GE
Grid Solutions

Multilin™ EPM 6000/6000T Power Meter

Instruction Manual

Software Revision: 1.17
Manual P/N: 1601-0215-A8
Manual Order Code: GEK-106558G

WORLDWIDE 10 YEAR WARRANTY

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EPM 6000/6000T Power Meter Instruction Manual for product revision 1.17.

Part number: 1601-0215-A8 (October 2017)

⚠CAUTION

GENERAL SAFETY PRECAUTIONS - EPM 6000

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

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Europe e-mail: multilin.tech.euro@ge.com
Website: http://www.gegridsolutions.com/multilin

Warranty

For products shipped as of 1 October 2013, 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

For products shipped before 1 October 2013, the standard 24-month warranty applies.

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EPM 6000 Power Meter

Chapter 1: 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.

1.1 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.

1.2 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. Figure 1.1 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).

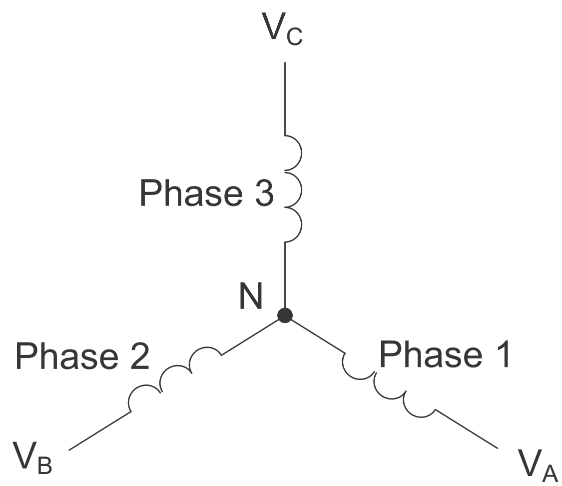


Figure 1-1: Three-phase Wye Winding

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 Figure 1.2.

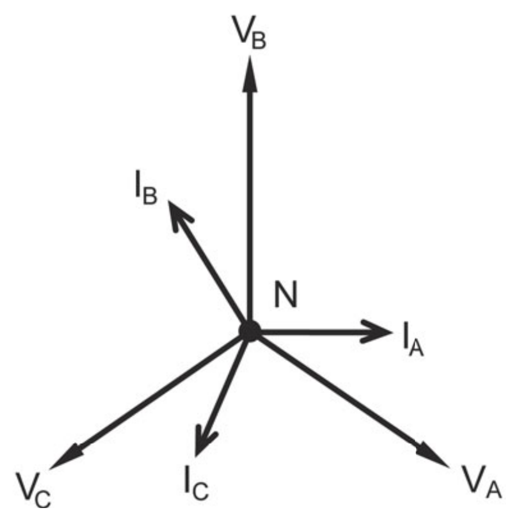


Figure 1-2: Phasor Diagram Showing Three-phase Voltages and Currents

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. Table 1.1 shows the common voltages used in the United States for wye-connected systems.

Table 1.1: 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

Table 1.1: Common Phase Voltages on Wye Services

Phase to Ground Voltage	Phase to Phase Voltage
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 Figure 1.1). 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 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.

1.3 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. Figure 1.3 shows the physical load connections for a delta service.

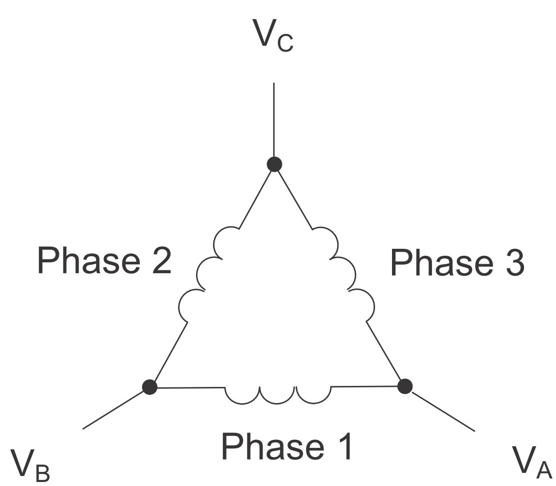


Figure 1-3: Three-phase Delta Winding Relationship

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.

Figure 1.4 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.

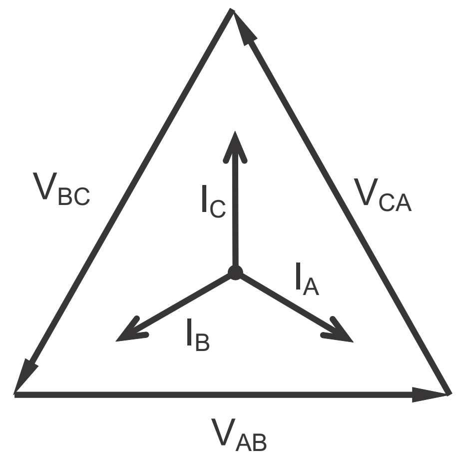


Figure 1-4: Phasor Diagram, Three-Phase Voltages and Currents, Delta-Connected

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 1.5 shows the phasor diagram for the voltages in a three-phase, four-wire delta system.

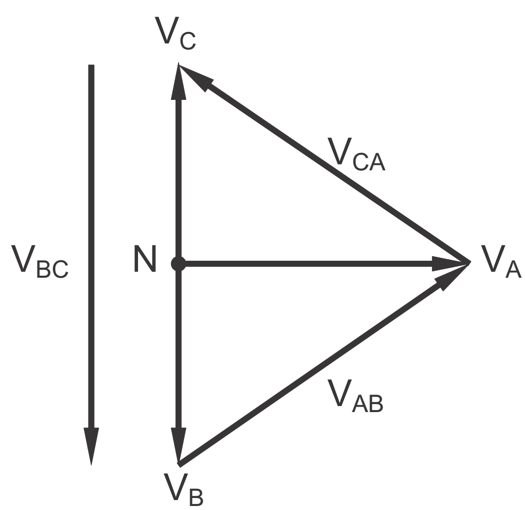


Figure 1-5: Phasor Diagram Showing Three-phase Four-Wire Delta-Connected System

1.4 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.

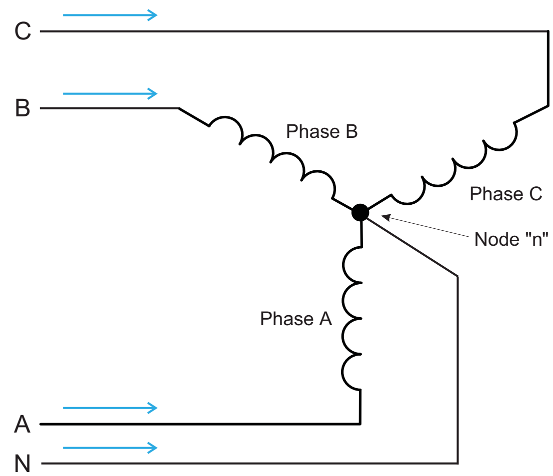


Figure 1-6: Three-Phase Wye Load Illustrating Kirchoff's Law and Blondel's Theorem

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 1.6 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 1.6 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.

1.5 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 1.7 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 1.7 is reproduced in Table 1.2 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).

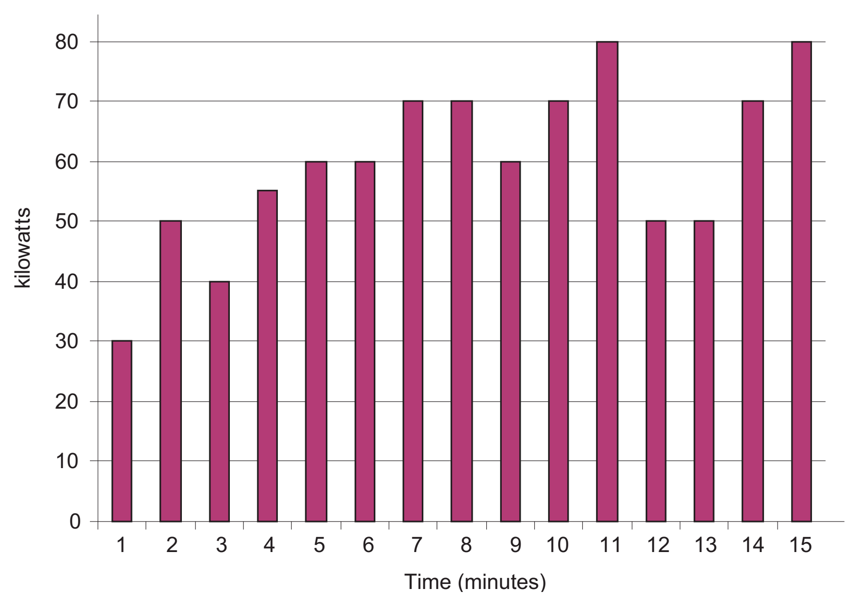


Figure 1-7: Power Use over Time

Table 1.2: 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

Table 1.2: Power and Energy Relationship over Time

Time Interval (minute)	Power (kW)	Energy (kWh)	Accumulated Energy (kWh)
7	70	1.17	6.09
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 1.2, the accumulated energy for the power load profile of Figure 1.7 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 1.7) 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 1.8 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.

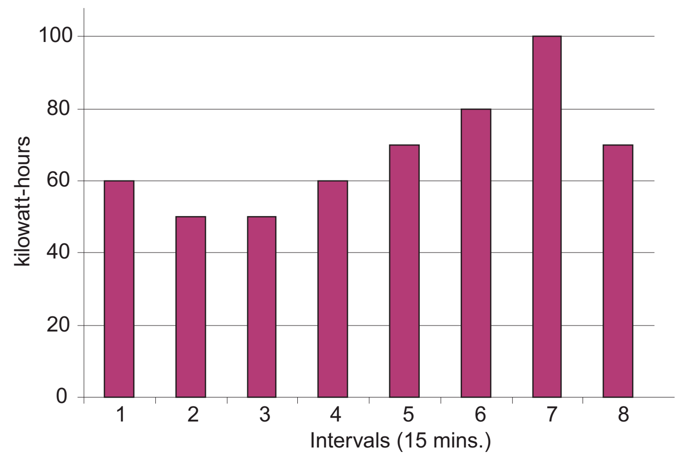


Figure 1-8: Energy Use and Demand

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.

1.6 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 1.9 shows a single-phase voltage and current and breaks the current into its in-phase and quadrature components.

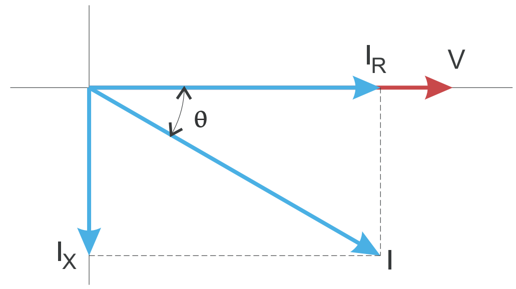


Figure 1-9: Voltage and Complex Current

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 1.9) 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. 1.9).

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.

1.7 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 1.10 shows a normal, sinusoidal current waveform. This example has no distortion.

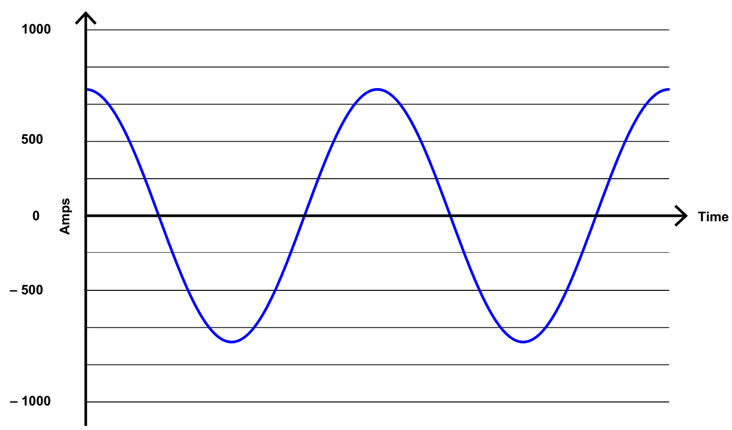


Figure 1-10: Nondistorted Current Waveform

Figure 1.11 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 1.10.

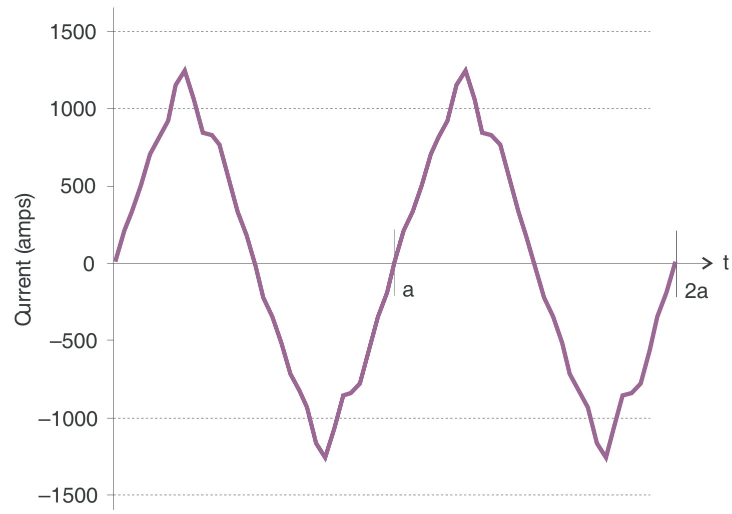


Figure 1-11: Distorted Current Waveform

The distortion observed in Figure 1.11 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 1.12 shows the content of the harmonic frequencies that make up the distortion portion of the waveform in Figure 1.11.

