both load and generation applications. However, this discussion will be limited to analysis of reactive power and power factor as they relate to loads. To simplify the discussion, generation will not be considered.

Real power (and energy) is the component of power that is the combination of the voltage and the value of corresponding current that is directly in phase with the voltage. However, in actual practice the total current is almost never in phase with the voltage. Since the current is not in phase with the voltage, it is necessary to consider both the inphase component and the component that is at quadrature (angularly rotated 90o or perpendicular) to the voltage. Figure A.9 shows a single-phase voltage and current and breaks the current into its in-phase and quadrature components.

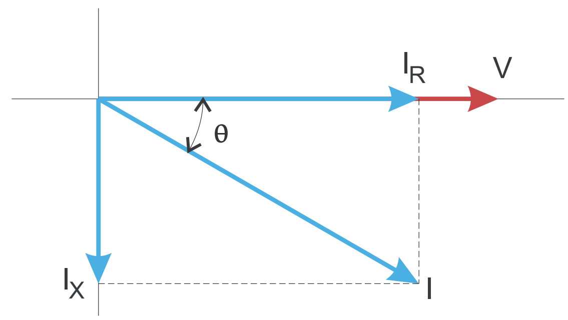


Figure A-9: Voltage and Complex Current

The voltage (V) and the total current (I) can be combined to calculate the apparent power or VA. The voltage and the in-phase current (IR) are combined to produce the real power or watts. The voltage and the quadrature current (IX) are combined to calculate the reactive power.

The quadrature current may be lagging the voltage (as shown in Figure A.9) or it may lead the voltage. When the quadrature current lags the voltage the load is requiring both real power (watts) and reactive power (VARs). When the quadrature current leads the voltage the load is requiring real power (watts) but is delivering reactive power (VARs) back into the system; that is VARs are flowing in the opposite direction of the real power flow.

Reactive power (VARs) is required in all power systems. Any equipment that uses magnetization to operate requires VARs. Usually the magnitude of VARs is relatively low compared to the real power quantities. Utilities have an interest in maintaining VAR requirements at the customer to a low value in order to maximize the return on plant invested to deliver energy. When lines are carrying VARs, they cannot carry as many watts. So keeping the VAR content low allows a line to carry its full capacity of watts. In order to encourage customers to keep VAR requirements low, some utilities impose a penalty if the VAR content of the load rises above a specified value.

A common method of measuring reactive power requirements is power factor. Power factor can be defined in two different ways. The more common method of calculating power factor is the ratio of the real power to the apparent power. This relationship is expressed in the following formula:

Total PF = real power / apparent power = watts/VA

This formula calculates a power factor quantity known as Total Power Factor. It is called Total PF because it is based on the ratios of the power delivered. The delivered power quantities will include the impacts of any existing harmonic content. If the voltage or current includes high levels of harmonic distortion the power values will be affected. By calculating power factor from the power values, the power factor will include the impact of harmonic distortion. In many cases this is the preferred method of calculation because the entire impact of the actual voltage and current are included.

A second type of power factor is Displacement Power Factor. Displacement PF is based on the angular relationship between the voltage and current. Displacement power factor does not consider the magnitudes of voltage, current or power. It is solely based on the phase angle differences. As a result, it does not include the impact of harmonic distortion. Displacement power factor is calculated using the following equation:

$$\text{Displacement PF} = \cos\theta$$

where q is the angle between the voltage and the current (see Fig. A.9).

In applications where the voltage and current are not distorted, the Total Power Factor will equal the Displacement Power Factor. But if harmonic distortion is present, the two power factors will not be equal.

A.7 Harmonic Distortion

Harmonic distortion is primarily the result of high concentrations of non-linear loads. Devices such as computer power supplies, variable speed drives and fluorescent light ballasts make current demands that do not match the sinusoidal waveform of AC electricity. As a result, the current waveform feeding these loads is periodic but not sinusoidal. Figure A.10 shows a normal, sinusoidal current waveform. This example has no distortion.