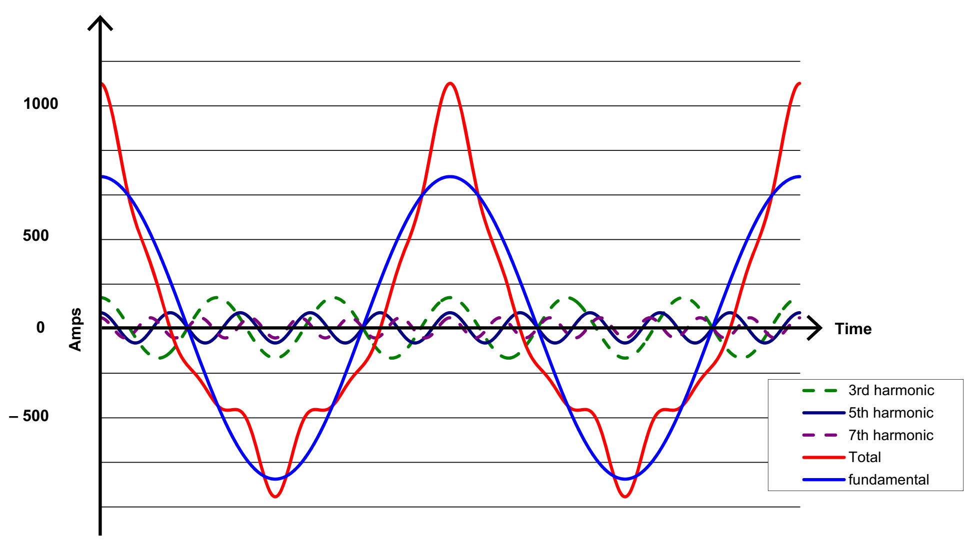


Figure 1-12: Waveforms of the Harmonics

The waveforms shown in Figure 1.12 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.

1.8 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 Table 1.3.

Table 1.3: 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.

EPM 6000 Power Meter

Chapter 2: Overview and Specifications

NOTICE

In European Union member state countries, this meter is NOT certified for revenue metering. See the Safety Precautions section for meter certification details.

2.1 Hardware Overview

The EPM 6000 multifunction power meters is designed for use with and/or within Industrial Control Panels in electrical substations, panel boards, and as a power meter for OEM equipment. EPM 6000 meters provide multifunction measurement of all electrical parameters.

The EPM 6000 is designed with advanced measurement capabilities, allowing it to achieve high performance accuracy. The EPM 6000 meter is specified as a 0.2% class energy meter for billing applications as well as a highly accurate panel indication meter. UL 61010-1 does not address performance criteria for revenue generating watt-hour meters for use in metering of utilities and/or communicating directly with utilities, or use within a substation. Use in revenue metering, communicating with utilities, and use in substations was verified according to the ANSI and IEC standards listed in the Compliance Section (2.3).

The EPM 6000 meter provides a host of additional capabilities, including either standard RS485 Modbus or RJ45 Ethernet, DNP Protocols and an IrDA Port for remote interrogation.

EPM 6000 meter features that are detailed in this manual are as follows:

- 0.2% Class Revenue Certifiable Energy and Demand Metering
- Meets ANSI C12.20 (0.2%) and IEC 62053-22 (0.2%) Classes
- Multifunction Measurement including Voltage, Current, Power, Frequency, Energy, etc.
- Power Quality Measurements (%THD and Alarm Limits)
- Percentage of Load Bar for Analog Meter Perception
- Easy to Use Faceplate Programming
- IrDA Port for PC Remote Read

- RS485 or RJ45 Modbus Communication

The EPM 6000 comes in either of two models - the Meter/Digital Transducer or the Digital Transducer only.

EPM 6000 Meter / Digital Transducer: Meter and transducer in one compact unit. Features an IrDA port as well as either an RS485 or RJ45 port, and can be programmed using the faceplate of the meter. ANSI or DIN mounting may be used.

Figure 2-1: EPM 6000T

EPM 6000T Digital Transducer: A Digital Transducer only unit providing either RS485 or RJ45 communication via Modbus RTU, Modbus ASCII, and DNP 3.0 protocols (THD Option only). The unit is designed to install using DIN Rail Mounting (see Section 3.3).

2.1.1 Voltage and Current Inputs

Universal Voltage Inputs

Voltage Inputs allow measurement to 416 Volts Line-to-Neutral and 721 Volts Line-to-Line. One unit will perform to specification when directly connected to 69 Volt, 120 Volt, 230 Volt, 277 Volt, 277 Volt and 347 Volt power systems.

Current Inputs

The EPM 6000 meter's Current Inputs use a unique dual input method:

Method 1: CT Pass Through

The CT wire passes directly through the meter without any physical termination on the meter. This insures that the meter cannot be a point of failure on the CT circuit. This is preferable for utility users when sharing relay class CTs.

Method 2: Current "Gills"

This unit additionally provides ultra-rugged Termination Pass Through Bars that allow CT leads to be terminated on the meter. This, too, eliminates any possible point of failure at the meter. This is a preferred technique for insuring that relay class CT integrity is not compromised (the CT will not open in a fault condition).

2.1.2 Order Codes

The order codes for the EPM 6000 and EPM 6000T are indicated below.

Table 2–1: EPM 6000 Order Codes

	PL6000 –	* –	* –	* –	* –	* –	*	
Base Unit	PL6000		|	|	|	|	|	EPM 6000 Power Meter
Enclosure Option		ENC120	|	|	|	|	|	NEMA1 Rated - Indoor, Single Meter Enclosure, 120V
		ENC277	|	|	|	|	|	NEMA1 Rated - Indoor, Single Meter Enclosure, 277V
System Frequency			5	|	|	|	|	50 Hz AC frequency system
			6	|	|	|	|	60 Hz AC frequency system
Current Input				1A	|	|	|	1 A secondary CT
				5A	|	|	|	5 A secondary CT
Software Option					0	|	|	No THD or pulse output option
					THD	|	|	THD, limit alarms, and 1 KYZ pulse output
Power Supply						LDC	|	Low Voltage (18 to 60) V DC Power Supply to Substitute Standard AC/DC Power Supply
Communications Option							S	Standard Serial option
							E	Ethernet communications option

Table 2–2: EPM 6000T Order Codes

	PL6000T –	* –	* –	* –	* –	*	
Base Unit	PL6000T	|	|	|	|	|	EPM 6000 Power Meter - no display
System Frequency		5	|	|	|	|	50 Hz AC frequency system
		6	|	|	|	|	60 Hz AC frequency system
Current Input			1A	|	|	|	1 A secondary CT
			5A	|	|	|	5 A secondary CT
Software Option				0	|	|	No THD or pulse output option
				THD	|	|	THD, limit alarms, and 1 KYZ pulse output
Power Supply					LDC	|	Low Voltage (18 to 60) V DC Power Supply to Substitute Standard AC/DC Power Supply
Communications Option						S	Standard Serial option
						E	Ethernet communications option

For example, to order an EPM 6000 for 60 Hz system with a 1 A secondary CT input and no THD or pulse output option, and including an Ethernet communications option (replacing standard Base Unit serial port communications), select order code PL6000-6-1A-0-E. The standard unit includes display, all current/voltage/power/frequency/energy counters, percent load bar, RS485, and IrDA communication ports.

2.1.3 Measured Values

The following table lists the measured values available in real time, average, maximum, and minimum.

Table 2–3: EPM 6000 Measured Values

Measured Values	Real Time	Average	Maximum	Minimum
Voltage L-N	X		X	X
Voltage L-L	X		X	X
Current per phase	X	X	X	X
Current Neutral	X			
Watts	X	X	X	X
VARs	X	X	X	X
VA	X	X	X	X
Power Factor (PF)	X	X	X	X
Positive watt-hours	X			
Negative watt-hours	X			
Net watt-hours	X			
Positive VAR-hours	X			
Negative VAR-hours	X			
Net VAR-hours	X			
VA-hours	X			
Frequency	X		X	X
%THD[1]	X		X	X
Voltage angles	X			
Current angles	X			
% of load bar	X			

[1] The EPM 6000/6000T meter measures harmonics up to the 7th order for current and up to the 3rd order for voltage.

2.1.4 Utility Peak Demand

The EPM 6000 provides user-configured Block (fixed) or Rolling window demand. This feature allows you to set up a customized demand profile. Block window demand is demand used over a user-defined demand period (usually 5, 15, or 30 minutes). Rolling window demand is a fixed window demand that moves for a user-specified subinterval period. For example, a 15-minute demand using 3 subintervals and providing a new demand reading every 5 minutes, based on the last 15 minutes.

Utility demand features can be used to calculate kW, kvar, kVA and PF readings. All other parameters offer maximum and minimum capability over the user-selectable averaging period. Voltage provides an instantaneous maximum and minimum reading which displays the highest surge and lowest sag seen by the meter.

2.2 Specifications

POWER SUPPLY

Range: Standard (HI) Option: Universal, 90 to 265 V AC at 50/60Hz, or 100 to 370 V DC
LDC Option: 18 to 60 V DC

Power consumption: 5 VA, 3.5 W

VOLTAGE INPUTS (MEASUREMENT CATEGORY III)

Range: Universal, Auto-ranging up to 416 V AC L-N, 721 V AC L-L

Supported hookups: 3-element Wye, 2.5-element Wye,
2-element Delta, 4-wire Delta

Input impedance: 1 MOhm/phase

Burden: 0.0144 VA/phase at 120 Volts

Pickup voltage: 10 V AC

Connection: Screw terminal

Maximum input wire gauge: AWG #12 / 2.5 mm^2

Fault Withstand: Meets IEEE C37.90.1

Reading: Programmable full-scale to any PT ratio

CURRENT INPUTS

Class 10: 5 A nominal, 10 A maximum

Class 2: 1 A nominal, 2 A maximum

Burden: 0.005 VA per phase maximum at 11 A

Pickup current: 0.1% of nominal

Connections: O or U lug electrical connection
Pass-through wire, 0.177" / 4.5 mm maximum diameter
Quick connect, 0.25" male tab

Fault Withstand (at 23°C): 100 A / 10 seconds, 300 A / 3 seconds, 500 A / 1 second

Reading: Programmable full-scale to any CT ratio

ISOLATION

All Inputs and Outputs are galvanically isolated to 2500 V AC

ENVIRONMENTAL

Storage: –20 to 70°C

Operating: –20 to 70°C

Humidity: up to 95% RH, non-condensing

Faceplate rating: NEMA 1; mounting gasket included

MEASUREMENT METHODS

Voltage and current: True RMS

Power: Sampling at 400+ samples/cycle on all channels measured; readings simultaneously

A/D conversion: 6 simultaneous 24-bit analog-to-digital converters

UPDATE RATE

Watts, VAR, and VA: 100 ms (10 times per second)

All other parameters: 1 second

COMMUNICATIONS FORMAT

Types: RS485 or RJ45 port through back plate plus KYZ Pulse
IrDA port through face plate

COMMUNICATIONS PORTS

Protocols:..Modbus RTU, Modbus ASCII, DNP 3.0 (THD Option only)
Baud rate:..9600 to 57600 bps
Port address:....................................001 to 247
Data format:.....................................8 bits, no parity
EPM 6000T Transducer:..............Default initial communication 9600 Baud

MECHANICAL PARAMETERS

Dimensions:......................................4.25" × 4.85" × 4.85" (L × W × H)
105.4 mm × 123.2 mm × 123.2 mm (L × W × H)
Mounting: ....mounts in 92 mm square DIN or ANSI C39.1, 4-inch round cut-out
Weight: ....2 pounds / 0.907 kg

KYZ/RS485 PORT SPECIFICATIONS

RS485 Transceiver; meets or exceeds EIA/TIA-485 Standard:
Type: ....Two-wire, half duplex
Min. Input Impedance: 96kΩ
Max. Output Current: ....±60mA

WH PULSE

KYZ output contacts (and infrared LED light pulses through face plate):
Pulse Width: 40ms
Full Scale Frequency: ....~6Hz
Contact type: ....Solid State – SPDT (NO – C – NC)
Relay type: ....Solid state
Peak switching voltage: ....DC ±350V
Continuous load current: 120mA
Peak load current: ....350mA for 10ms
On resistance, max.: 35Ω
Leakage current: ....1µA@350V
Isolation: ....AC 3750V
Reset State: ....(NC - C) Closed; (NO - C) Open
Infrared LED:
Peak Spectral Wavelength: 940nm
Reset State: ....Off

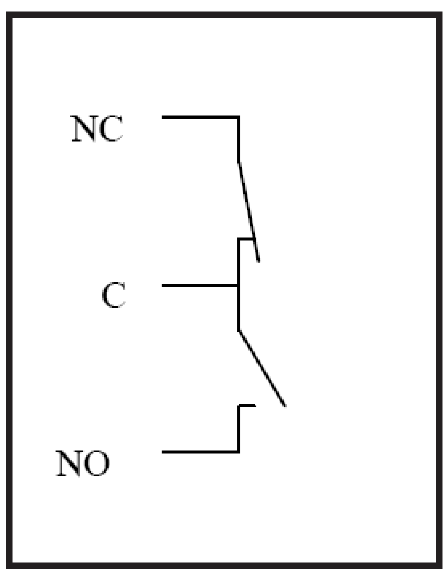


Figure 2-2: Internal Schematic (De-energized State)

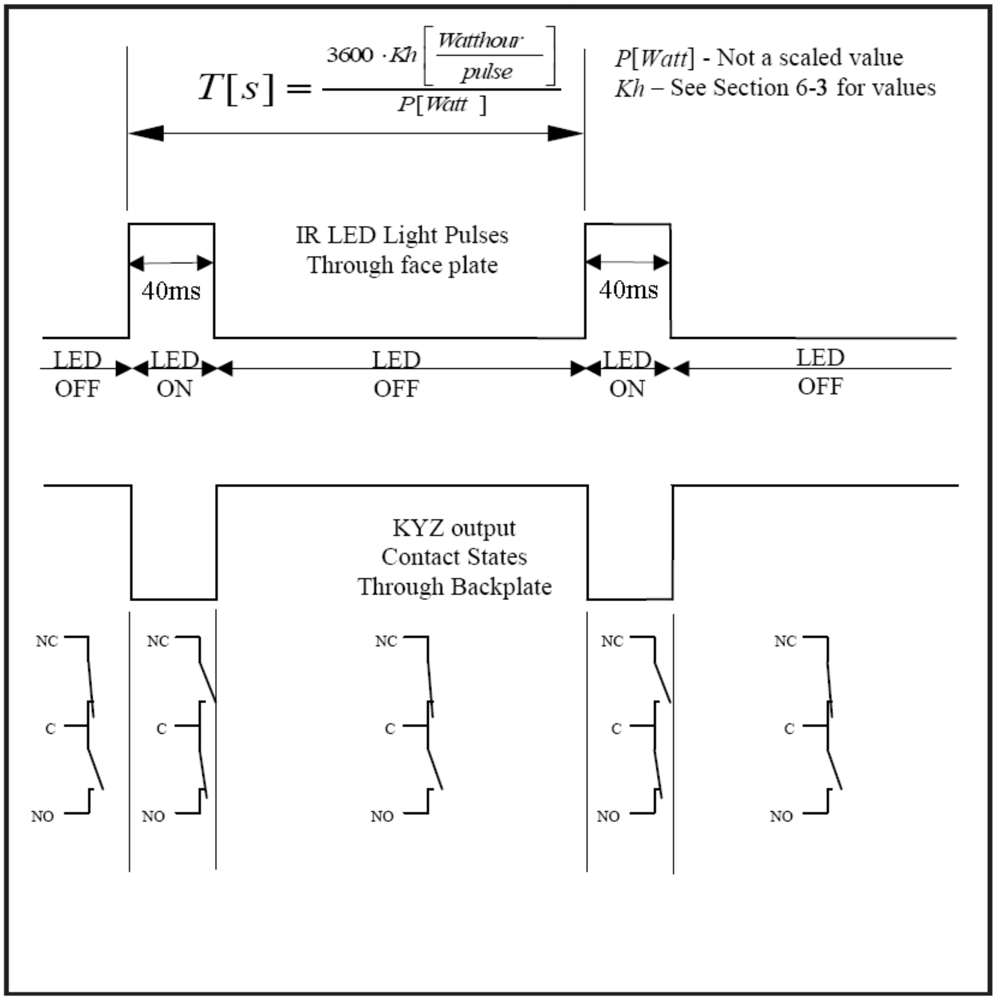


Figure 2-3: Output Timing

2.3 Compliance

COMPLIANCE

Test	Reference Standard	Level/Class
IEC62053-22 (0.2% Accuracy)		
ANSI C12.20 (0.2% Accuracy)		
CE Compliant		
REACH Compliant		
RoHS Compliant		
Surge Withstand	ANSI (IEEE) C37.90.1	
Burst	ANSI C62.41	
Electrostatic Discharge	IEC61000-4-2	Level 3
RF Immunity	IEC61000-4-3	10 V/min
Fast Transient	IEC61000-4-4	Level 3
Surge Immunity	IEC61000-4-5	Level 3
Conducted Disturbance Immunity	IEC61000-4-6	Level 3
Voltage Dips and Sags Immunity	IEC61000-4-11	0, 40, 70, 100% dips, 250/300 cycle interrupts
Emission Standards for Industrial Environments	EN61000-6-4	Class A
EMC Requirements	EN61326-1	

APPROVALS

	Applicable Council Directive	According to:
North America	UL Recognized	UL61010-1 C22.2. No 61010-1 (PICQ7) File e200431
ISO	Manufactured under a registered quality program	ISO9001

2.4 Accuracy

For 23 °C, 3 Phase balanced Wye or Delta load, at 50 or 60 Hz (as per order), 5A (Class 10 nominal unit:

Parameter	Accuracy	Accuracy Input Range
Voltage L-N [V]	0.1% of reading[2]	69 to 480 V
Voltage L-L [V]	0.1% of reading	120 to 600 V
Current Phase [A]	0.1% of reading[1]	0.15 to 5 A
Current Neutral (calculated) [A]	2.0% of Full Scale[1]	0.15 to 5 A @ 45 to 65 Hz
Active Power Total [W]	0.2% of reading[1,2]	0.15 to 5 A @ 69 to 480 V @ +/- 0.5 to 1 lag/lead PF
Active Energy Total [Wh]	0.2% of reading[1,2]	0.15 to 5 A @ 69 to 480 V @ +/- 0.5 to 1 lag/lead PF
Reactive Power Total [VAR]	0.2% of reading[1,2]	0.15 to 5 A @ 69 to 480 V @ +/- 0 to 0.8 lag/lead PF
Reactive Energy Total [VARh]	0.2% of reading[1,2]	0.15 to 5 A @ 69 to 480 V @ +/- 0 to 0.8 lag/lead PF
Apparent Power Total [VA]	0.2% of reading[1,2]	0.15 to 5 A @ 69 to 480 V @ +/- 0.5 to 1 lag/lead PF
Apparent Energy Total [VAh]	0.2% of reading[1,2]	0.15 to 5 A @ 69 to 480 V @ +/- 0.5 to 1 lag/lead PF
Power Factor	0.2% of reading[1,2]	0.15 to 5 A @ 69 to 480 V @ +/- 0.5 to 1 lag/lead PF
Frequency	+/- 0.01Hz	45 to 65 Hz
Total Harmonic Distortion (%)	5.0%[1]	0.5 to 10 A or 69 to 480 V, measurement range - 1 to 99.99%
Load Bar	+/- 1 segment[1]	0.005 to 6 A

[1] For 2.5 element programmed units, degrade accuracy by an additional 0.5% of reading.

- For 1A (Class 2) Nominal, degrade accuracy by an additional 0.5% of reading.
- For 1A (Class 2) Nominal, the input current range for Accuracy specification is 20% of the values listed in the table.

[2] For unbalanced voltage inputs where at least one crosses the 150V auto-scale threshold (for example, 120V/120V/208V system), degrade accuracy by additional 0.4%.

EPM 6000 Power Meter

Chapter 3: Mechanical Installation

3.1 Introduction

The EPM 6000 meter can be installed using a standard ANSI C39.1 (4" Round) or an IEC 92mm DIN (Square) form. In new installations, simply use existing DIN or ANSI punches. For existing panels, pull out old analog meters and replace with the EPM 6000 meter. The various models use the same installation. See Chapter 4 for wiring diagrams.

⚠WARNING

POTENTIAL ELECTRICAL EXPOSURE - The EPM 6000/6000T must be installed in an electrical enclosure where any access to live electrical wiring is restricted only to authorized service personnel.

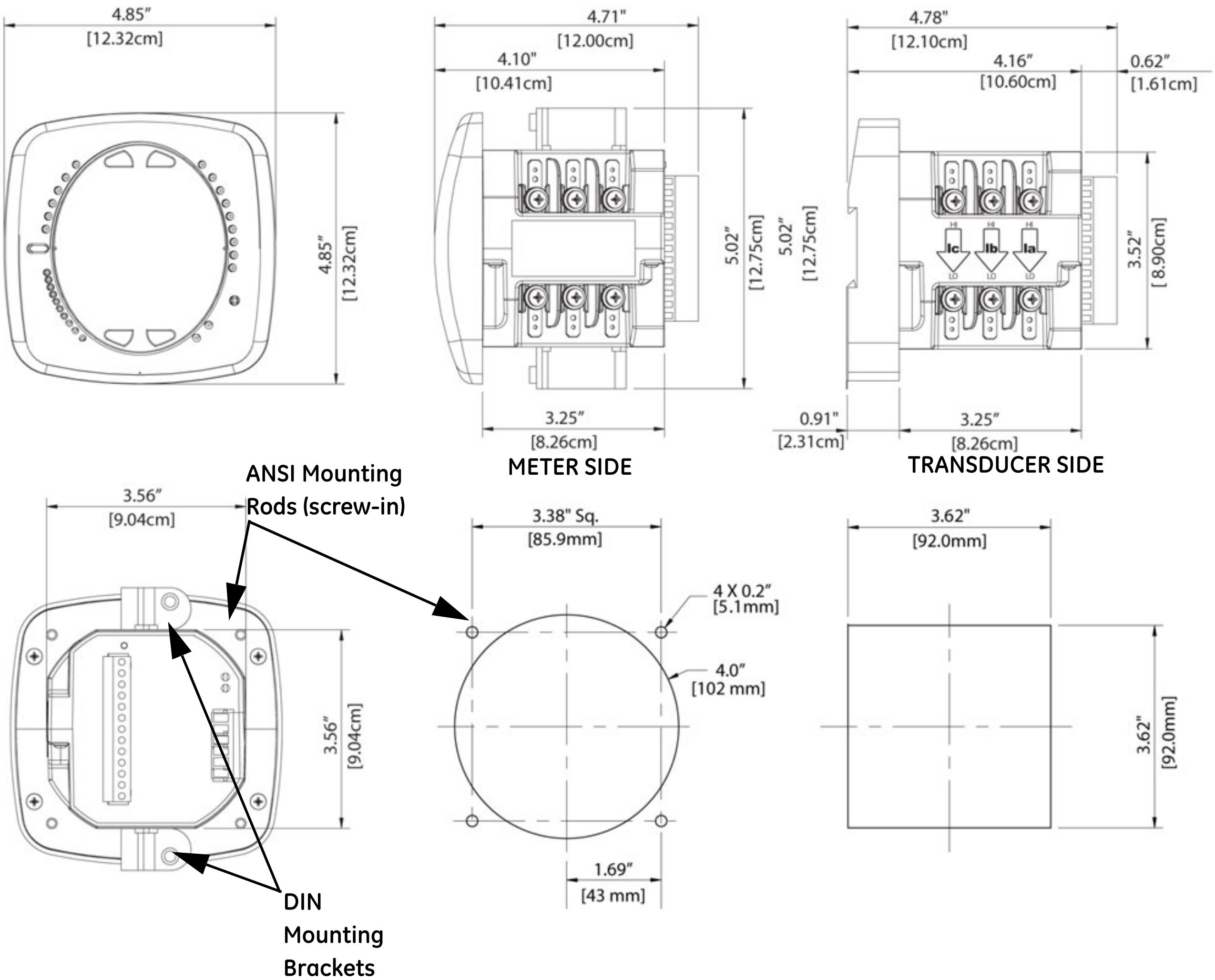


Figure 3-1: EPM 6000 Mounting Information

Recommended Tools for EPM 6000 Meter Installation:

- #2 Phillips screwdriver, small wrench and wire cutters. EPM 6000T Transducer Installation requires no tools.
- Mount the meter in a dry location free from dirt and corrosive substances. The meter is designed to withstand harsh environmental conditions. (See Environmental Specifications in 2.2 *Specifications* on page 2–5.)

3.2 ANSI Installation Steps

1. Insert 4 threaded rods by hand into the back of meter. Twist until secure.
2. Slide ANSI 12 Mounting Gasket onto back of meter with rods in place.
3. Slide meter with Mounting Gasket into panel.

4. Secure from back of panel with lock washer and nut on each threaded rod. Use a small wrench to tighten. Do not overtighten. The maximum installation torque is 0.4 Newton-Meter (3.5 lb-in).

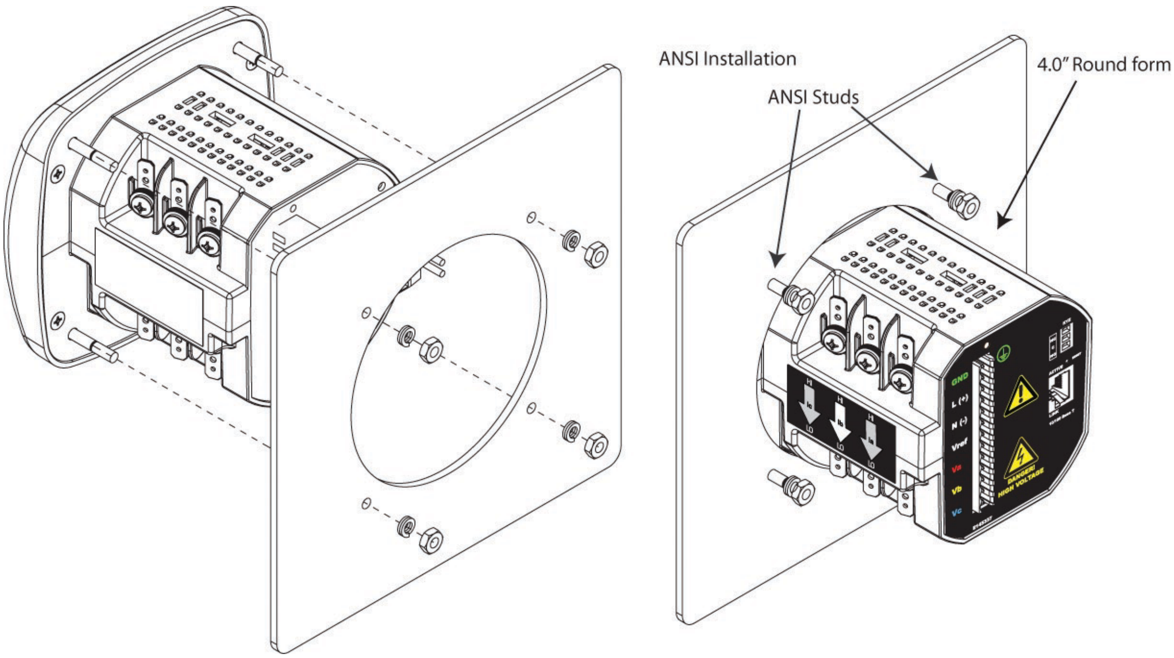


Figure 3-2: ANSI Mounting Procedure

3.3 DIN Installation Steps

1. Slide meter with NEMA 12 Mounting Gasket into panel. (Remove ANSI Studs, if in place.)
2. From back of panel, slide 2 DIN Mounting Brackets into grooves in top and bottom of meter housing. Snap into place.
3. Secure meter to panel with lock washer and a #8 screw through each of the 2 mounting brackets. Tighten with a #2 Phillips screwdriver. Do not overtighten. The maximum installation torque is 0.4 Newton-Meter (3.5 lb-in).