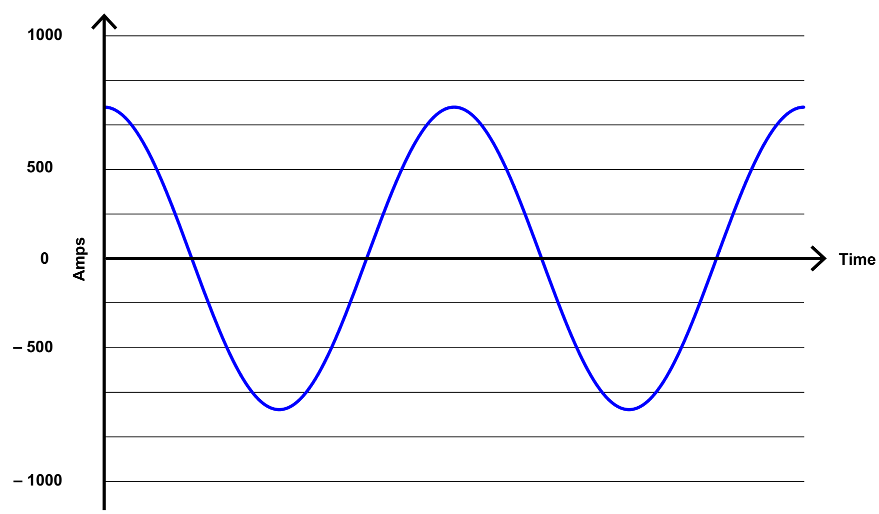


Figure A-10: Nondistorted Current Waveform

Figure A.11 shows a current waveform with a slight amount of harmonic distortion. The waveform is still periodic and is fluctuating at the normal 60 Hz frequency. However, the waveform is not a smooth sinusoidal form as seen in Figure A.10.

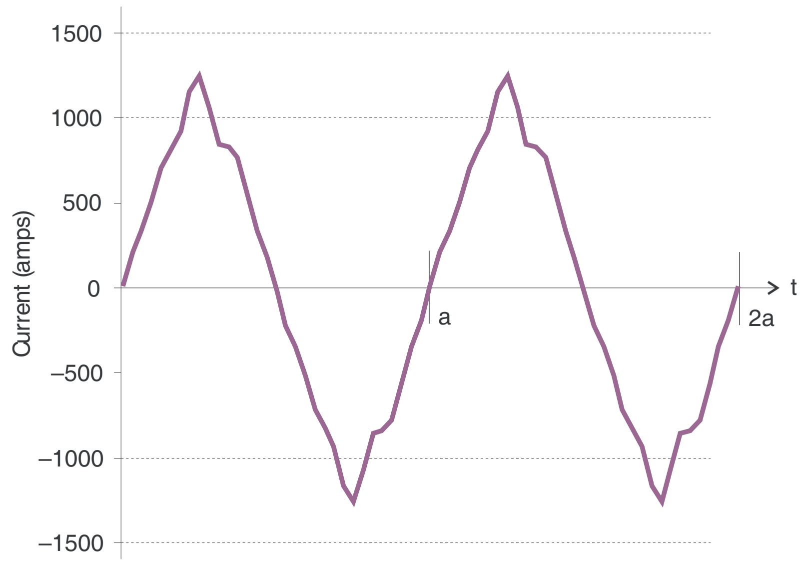


Figure A-11: Distorted Current Waveform

The distortion observed in Figure A.11 can be modeled as the sum of several sinusoidal waveforms of frequencies that are multiples of the fundamental 60 Hz frequency. This modeling is performed by mathematically disassembling the distorted waveform into a collection of higher frequency waveforms.

These higher frequency waveforms are referred to as harmonics. Figure A.12 shows the content of the harmonic frequencies that make up the distortion portion of the waveform in Figure A.11.

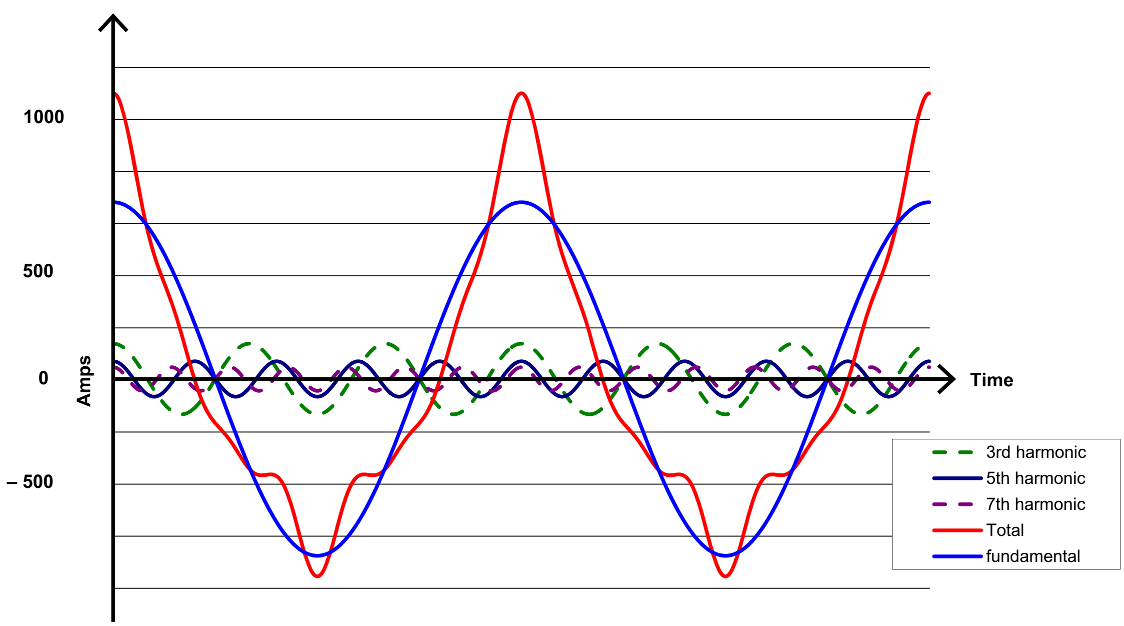


Figure A-12: Waveforms of the Harmonics

The waveforms shown in Figure A.12 are not smoothed but do provide an indication of the impact of combining multiple harmonic frequencies together.