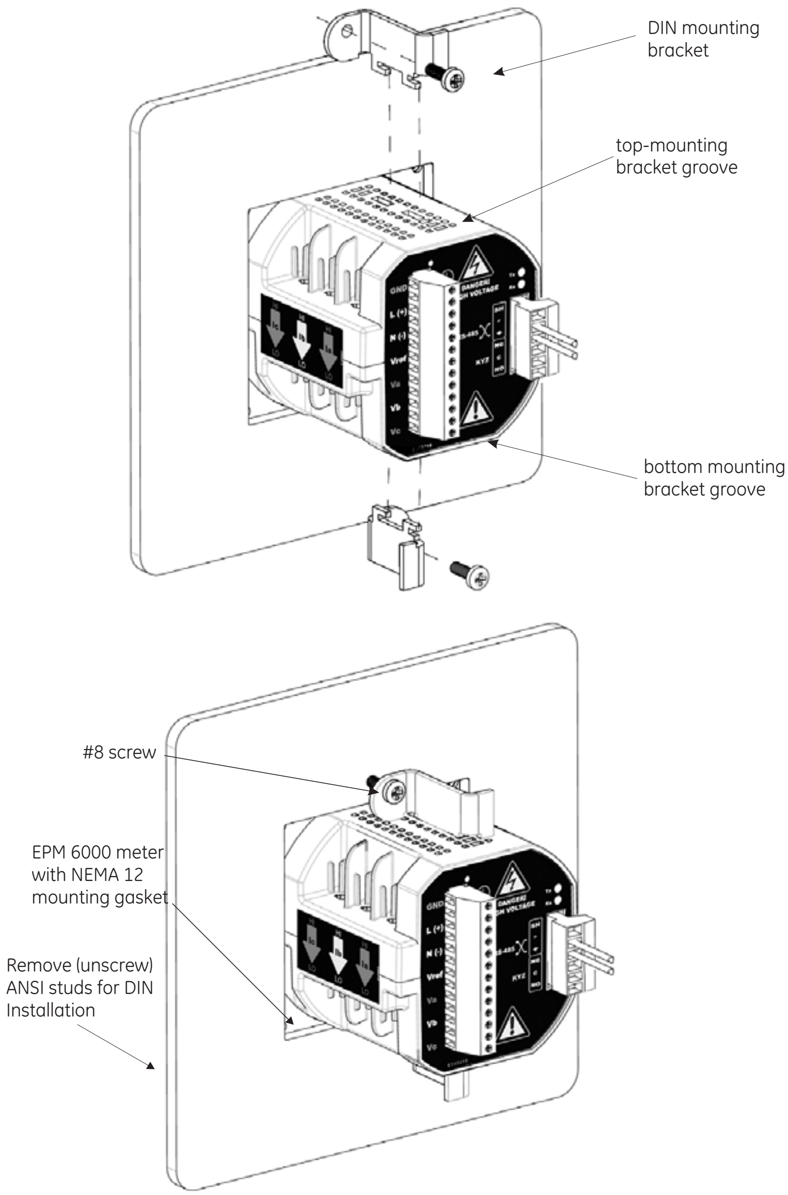


Figure 3-3: DIN Mounting Procedure

3.4 EPM 6000T Transducer Installation

The EPM 6000T Transducer model is installed using DIN Rail Mounting.

Specs for DIN Rail Mounting:

- International Standards: DIN 46277/3
- DIN Rail (Slotted) Dimensions: 0.297244” x 1.377953” x 3” (inches) [7.55mm x 35mm x 76.2mm (millimeters)].

DIN Rail Installation Steps:

1. Slide top groove of meter onto the DIN Rail.
2. Press gently until the meter clicks into place.

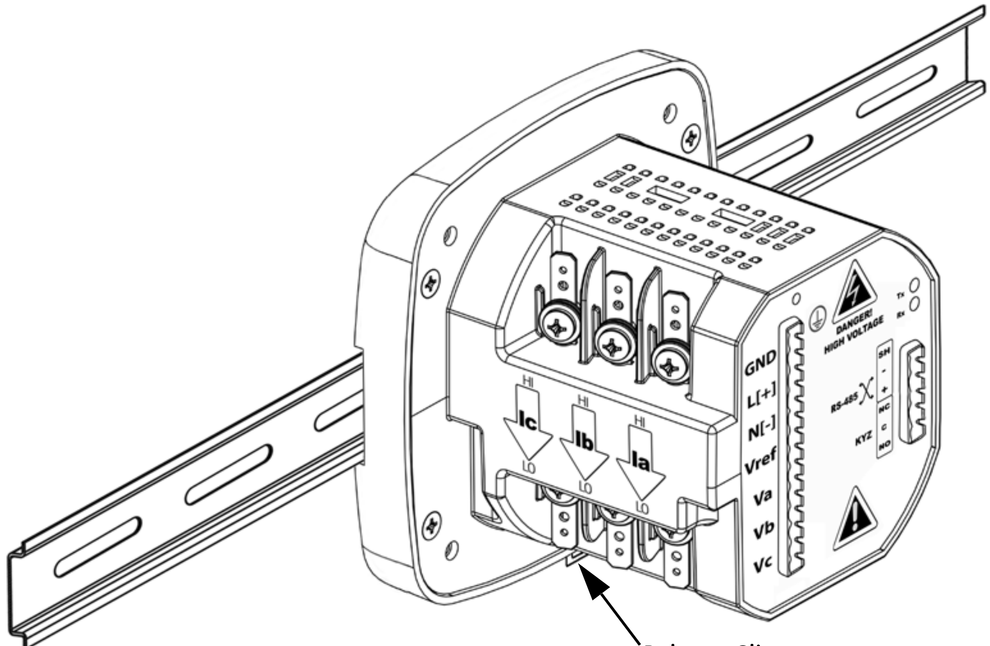


Figure 3-4: DIN Rail Mounting Procedure

NOTICE

If mounting with the **DIN Rail provided**, use the **Black Rubber Stoppers** (also provided).

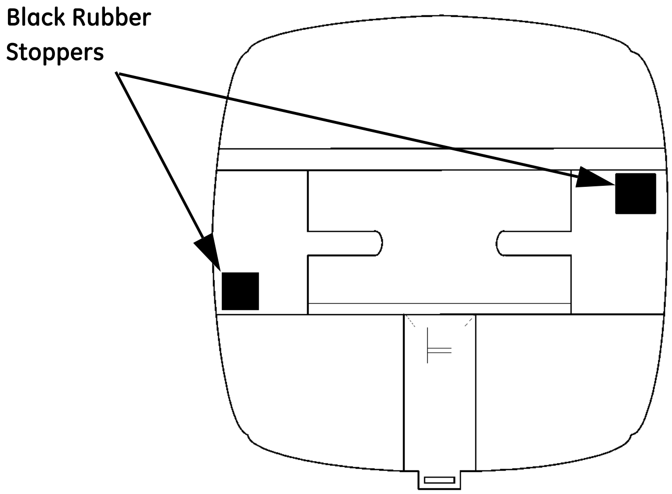


Figure 3-5: DIN Rail Detail

To Remove Meter from DIN Rail:

Pull down on **Release Clip** to detach the unit from the DIN Rail.

NOTE

DIN Rails are commonly used as a mounting channel for most terminal blocks, control devices, circuit protection devices and PLCs. DIN Rails are made of cold rolled steel electrolytically plated, and are also available in aluminum, PVC, stainless steel and copper.

EPM 6000 Power Meter

Chapter 4: Electrical Installation

4.1 Considerations When Installing Meters

⚠WARNING

POTENTIAL ELECTRICAL EXPOSURE - The EPM 6000/6000T must be installed in an electrical enclosure where any access to live electrical wiring is restricted only to authorized service personnel.

- Installation of the EPM 6000 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 is recommended.
- During normal operation of the EPM 6000 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 Modules (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 Output 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 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.

- GE requires the use of **Fuses** for voltage leads and power supply and **Shorting Blocks** to prevent hazardous voltage conditions or damage to CTs, if the meter needs to be removed from service. **CT grounding is optional, but recommended**.

NOTICE

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

⚠CAUTION

If the equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may 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: 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.

4.1.1 CT Leads Terminated to Meter

The EPM 6000 is designed to have Current Inputs wired in one of three ways. Figure 4-1 below, shows the most typical connection where CT Leads are terminated to the meter at the Current Gills.

This connection uses Nickel-Plated Brass Studs (Current Gills) with screws at each end. This connection allows the CT wires to be terminated using either an “O” or a “U” lug. Tighten the screws with a #2 Phillips screwdriver. The maximum installation torque is 1 Newton-Meter (8.8 lb-in).

Other current connections are shown in Figures 4-2 and 4-3. Voltage Connection and RS485/KYZ Connection (Com Option S only) is shown in Figure 4-4: *Voltage Connection* on page 4–6.

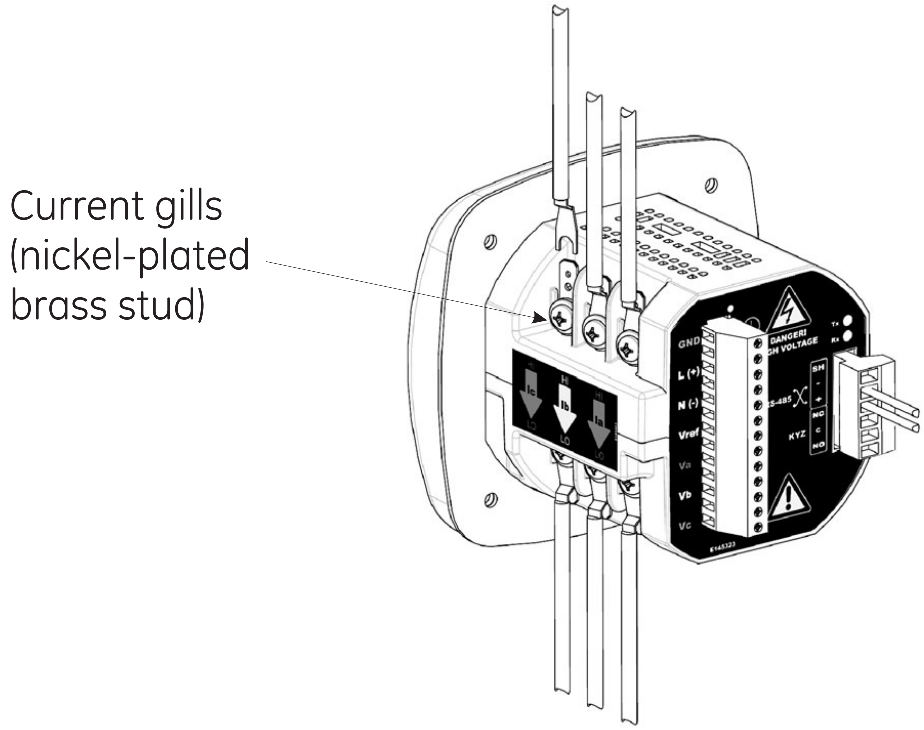


Figure 4-1: CT leads terminated to meter, #8 screw for lug connection

Wiring diagrams are detailed in the diagrams shown below in this chapter. Communications connections are detailed in Chapter 5.

4.1.2 CT Leads Pass-Through (No Meter Termination)

The second method allows the CT wires to pass through the CT Inputs without terminating at the meter. In this case, remove the current gills and place the CT wire directly through the CT opening. The opening will accommodate up to 0.177" / 4.5 mm maximum diameter CT wire.

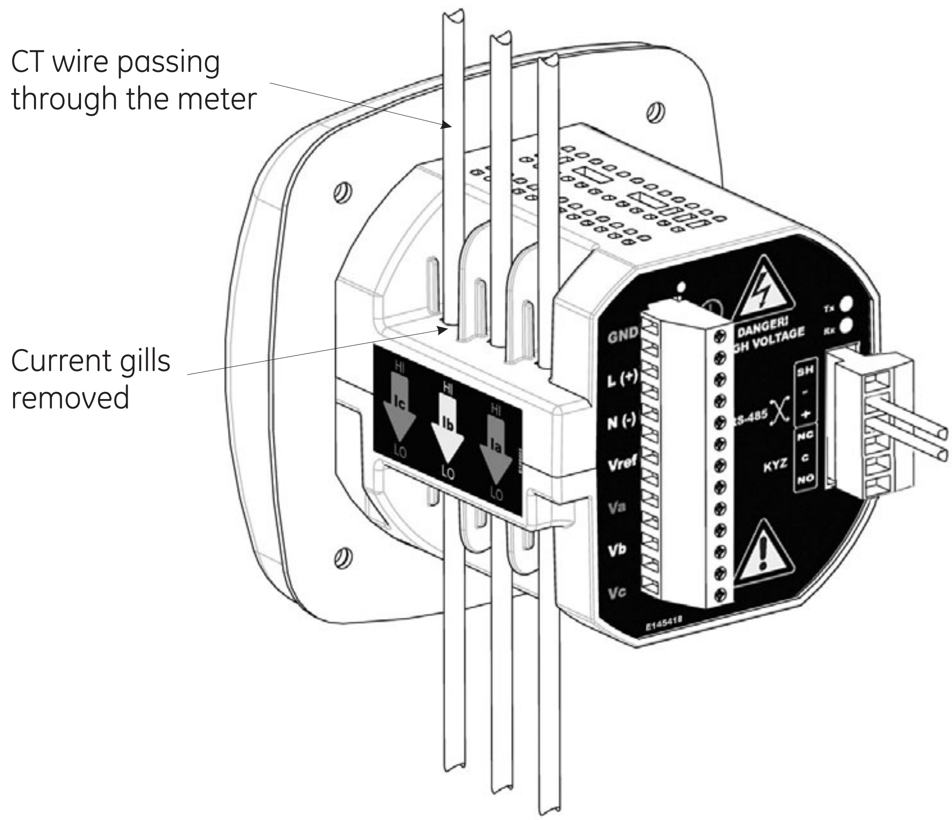


Figure 4-2: Pass-Through Wire Electrical Connection

4.1.3 Quick Connect Crimp CT Terminations

For quick termination or for portable applications, a quick connect crimp CT connection can also be used.

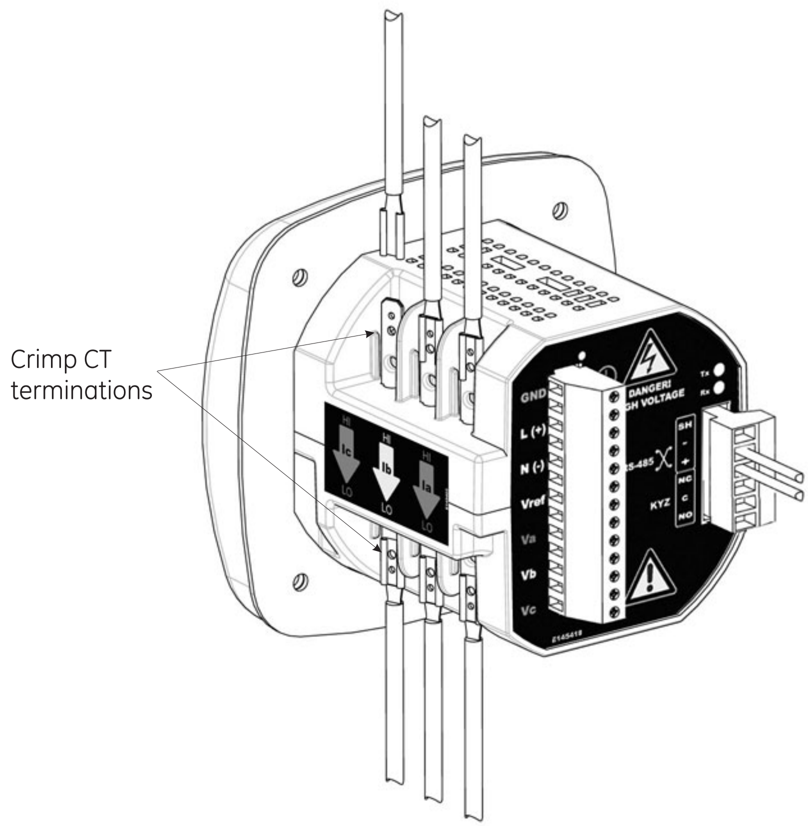


Figure 4-3: Quick Connect Electrical Connection

4.1.4 Voltage and Power Supply Connections

Voltage Inputs are connected to the back of the unit via a optional wire connectors. The connectors accommodate up to AWG#12 / 2.5 mm wire.

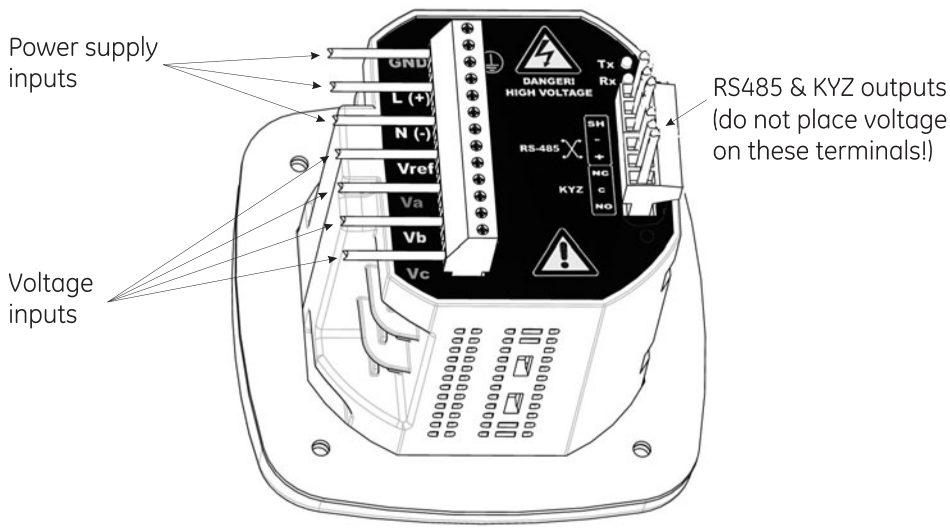


Figure 4-4: Voltage Connection

4.1.5 Ground Connections

The EPM 6000 ground terminals (⏚) should be connected directly to the installation's protective earth ground. Use 2.5 mm^2 wire for this connection.

4.1.6 Voltage Fuses

GE requires the use of fuses on each of the sense Voltages and on the control power.

- Use a 0.1 Amp fuse on each voltage input.
- Use a 3.0 Amp fuse on the Power Supply.

4.2 Electrical Connection Diagrams

4.2.1 Description

Choose the diagram that best suits your application and maintains the CT polarity.

(1) Wye, 4-Wire with no PTs and 3 CTs, 3 Element on page 4–8.

(1a) Dual Phase Hookup on page 4–9.

(1b) Single Phase Hookup on page 4–10.

(2) Wye, 4-Wire with no PTs and 3 CTs, 2.5 Element on page 4–11.

(3) Wye, 4-Wire with 3 PTs and 3 CTs, 3 Element on page 4–12.

(4) Wye, 4-Wire with 2 PTs and 3 CTs, 2.5 Element on page 4–13.

(5) Delta, 3-Wire with no PTs, 2 CTs on page 4–14.

(6) Delta, 3-Wire with 2 PTs, 2 CTs on page 4–15.

(7) Delta, 3-Wire with 2 PTs, 3 CTs on page 4–16.

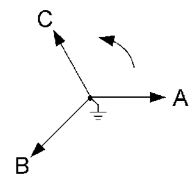
(8) Current-Only Measurement (Three-Phase) on page 4–17.

(9) Current-Only Measurement (Dual-Phase) on page 4–18.

(10) Current-Only Measurement (Single-Phase) on page 4–19.

4.2.2 (1) Wye, 4-Wire with no PTs and 3 CTs, 3 Element

For this wiring type, select **3 EL WYE** (3-element Wye) in the meter programming setup.



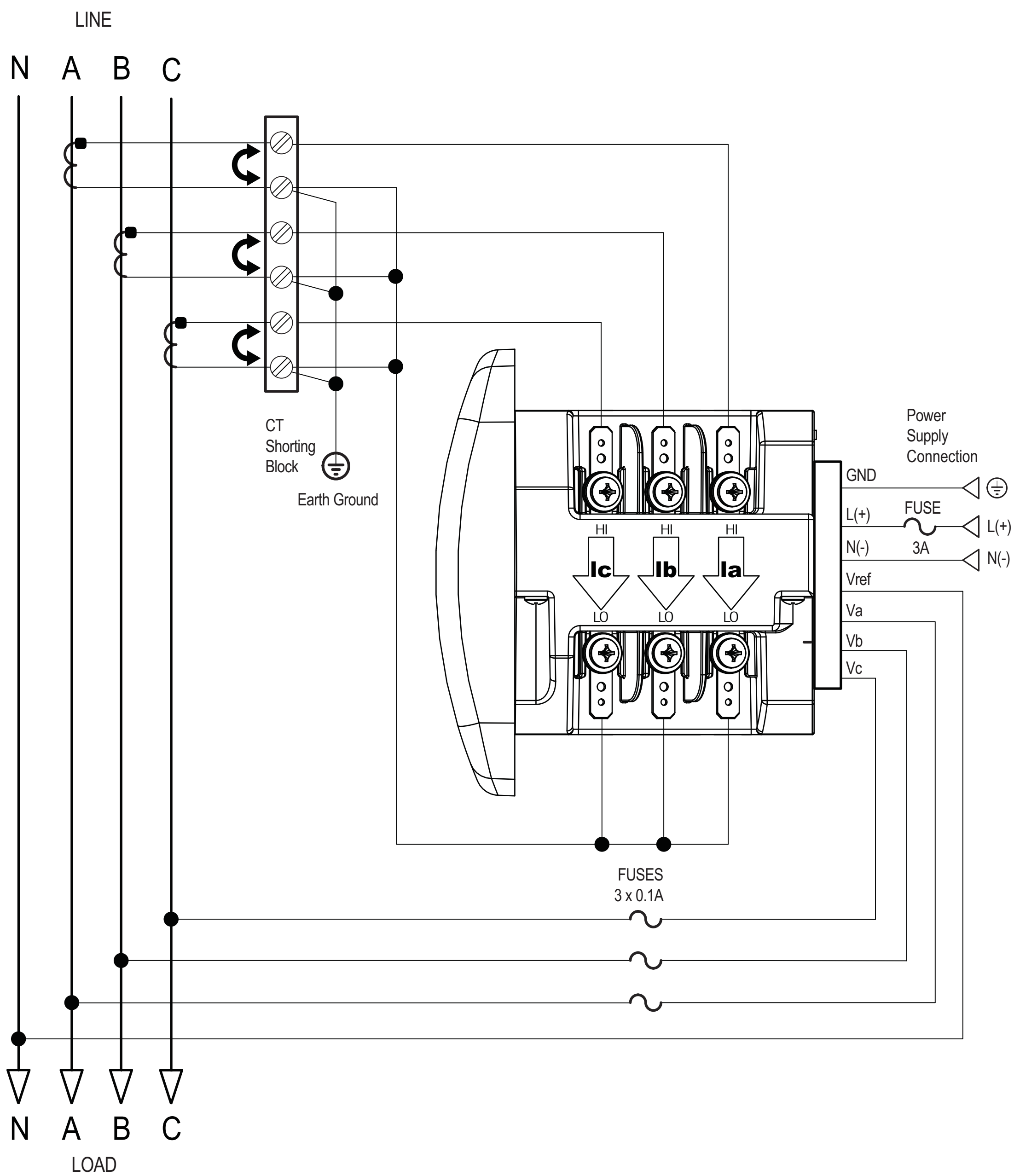


Figure 4-5: 4-Wire Wye with no PTs and 3 CTs, 3 Element

For this wiring type, select **3 EL WYE** (3-element Wye) in the meter programming setup.

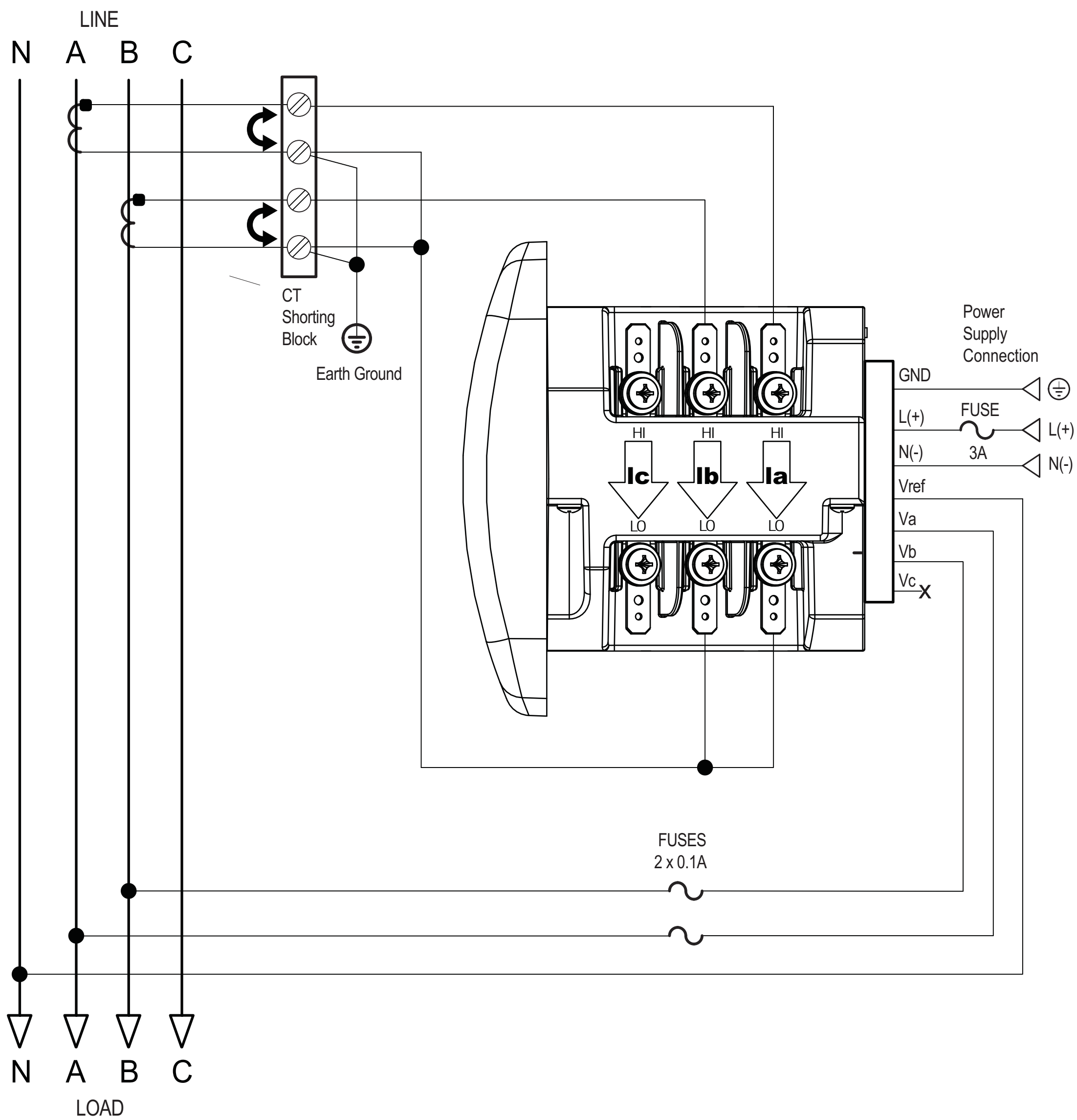


Figure 4-6: (1a) Dual Phase Hookup

For this wiring type, select **3 EL WYE** (3-element Wye) in the meter programming setup.

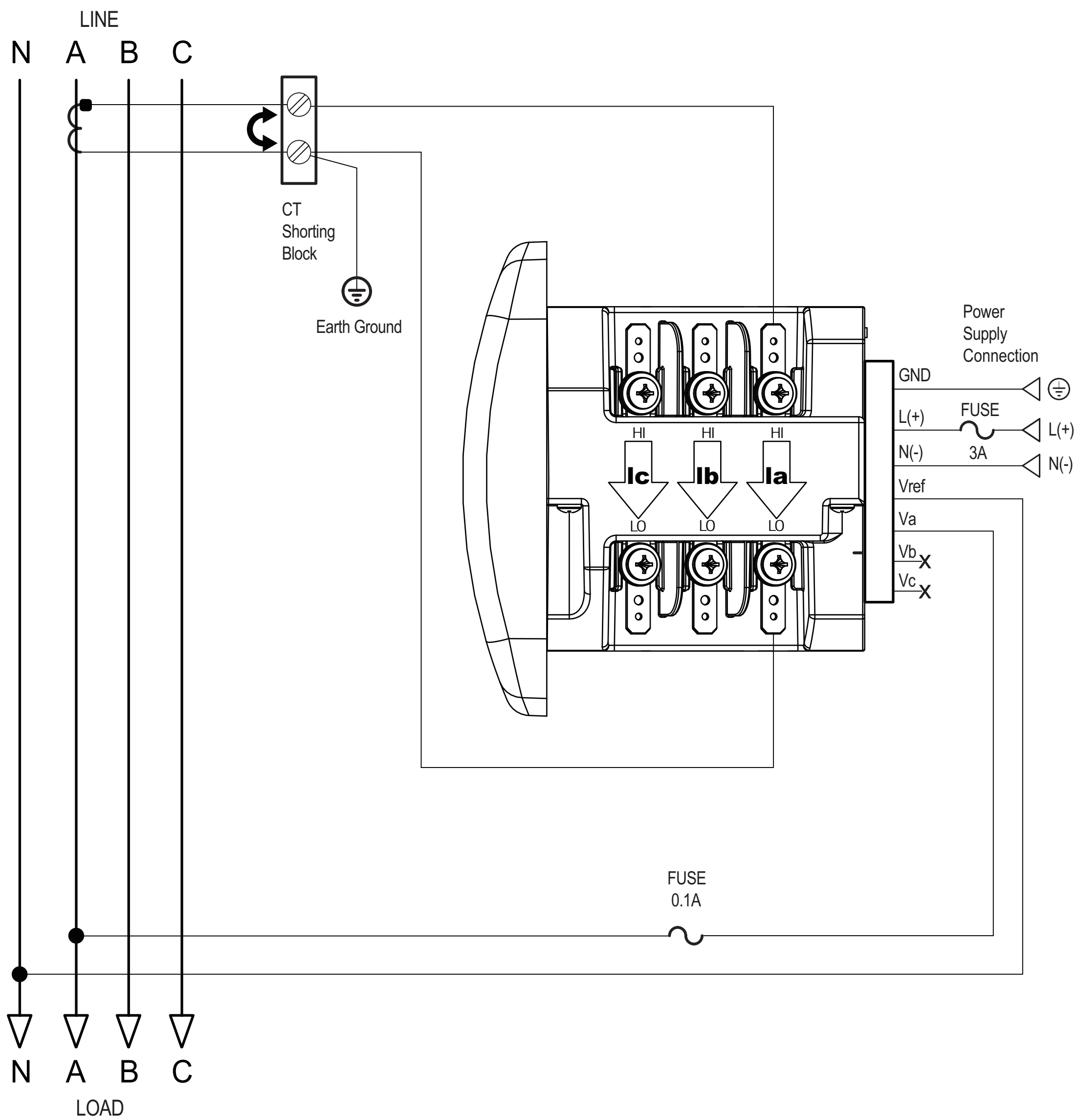
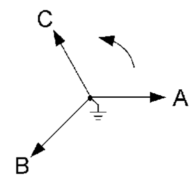


Figure 4-7: (1b) Single Phase Hookup

4.2.3 (2) Wye, 4-Wire with no PTs and 3 CTs, 2.5 Element

For this wiring type, select **2.5EL WYE** (2.5-element Wye) in the meter programming setup.