When harmonics are present it is important to remember that these quantities are operating at higher frequencies. Therefore, they do not always respond in the same manner as 60 Hz values.

Inductive and capacitive impedance are present in all power systems. We are accustomed to thinking about these impedances as they perform at 60 Hz. However, these impedances are subject to frequency variation.

XL = jwL and

XC = 1/jwC

At 60 Hz, w = 377; but at 300 Hz (5th harmonic) w = 1,885. As frequency changes impedance changes and system impedance characteristics that are normal at 60 Hz may behave entirely differently in the presence of higher order harmonic waveforms.

Traditionally, the most common harmonics have been the low order, odd frequencies, such as the 3rd, 5th, 7th, and 9th. However newer, non-linear loads are introducing significant quantities of higher order harmonics.

Since much voltage monitoring and almost all current monitoring is performed using instrument transformers, the higher order harmonics are often not visible. Instrument transformers are designed to pass 60 Hz quantities with high accuracy. These devices, when designed for accuracy at low frequency, do not pass high frequencies with high accuracy; at frequencies above about 1200 Hz they pass almost no information. So when instrument transformers are used, they effectively filter out higher frequency harmonic distortion making it impossible to see.

However, when monitors can be connected directly to the measured circuit (such as direct connection to a 480 volt bus) the user may often see higher order harmonic distortion. An important rule in any harmonics study is to evaluate the type of equipment and connections before drawing a conclusion. Not being able to see harmonic distortion is not the same as not having harmonic distortion.

It is common in advanced meters to perform a function commonly referred to as waveform capture. Waveform capture is the ability of a meter to capture a present picture of the voltage or current waveform for viewing and harmonic analysis. Typically a waveform capture will be one or two cycles in duration and can be viewed as the actual waveform, as a spectral view of the harmonic content, or a tabular view showing the magnitude and phase shift of each harmonic value. Data collected with waveform capture is typically not saved to memory. Waveform capture is a real-time data collection event.

Waveform capture should not be confused with waveform recording that is used to record multiple cycles of all voltage and current waveforms in response to a transient condition.

A.8 Power Quality

Power quality can mean several different things. The terms "power quality" and "power quality problem" have been applied to all types of conditions. A simple definition of "power quality problem" is any voltage, current or frequency deviation that results in mis-operation or failure of customer equipment or systems. The causes of power quality problems vary widely and may originate in the customer equipment, in an adjacent customer facility or with the utility.

In his book Power Quality Primer, Barry Kennedy provided information on different types of power quality problems. Some of that information is summarized in the table.

Table A.3: Typical Power Quality Problems and Sources

Cause	Disturbance Type	Source
Impulse transient	Transient voltage disturbance, sub-cycle duration	Lightning Electrostatic discharge Load switching Capacitor switching
Oscillatory transient with decay	Transient voltage, sub-cycle duration	Line/cable switching Capacitor switching Load switching
Sag/swell	RMS voltage, multiple cycle duration	Remote system faults
Interruptions	RMS voltage, multiple seconds or longer duration	System protection Circuit breakers Fuses Maintenance
Under voltage/over voltage	RMS voltage, steady state, multiple seconds or longer duration	Motor starting Load variations Load dropping
Voltage flicker	RMS voltage, steady state, repetitive condition	Intermittent loads Motor starting Arc furnaces
Harmonic distortion	Steady state current or voltage, long-term duration	Non-linear loads System resonance

It is often assumed that power quality problems originate with the utility. While it is true that power quality problems can originate with the utility system, many problems originate with customer equipment. Customer-caused problems may manifest themselves inside the customer location or they may be transported by the utility system to another adjacent customer. Often, equipment that is sensitive to power quality problems may in fact also be the cause of the problem.

If a power quality problem is suspected, it is generally wise to consult a power quality professional for assistance in defining the cause and possible solutions to the problem.

Multilin EPM 9700

Appendix B: Reference Material

This appendix contains basic explanations of some of the concepts mentioned in the manual.

B.1 Transformer Line/Loss Compensation

The Edison Electric Institute's Handbook for Electricity Metering, Ninth Edition defines Loss Compensation as:

> A means for correcting the reading of a meter when the metering point and point of service are physically separated, resulting in measurable losses including I2R losses in conductors and transformers and iron-core losses. These losses may be added to or subtracted from the meter registration.

Loss compensation may be used in any instance where the physical location of the meter does not match the electrical location where change of ownership occurs. Most often this appears when meters are connected on the low voltage side of power transformers when the actual ownership change occurs on the high side of the transformer. This condition is illustrated in Figure B.1.

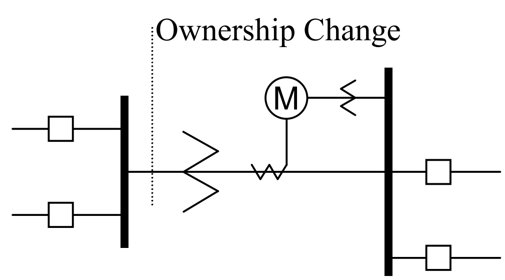


Figure B-1: Low Voltage Metering Installation Requiring Loss Compensation

It is generally less expensive to install metering equipment on the low voltage side of a transformer and in some conditions other limitations may also impose the requirement of low-side metering even though the actual ownership change occurs on the high voltage side.

The need for loss compensated metering may also exist when the ownership changes several miles along a transmission line where it is simply impractical to install metering equipment. Ownership may change at the midway point of a transmission line where there are no substation facilities. In this case, power metering must again be compensated. This condition is shown in Figure B.2.

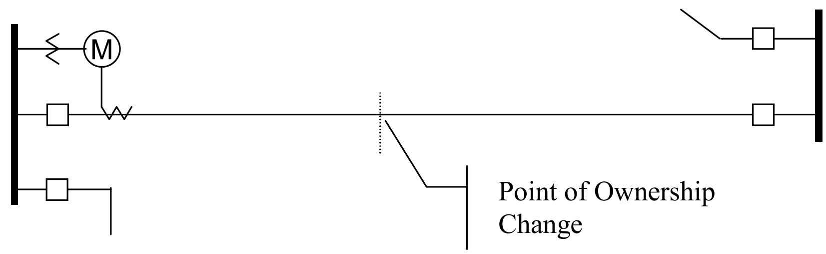


Figure B-2: Joint Ownership Line Meeting Requiring Loss Compensation

A single meter cannot measure the losses in a transformer or transmission line directly. It can, however, include computational corrections to calculate the losses and add or subtract those losses to the energy flow measured at the meter location. This is the method used for loss compensation in the EPM 9700 meter. Refer to the *GE Communicator Instruction Manual* for detailed explanation and instructions for using the Transformer Line Loss Compensation feature of the EPM 9700 meter.

The computational corrections used for transformer and transmission line loss compensation are similar. In both cases, no-load losses and full-load losses are evaluated and a correction factor for each loss level is calculated. However, the calculation of the correction factors that must be programmed into the meter differ for the two different applications. For this reason, the two methodologies will be treated separately in this chapter.

In the EPM 9700 meter, Loss Compensation is a technique that computationally accounts for active and reactive power losses. The meter calculations are based on the following formulae. These equations describe the amount of active (watts) and reactive (VARs) power lost due to both iron and copper effects (reflected to the secondary of the instrument transformers).

$$W_{TotalTransformerLoss} = VA_{TransformerFullScale} \times \left[\%LFWE \times \left(\frac{Vmeasured}{Vnominal}\right)^2 + \%LWCU \times \left(\frac{Imeasured}{Inominal}\right)^2\right]$$

$$VAR_{TotalTransfomerLoss} = VA_{TransformerFullScale} \times \left[\%LVFE \times \left(\frac{Vmeasured}{Vnominal}\right)^4 + \%LVCU \times \left(\frac{Imeasured}{Inominal}\right)^2\right]$$

The Values for %LWFE, %LWCU, %LVFE, and %LVCU are derived from the transformer and meter information, as demonstrated in the following sections.

The calculated loss compensation values are added to or subtracted from the measured Watts and VARs. The selection of adding or subtracting losses is made through the meter's profile when programming the meter (see the following section for instructions). The meter uses the combination of the add/subtract setting and the directional definition of power flow (also in the profile) to determine how to handle the losses. Losses will be "added to" or "subtracted from" (depending on whether add or subtract is selected) the Received Power flow. For example, if losses are set to "Add to" and received power equals 2000 kW and losses are equal to 20 kW then the total metered value with loss compensation would be 2020 kW; for these same settings if the meter measured 2000 kW of delivered power the total metered value with loss compensation would be 1980 kW.

Since transformer loss compensation is the more common loss compensation method, the meter has been designed for this application. Line loss compensation is calculated in the meter using the same terms but the percent values are calculated by a different methodology.

B.2 IEC 61000-4-30/EN 50160 Reporting

Flicker is the sensation that is experienced by the human visual system when it is subjected to changes occurring in the illumination intensity of light sources. The primary effects of Flicker are headaches, irritability and, sometimes, epileptic seizures.

IEC 61000-4-15 and former IEC 868 describe the methods used to determine Flicker severity. This phenomenon is strictly related to the sensitivity and the reaction of individuals. It can only be studied on a statistical basis by setting up suitable experiments among people.