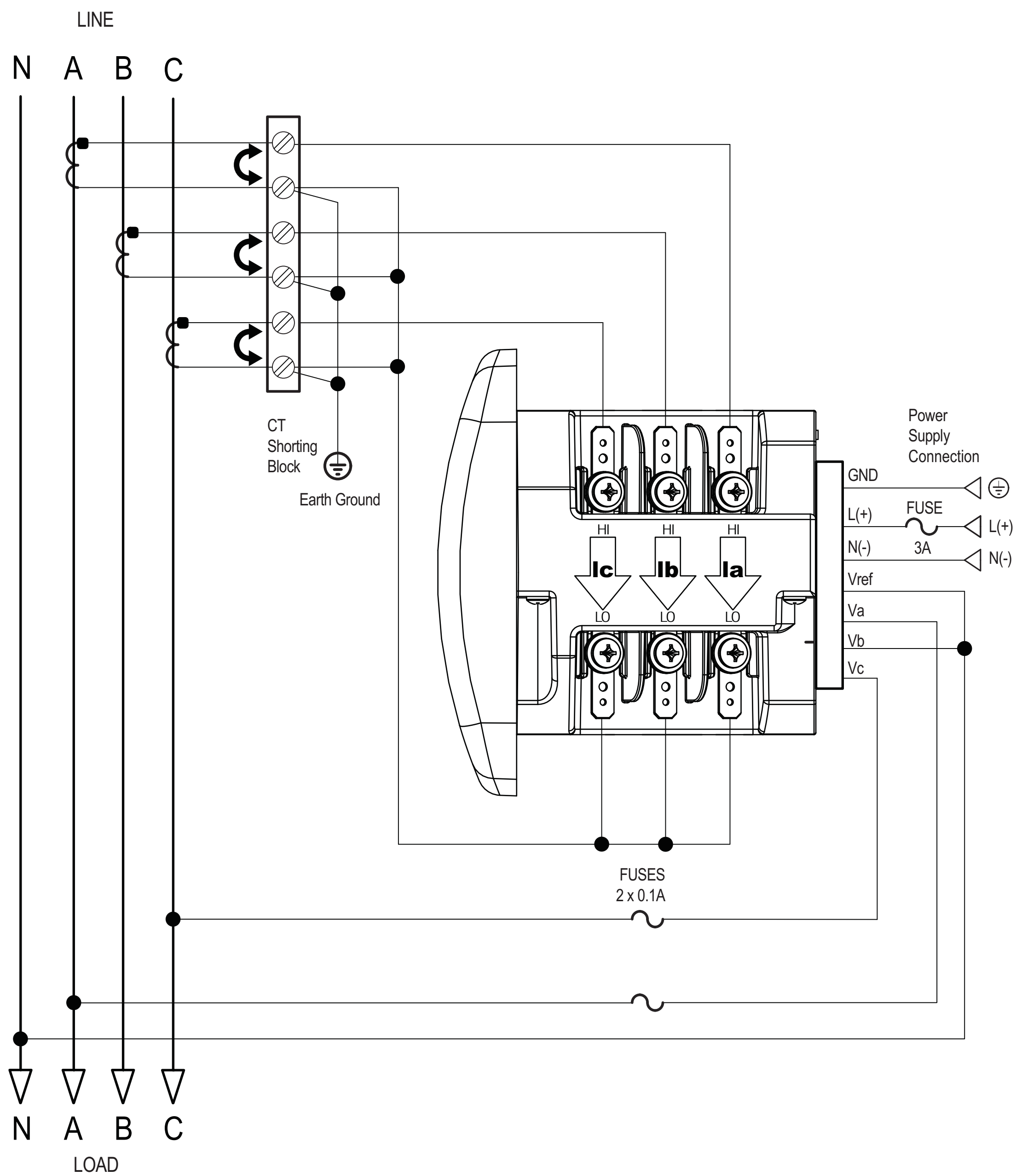
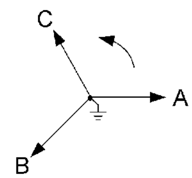


Figure 4-8: 4-Wire Wye with no PTs and 3 CTs, 2.5 Element

4.2.4 (3) Wye, 4-Wire with 3 PTs and 3 CTs, 3 Element

For this wiring type, select **3 EL WYE** (3-element Wye) in the meter programming setup.



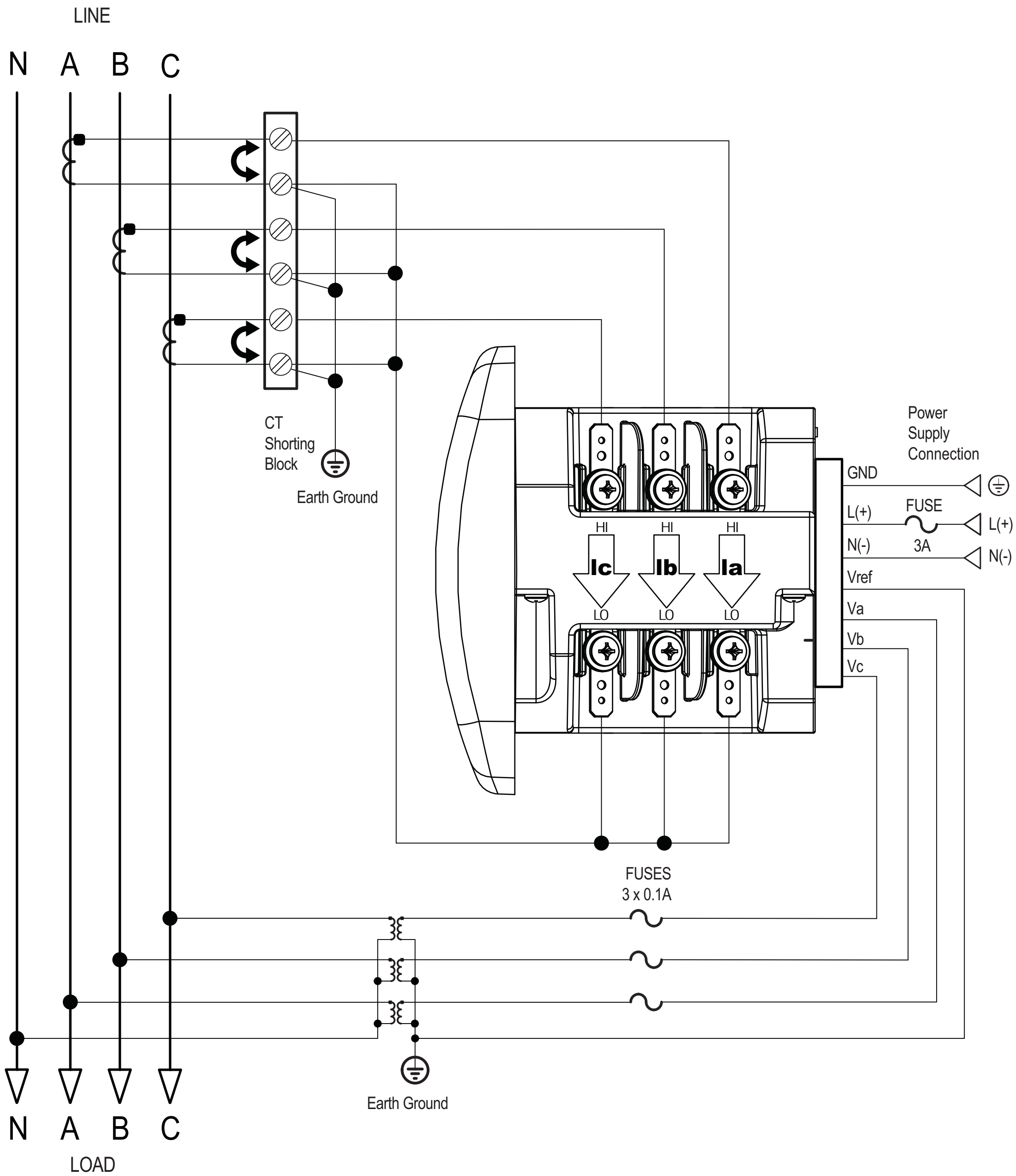
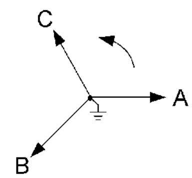


Figure 4-9: 4-Wire Wye with 3 PTs and 3 CTs, 3 Element

4.2.5 (4) Wye, 4-Wire with 2 PTs and 3 CTs, 2.5 Element

For this wiring type, select **2.5EL WYE** (2.5-element Wye) in the meter programming setup.



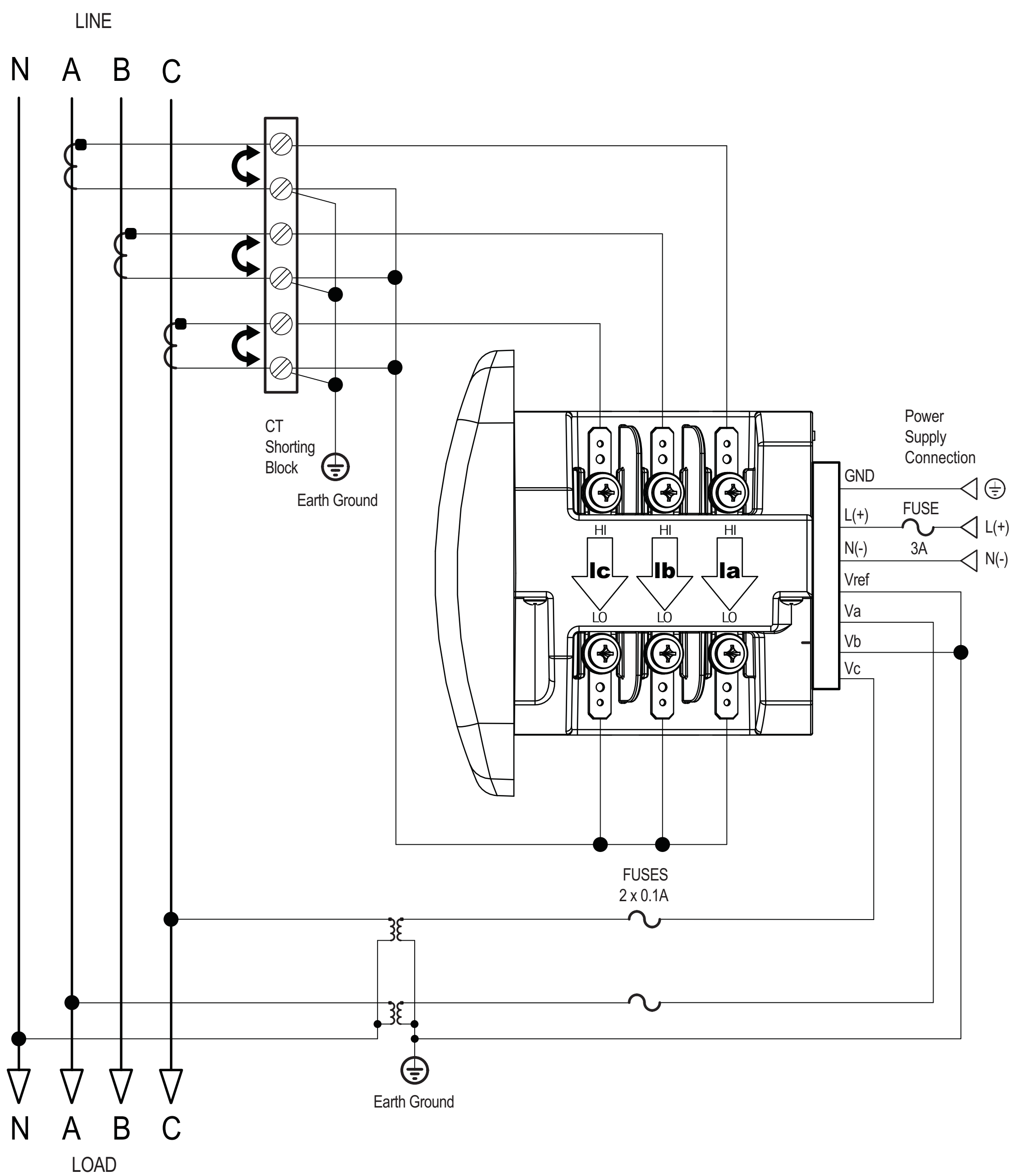
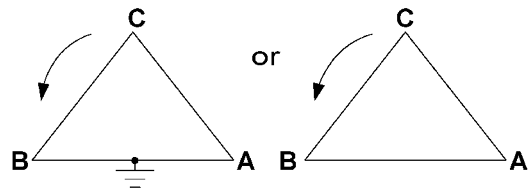


Figure 4-10: 4-Wire Wye with 2 PTs and 3 CTs, 2.5 Element

4.2.6 (5) Delta, 3-Wire with no PTs, 2 CTs

For this wiring type, select **2 Ct dEL** (2 CT Delta) in the meter programming setup.



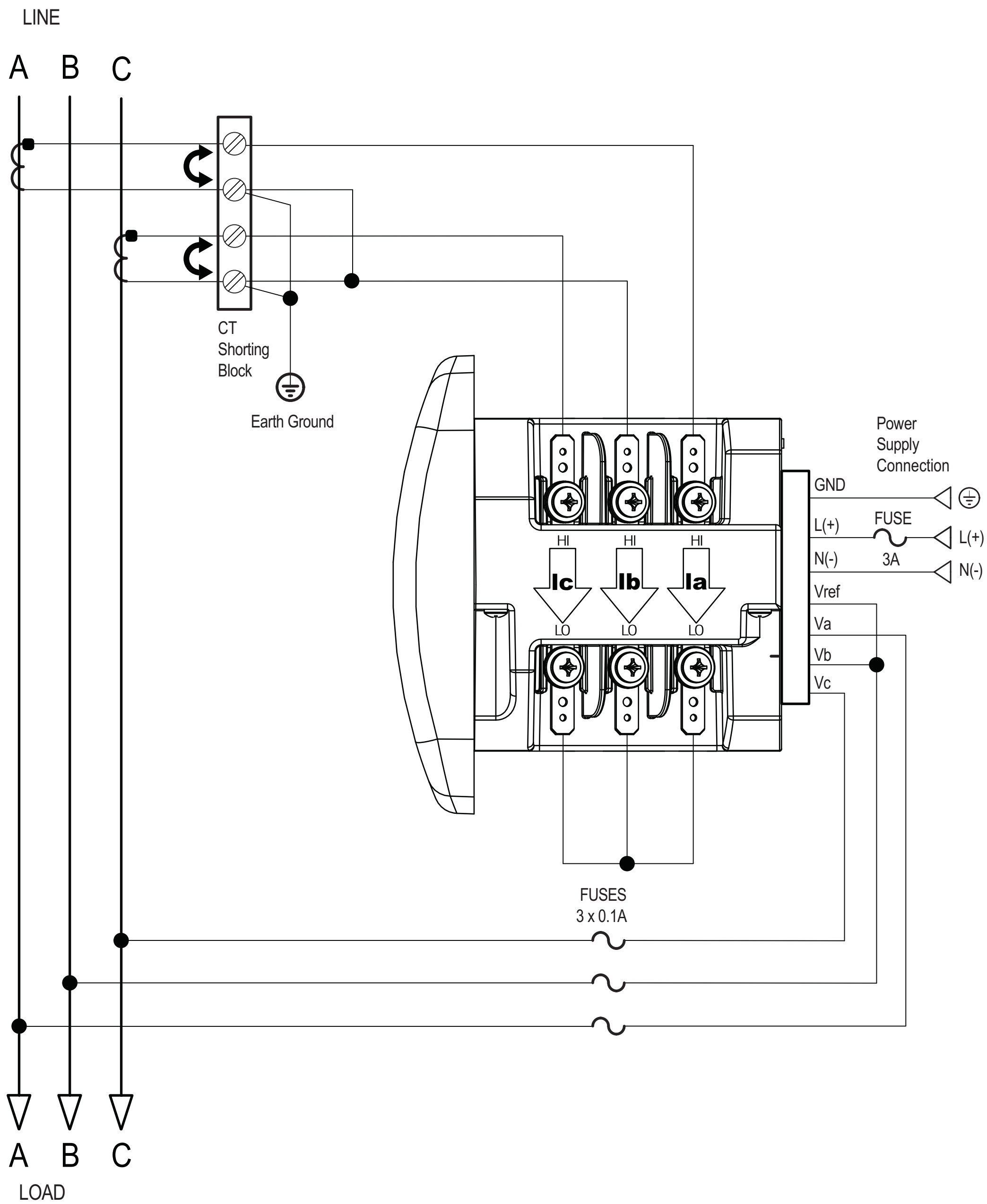


Figure 4-11: 3-Wire Delta with no PTs and 2 CTs

4.2.7 (6) Delta, 3-Wire with 2 PTs, 2 CTs

For this wiring type, select **2 Ct dEL** (2 CT Delta) in the meter programming setup.

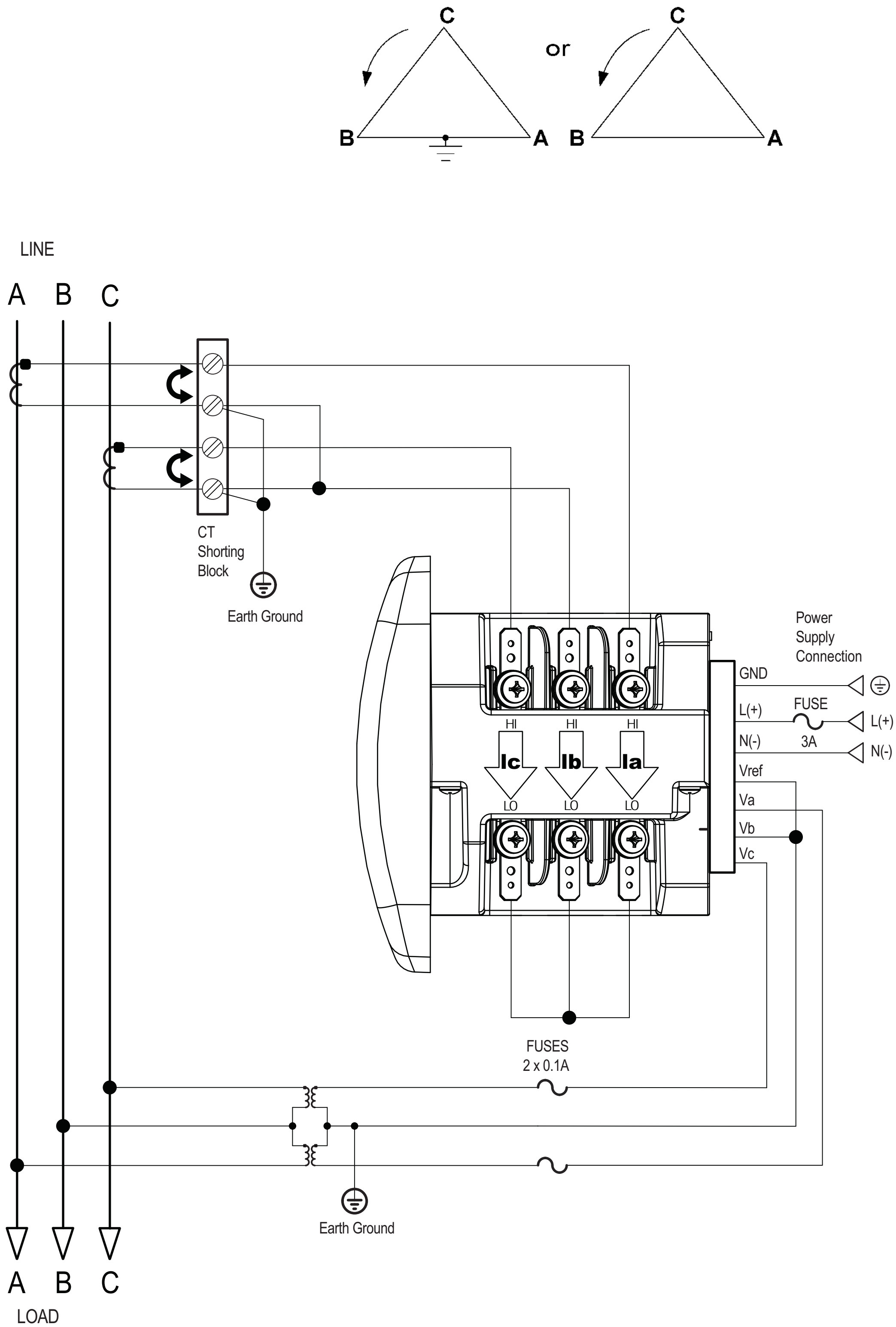
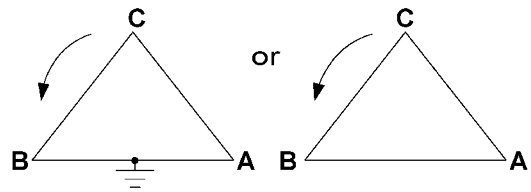


Figure 4-12: 3-Wire Delta with 2 PTs and 2 CTs

4.2.8 (7) Delta, 3-Wire with 2 PTs, 3 CTs

For this wiring type, select **2 Ct dEL** (2 CT Delta) in the meter programming setup.



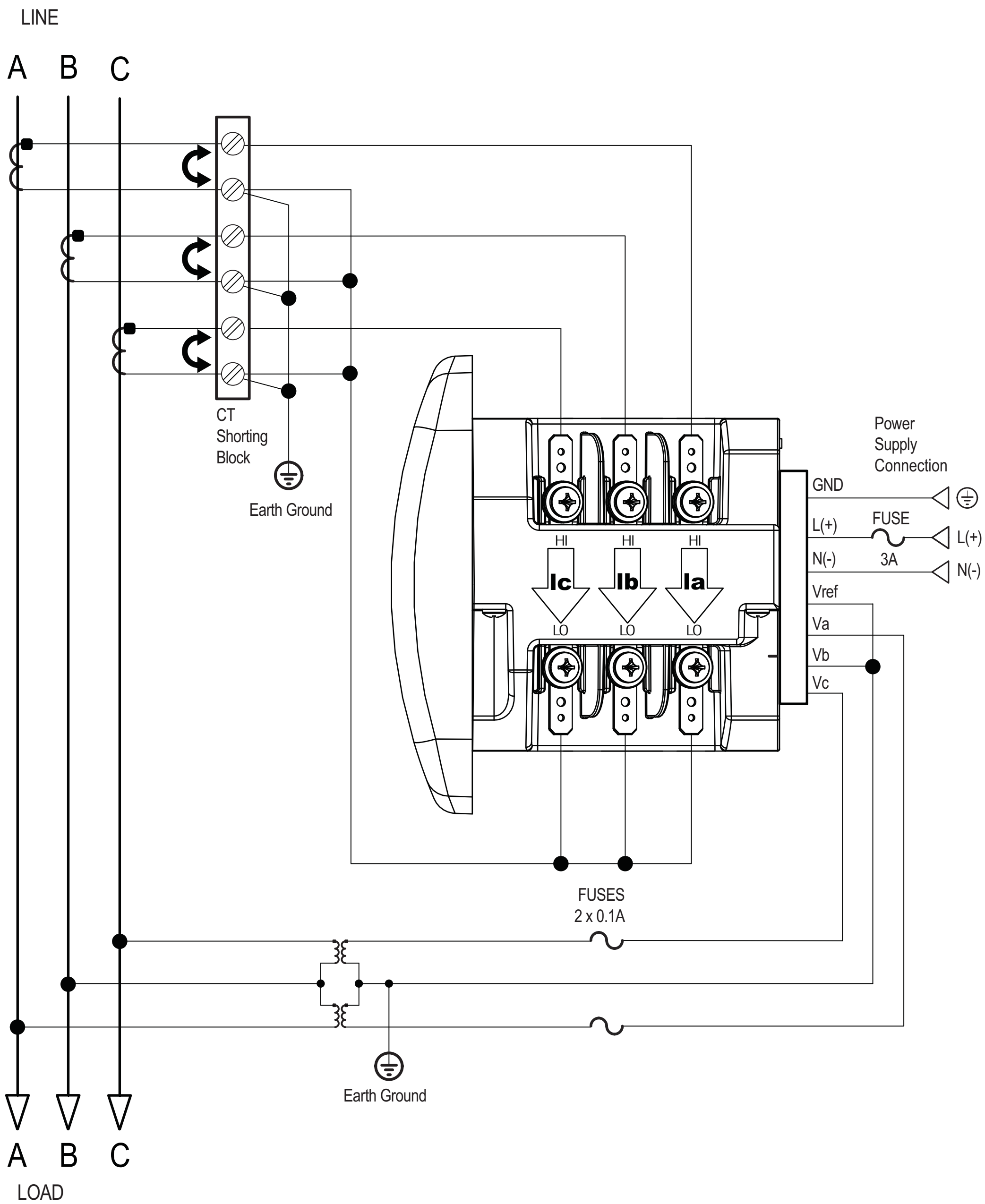


Figure 4-13: 3-Wire Delta with 2 PTs and 3 CTs

4.2.9 (8) Current-Only Measurement (Three-Phase)

For this wiring type, select **3 EL WYE** (3 Element Wye) in the meter programming setup.