B.2.1 Theory of Operation

Flicker can be caused by voltage variations that are in turn caused by variable loads, such as arc furnaces, laser printers and microwave ovens. In order to model the eye brain change, which is a complex physiological process, the signal from the power network has to be processed while conforming with Figure B.3.

- Block 1 consists of scaling circuitry and an automatic gain control function that normalizes input voltages to Blocks 2, 3 and 4. For the specified 50 Hz operation, the voltage standard is 230 V RMS.
- Block 2 recovers the voltage fluctuation by squaring the input voltage scaled to the reference level. This simulates the behavior of a lamp.

- Block 3 is composed of a cascade of two filters and a measuring range selector. In this implementation, a log classifier covers the full scale in use so the gain selection is automatic and not shown here. The first filter eliminates the DC component and the double mains frequency components of the demodulated output. The configuration consists of a .05 Hz Low High Pass filter and a 6 Pole Butterworth Low Pass filter located at 35 Hz. The second filter is a weighting filter that simulates the response of the human visual system to sinusoidal voltage fluctuations of a coiled filament, gas-filled lamp (60 W - 230 V). The filter implementation of this function is as specified in IEC 61000-4-15.
- Block 4 is composed of a squaring multiplier and a Low Pass filter. The Human Flicker Sensation via lamp, eye and brain is simulated by the combined non-linear response of Blocks 2, 3 and 4.
- Block 5 performs an online statistical cumulative probability analysis of the Flicker level. Block 5 allows direct calculation of the evaluation parameters Pst and Plt.

Flicker Evaluation occurs in the following forms: Instantaneous, Short Term or Long Term. Each form is detailed below:

- Instantaneous Flicker Evaluation: An output of 1.00 from Block 4 corresponds to the Reference Human Flicker Perceptibility Threshold for 50% of the population. This value is measured in Perceptibility Units (PU) and is labeled Pinst. This is a real time value and it is continuously updated.
- Short Term Flicker Evaluation: An output of 1.00 from Block 5 (corresponding to the Pst value) corresponds to the conventional threshold of irritability per IEC 61000-3-3. In order to evaluate Flicker severity, two parameters have been defined: one for the short term called Pst (defined in this section) and one for the long term called Plt (defined in the next section).

  The standard measurement time for Pst is 10 minutes. Pst is derived from the time at level statistics obtained from the level classifier in Block 5 of the Flicker meter. The following formula is used:

$$P_{st} = \sqrt{0.0314P_{0.1} + 0.0525P_{1s} + 0.0657P_{3s} + 0.28P_{10s} + 0.08P_{50s}}$$

  where the percentiles P(0.1), P(1), P(3), P(10), P(50) are the Flicker levels exceeded for 0.1, 1, 2, 20 and 50% of the time during the observation period. The suffix S in the formula indicates that the smoothed value should be used. The smoothed values are obtained using the following formulas:

  P(1s) = (P(.7) + P(1) + P(1.5))/3

  P(3s) = (P(2.2) + P(3) + P(4))/3

  P(10s) = (P(6) + P(8) + P(10) + P(13) + P(17))/5

  P(50s) = (P(30) + P(50) + P(80))/3

  The 0.3-second memory time constant in the Flicker meter ensures that P(0.1) cannot change abruptly and no smoothing is needed for this percentile.
- Long Term Flicker Evaluation: The 10-minute period on which the short-term Flicker severity is based is suitable for short duty cycle disturbances. For Flicker sources with long and variable duty cycles (e.g. arc furnaces) it is necessary to provide criteria for long-term assessment. For this purpose, the long-term Plt is derived from the short-

term values over an appropriate period. By definition, this is 12 short-term values of 10 minutes each over a period of 2 hours. The following formula is used:

$$P_{lt} = \sqrt[3]{\frac{\sum_{i=1}^{N} P_{sti}^3}{N}}$$

where Psti (i = 1, 2, 3, ...) are consecutive readings of the short-term severity Pst.

B.2.2 Summary

Flicker is changes in the illumination of light sources due to cyclical voltage variations.

Pinst is Instantaneous Flicker values in Perceptibility Units (PU).

Pst is value based on 10-minute analysis.

Plt is value based on 12 Pst values.

Measurement Procedure

1. Original Signal with amplitude variations
2. Square demodulator
3. Weighted filter
4. Low pass filter 1st order
5. Statistical computing

Data available

- Pst, Pst Max, Pst Min values for short term recording
- Plt, Plt Max, Plt Min values for long term recording

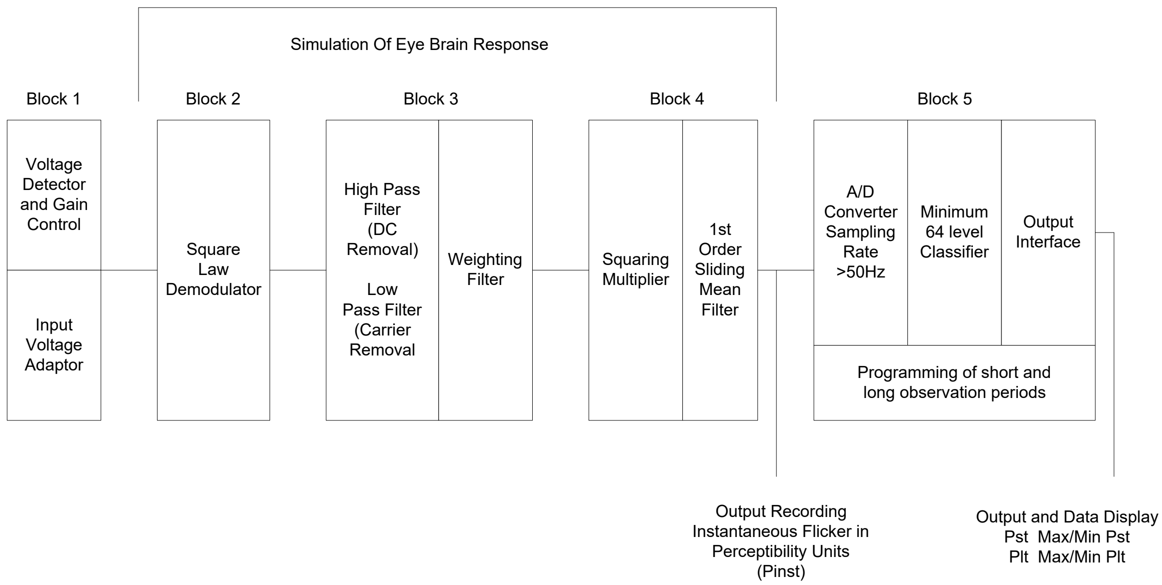


Figure B-3: Simulation of Eye Brain Response

Refer to Chapter 23 in the *GE Communicator Instruction Manual* for additional information.

Multilin EPM 9700

Appendix C: Manual Revision History

C.1 Release Notes

Table C–1: Release Dates

MANUAL	GE PART NO.	RELEASE DATE
GEK-131026D	1601-0715-A1	May 2018
GEK-131026DA	1601-0715-A2	July 2018
GEK-131026DB	1601-0715-A3	July 2019
GEK-131026DC	1601-0715-A4	January 2020
GEK-131026DD	1601-0715-A5	April 2020
N/A	1601-0715-A6	September 2021

Multilin EPM 9700

Glossary

0.2 Second Values:

These values are the RMS values of the indicated quantity as calculated after approximately 200 milliseconds (3 cycles) of sampling.

1- Second Values:

These values are the RMS values of the indicated quantity as calculated after one second (60 cycles) of sampling.

Alarm:

An event or condition in a meter that can cause a trigger or call-back to occur.

Annunciator:

A short label that identifies particular quantities or values displayed, for example kWh.

Average (Current):

When applied to current values (Amps) the average is a calculated value that corresponds to the thermal average over a specified time interval.

The interval is specified by the user in the meter profile. The interval is typically 15 minutes. So, Average Amps is the thermal average of Amps over the previous 15-minute interval. The thermal average rises to 90% of the actual value in each time interval. For example, if a constant 100 Amp load is applied, the thermal average will indicate 90 amps after one time interval, 99 amps after two time intervals and 99.9 amps after three time intervals.

Average (Input Pulse Accumulations):

When applied to Input Pulse Accumulations, the “Average” refers to the block (fixed) window average value of the input pulses.

Average (Power):

When applied to power values (Watts, VARs, VA), the average is a calculated value that corresponds to the thermal average over a specified time interval.

The interval is specified by the user in the meter profile. The interval is typically 15 minutes. So, the Average Watts is the thermal average of Watts over the previous 15-minute interval. The thermal average rises to 90% of the actual value in each time interval. For example, if a constant 100 kW load is applied, the thermal average will indicate 90 kW after one time interval, 99 kW after two time intervals and 99.9 kW after three time intervals.

Bit:

A unit of computer information equivalent to the result of a choice between two alternatives (Yes/No, On/Off, for example).

Or, the physical representation of a bit by an electrical pulse whose presence or absence indicates data.

Binary:

Relating to a system of numbers having 2 as its base (digits 0 and 1).

Block Window Avg. (Power):

The Block (Fixed) Window Average is the average power calculated over a user-set time interval, typically 15 minutes. This calculated average corresponds to the demand calculations performed by most electric utilities in monitoring user power demand. (See Rolling Window Average.)

Byte:

A group of 8 binary digits processed as a unit by a computer (or device) and used especially to represent an alphanumeric character.

CBEMA Curve:

A voltage quality curve established originally by the Computer Business Equipment Manufacturers Association. The CBEMA Curve defines voltage disturbances that could cause malfunction or damage in microprocessor devices. The curve is characterized by voltage magnitude and the duration which the voltage is outside of tolerance. (See ITIC Curve.)

Channel:

The storage of a single value in each interval in a load profile.

Cold Load Pickup:

This value is the delay from the time control power is restored to the time when the user wants to resume demand accumulation.

CRC Field:

Cyclic Redundancy Check Field (Modbus communication) is an error checksum calculation that enables a Slave device to determine if a request packet from a Master device has been corrupted during transmission. If the calculated value does not match the value in the request packet, the Slave ignores the request.

CT (Current) Ratio:

A Current Transformer Ratio is used to scale the value of the current from a secondary value up to the primary side of an instrument transformer.

Cumulative Demand:

The sum of the previous billing period maximum demand readings at the time of billing period reset. The maximum demand for the most recent billing period is added to the previously accumulated total of the maximum demands.

Demand:

The average value of power or a similar quantity over a specified period of time.

Demand Interval:

A specified time over which demand is calculated.

Display:

User-configurable visual indication of data in a meter.

DNP3:

A robust, non-proprietary protocol based on existing open standards. DNP3 is used to operate between various systems in electric and other utility industries and SCADA networks.

More information is available in the *EPM 9000 Series DNP Guide*.

EEPROM:

Nonvolatile memory; Electrically Erasable Programmable Read Only Memory that retains its data during a power outage without need for a battery. Also refers to meter's FLASH memory.

Energy Register:

Programmable record that monitors any energy quantity. Example: Watt-hours, VAR-hours, VA-hours.

Ethernet:

A type of LAN network connection that connects two or more devices on a common communi-cations backbone. An Ethernet LAN consists of at least one hub device (the network backbone) with multiple devices connected to it in a star configuration. The most common versions of Ethernet in use are 10BaseT and 100BaseT as defined in IEEE 802.3 standards. However, several other versions of Ethernet are also available.

Flicker:

Flicker is the sensation that is experienced by the human visual system when it is subjected to changes occurring in the illumination intensity of light sources. IEC 61000-4-15 and former IEC 868 describe the methods used to determine Flicker severity.

Harmonics:

Measuring values of the fundamental current and voltage and percent of the fundamental.

Heartbeat Pulse:

Energy indicator on the face of the EPM 9700 meter; pulses are generated per the programme Ke value.

I2T Threshold:

Data will not accumulate until current reaches programmed level.

Integer:

Any of the natural numbers, the negatives of those numbers, or zero.

Internal Modem:

An optional modem within the meter's enclosure that connects to the RJ11 telephone connector.

Invalid Register:

In the EPM 9700 meter's Modbus Map there are gaps between Registers. For example, the next Register after 08320 is 34817. Any unmapped Register stores no information and is said to be invalid.

ITIC Curve:

An updated version of the CBEMA Curve that reflects further study into the performance of microprocessor devices. The curve consists of a series of steps but still defines combinations of voltage magnitude and duration that will cause malfunction or damage.

Ke:

kWh per pulse; i.e. the energy.

kWh:

Kilowatt hours; kW x demand interval in hours.

KYZ Output:

Output where the rate of changes between 1 and 0 reflects the magnitude of a metered quantity.

LCD:

Liquid Crystal Display.

LED:

Light Emitting Diode.

Maximum Demand:

The largest demand calculated during any interval over a billing period.

Modbus ASCII:

Alternate version of the Modbus protocol that utilizes a different data transfer format. This version is not dependent upon strict timing, as is the RTU version. This is the best choice for telecommunications applications (via modems).

More information is available in the *EPM 9700 Modbus Guide*.

Modbus RTU:

The most common form of Modbus protocol. Modbus RTU is an open protocol spoken by many field devices to enable devices from multiple vendors to communicate in a common language. Data is transmitted in a timed binary format, providing increased throughput and therefore, increased performance.

More information is available in the *EPM 9700 Modbus Guide*.

Network:

A communications connection between two or more devices to enable those devices to send to and receive data from one another. In most applications, the network is either a serial type or a LAN type.

NVRAM:

Nonvolatile Random Access Memory: able to keep the stored values in memory even during the loss of circuit or control power. High speed NVRAM is used in the EPM 9700 meter to gather measured information and to insure that no information is lost.

Optical Port:

A port that facilitates infrared communication with a meter. Using an ANSI C12.13 Type II magnetic optical communications coupler and an RS232 cable from the coupler to a PC, the meter can be programmed with GE Communicator software.

Packet:

A short fixed-length section of data that is transmitted as a unit. Example: a serial string of 8-bit bytes.

Percent (%) THD:

Percent Total Harmonic Distortion. (See THD.)

Protocol:

A language that is spoken between two or more devices connected on a network.

PT Ratio:

Potential Transformer Ratio used to scale the value of the voltage to the primary side of an instrument transformer. Also referred to as VT Ratio.

Pulse:

The closing and opening of the circuit of a two-wire pulse system or the alternate closing and opening of one side and then the other of a three-wire system (which is equal to two pulses).

Q Readings:

Q is the quantity obtained by lagging the applied voltage to a wattmeter by 60 degrees. Values are displayed on the Uncompensated Power and Q Readings screen.

Quadrant (Programmable Values and Factors on the EPM 9700 meter):

Watt and VAR flow is typically represented using an X-Y coordinate system. The four corners of the X-Y plane are referred to as quadrants. Most power applications label the right hand corner as the first quadrant and number the remaining quadrants in a counter-clockwise rotation. Following are the positions of the quadrants: 1st - upper right, 2nd - upper left, 3rd - lower left and 4th - lower right.

Power flow is generally positive in quadrants 1 and 4.

VAR flow is positive in quadrants 1 and 2. The most common load conditions are: Quadrant 1 - power flow positive, VAR flow positive, inductive load, lagging or positive power factor; Quadrant 2 - power flow negative, VAR flow positive, capacitive load, leading or negative power factor.

Register:

An entry or record that stores a small amount of data.

Register Rollover:

A point at which a Register reaches its maximum value and rolls over to zero.

Reset:

Logs are cleared or new (or default) values are sent to counters or timers.

Rolling Window Average (Power):

The Rolling (Sliding) Window Average is the average power calculated over a user-set time interval that is derived from a specified number of sub-intervals, each of a specified time. For example, the average is calculated over a 15-minute interval by calculating the sum of the average of three consecutive 5-minute intervals. This demand calculation methodology has been adopted by several utilities to prevent customer manipulation of kW demand by simply spreading peak demand across two intervals.

RS232:

A type of serial network connection that connects two devices to enable communication between the devices. An RS232 connection connects only two points. Distance between devices is typically limited to fairly short runs.

Current standards recommend a maximum of 50 feet but some users have had success with runs up to 100 feet. Communications speed is typically in the range of 1200 bits per second to 57,600 bits per second. RS232 connection can be accomplished using Port 1 of the EPM 9700 meter.

RS485:

A type of serial network connection that connects two or more devices to enable communication between the devices. An RS485 connection allows multi-drop communication from one to many points.

Distance between devices is typically limited to around 2,000 to 3,000 wire feet. Communications speed is typically in the range of 120 bits per second to 115,000 bits per second.

Sag:

A voltage quality event during which the RMS voltage is lower than normal for a period of time, typically from 1/2 cycle to 1 minute.

Secondary Rated:

Any Register or pulse output that does not use any CT or PT(VT) Ratio.

Serial Port:

The type of port used to directly interface with a device using the RS232 standard.

Swell:

A voltage quality event during which the RMS voltage is higher than normal for a period of time, typically from 1/2 cycle to 1 minute.

TDD:

The Total Demand Distortion of the current waveform. The ratio of the root-sum-square value of the harmonic current to the maximum demand load current. (See equation below.)

NOTE: The TDD displayed in the Harmonics screen is calculated by GE Communicator software, using the Max Average Demand.

$$TDD_I = \frac{\sqrt{I_2^2 + I_3^2 + I_4^2 + I_5^2 + \dots}}{I_L} \times 100 \quad \%$$

THD:

Total Harmonic Distortion is the combined effect of all harmonics measured in a voltage or current. The THD number is expressed as a percent of the fundamental. For example, a 3% THD indicates that the magnitude of all harmonic distortion measured equals 3% of the magnitude of the fundamental 60Hz quantity. The %THD displayed is calculated by your EPM 9700 meter.

$$THD_I = \frac{\sqrt{I_2^2 + I_3^2 + I_4^2 + I_5^2 + \dots}}{I_1} \times 100 \quad \%$$

Time Stamp:

A stored representation of the time of an event. Time Stamp can include year, month, day, hour, minute, second and Daylight Savings Time indication.

TOU:

Time of Use.

Uncompensated Power:

VA, Watt and VAR readings not adjusted by Transformer Loss Compensation.

V2T Threshold:

Data stops accumulating when voltage falls below programmed level.

Voltage Imbalance:

The ratio of the voltage on a phase to the average voltage on all phases.

Voltage Quality Event:

An instance of abnormal voltage on a phase. The events the meter tracks include sags, swells, interruptions and imbalances.

VT Ratio:

The Voltage Transformer Ratio is used to scale the value of the voltage to the primary side of an instrument transformer. Also referred to as PT Ratio.

Voltage, Vab:

Vab, Vbc, Vca are all Phase-to-Phase voltage measurements. These voltages are measured between the three phase voltage inputs to the meter.

Voltage, Van:

Van, Vbn, Vcn are all Phase-to-Neutral voltages applied to the monitor. These voltages are measured between the phase voltage inputs and Vn input to the meter. Technologically, these voltages can be "measured" even when the meter is in a Delta configuration and there is no connection to the Vn input. However, in this configuration, these voltages have limited meaning and are typically not reported.

Voltage, Vaux:

This is the fourth voltage input measured frombetween the Vaux and Vref inputs. This input can be scaled to any value. However, the actual input voltage to the meter should be of the same magnitude as the voltages applied to the Va, Vb and Vc terminals.