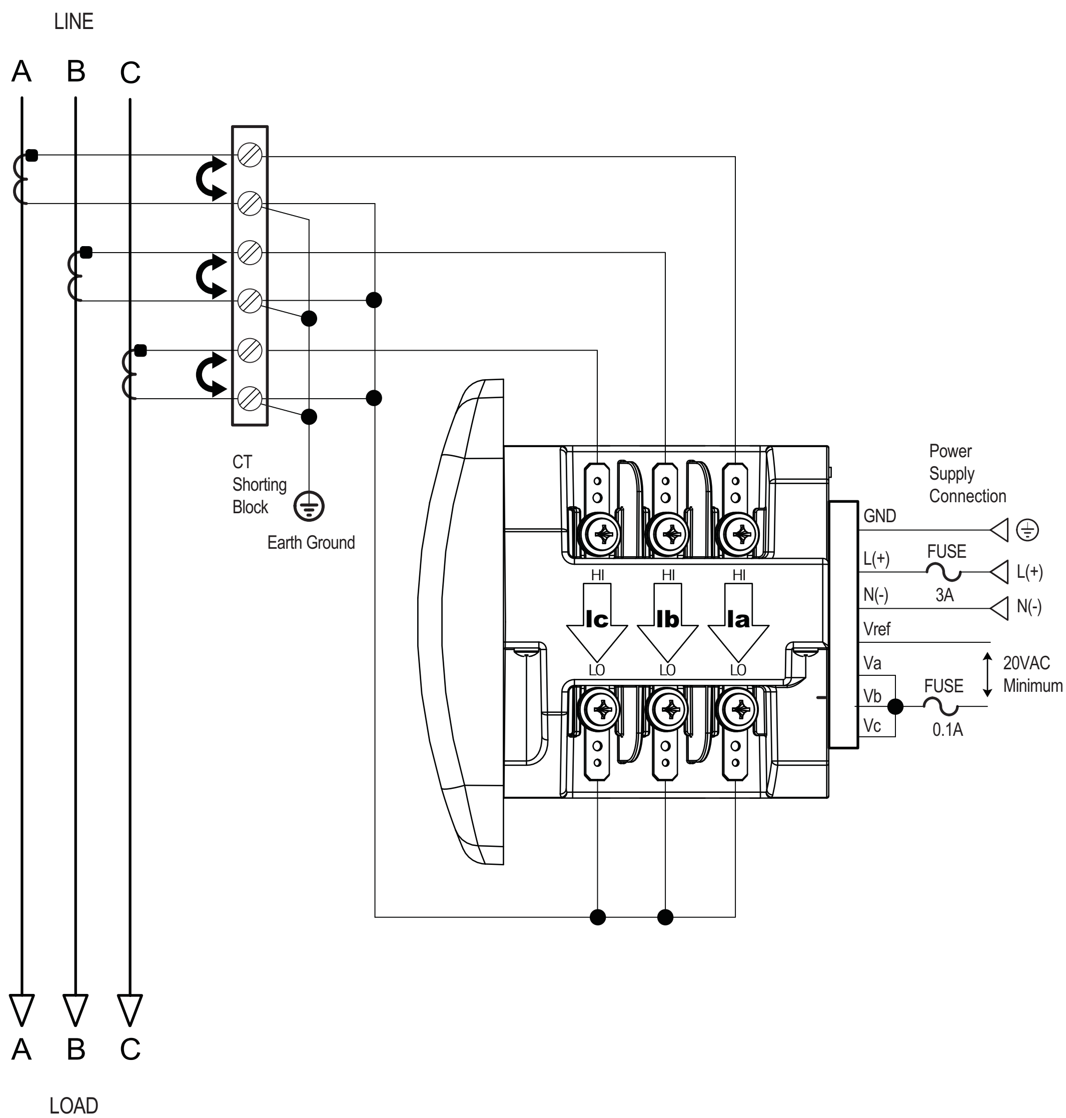


Figure 4-14: Current-Only Measurement (Three-Phase)

NOTE

Even if the meter is used only for current measurement, the unit requires a AN volts reference. Please ensure that the voltage input is attached to the meter. AC control power can be used to provide the reference signal.

4.2.10 (9) Current-Only Measurement (Dual-Phase)

For this wiring type, select **3 EL WYE** (3 Element Wye) in the meter programming setup.

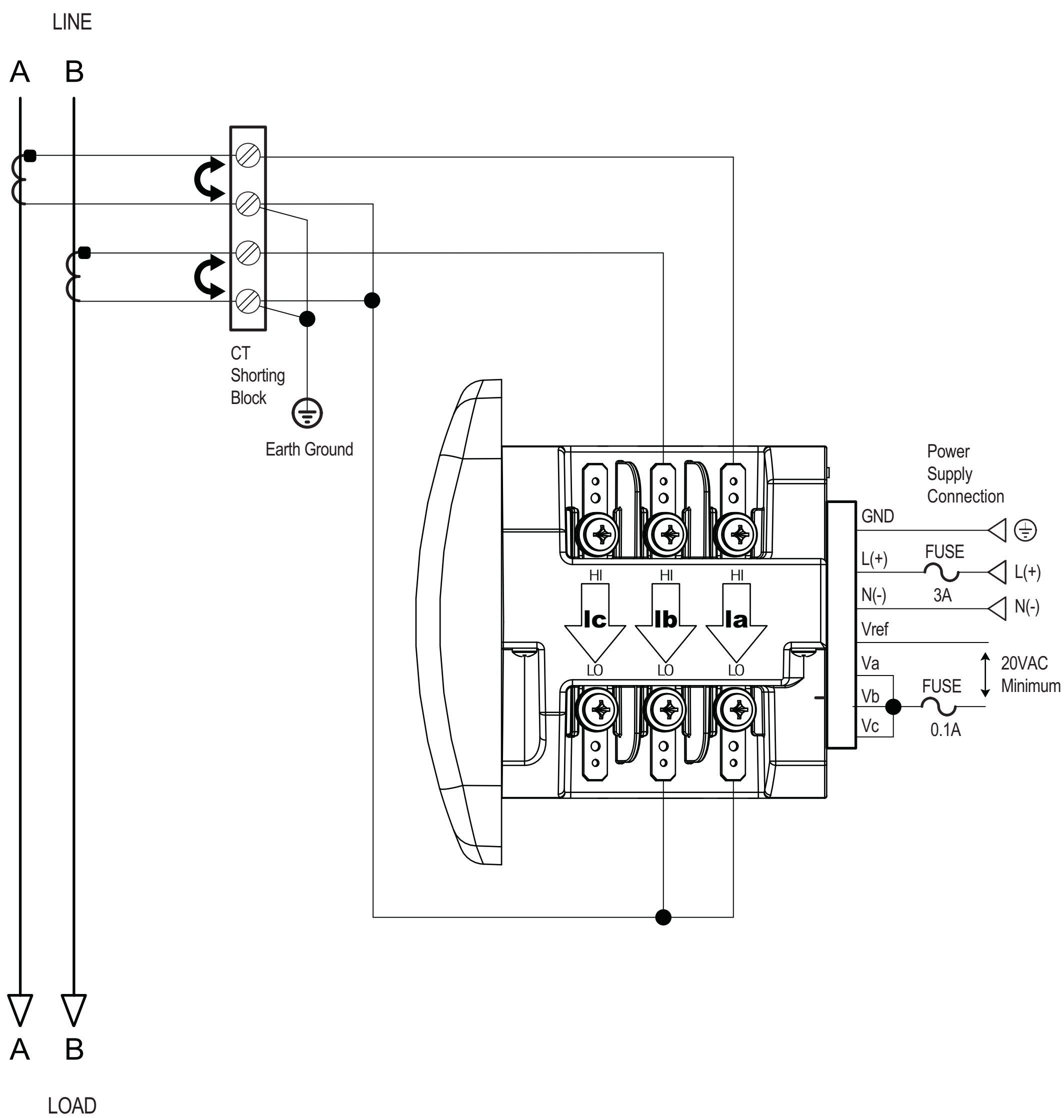


Figure 4-15: Current-Only Measurement (Dual-Phase)

NOTE

Even if the meter is used only for current measurement, the unit requires a AN volts reference. Please ensure that the voltage input is attached to the meter. AC control power can be used to provide the reference signal.

4.2.11 (10) Current-Only Measurement (Single-Phase)

For this wiring type, select **3 EL WYE** (3 Element Wye) in the meter programming setup.

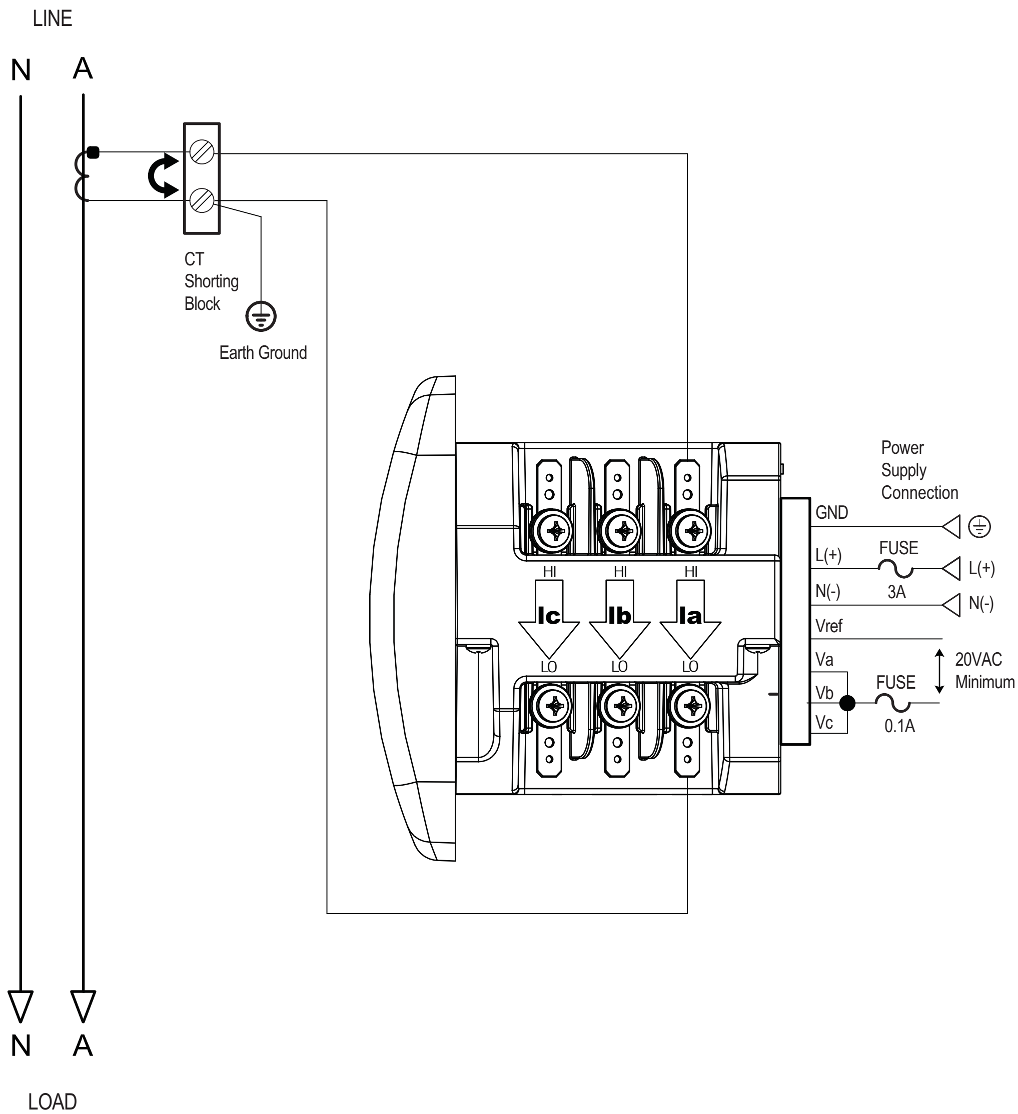


Figure 4-16: Current-Only Measurement (Single-Phase)

NOTE

Even if the meter is used only for current measurement, the unit requires a AN volts reference. Please ensure that the voltage input is attached to the meter. AC control power can be used to provide the reference signal.

EPM 6000 Power Meter

Chapter 5: Communication Installation

The EPM 6000 meter provides two independent Communication Ports. The first port, Com 1, is an Optical IrDA Port. The second port, Com 2, provides either RS-485 communication (Com Option S) speaking Modbus ASCII, Modbus RTU, and DNP 3.0 (THD Option only) protocols, or an RJ45 port (Com Option E) with a 10/100BaseT Modbus TCP/IP Ethernet connection.

The EPM 6000T Transducer model does not include a display, so there are no buttons or IrDA Port on the face of the meter. Programming and communication use the connection on the back of the meter. Once a connection is established, GE Communicator software can be used to program the meter.

5.1 IrDA Communication

The EPM 6000 meter's Com 1 IrDA Port is on the face of the meter. The IrDA Port allows the unit to be set up and programmed using a remote laptop without the need for a communication cable. Just point at the meter with an IrDA-equipped PC and configure it.

Figure 5-1: Simultaneous Dual Communication Paths

The settings for Com 1 (IrDA Port) are as follows:

- Address: 1
- Baud Rate: 57.6k
- Protocol Modbus ASCII

Additional settings are configured using GE Communicator software.

NOTE

An EPM 6000T transducer does not have an IrDA Port.

5.2 RS-485 / KYZ Output COM 2 (Com Option S)

The Serial Option provides a combination RS-485 and a KYZ Pulse Output for pulsing energy values. The RS-485 / KYZ Combo is located on the terminal section of the meter.

See section 6.3.1 for Pulse Constants.

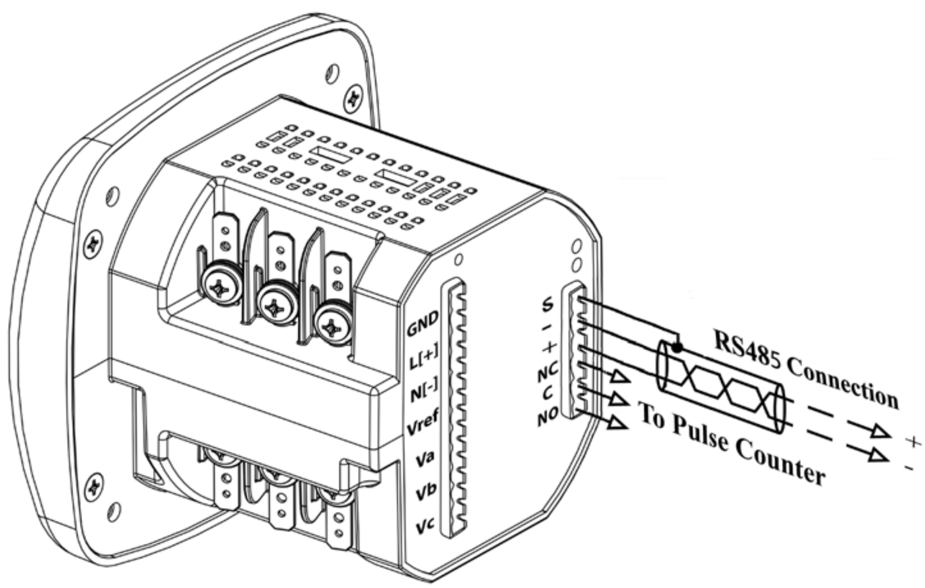


Figure 5-2: Serial Option with RS-485 Communication Installation

RS485 allows you to connect one or multiple EPM 6000 meters to a PC or other device, at either a local or remote site. All RS485 connections are viable for up to 4000 feet (1219.20 meters).

The EPM 6000 meter's RS485 can be programmed using the buttons on the face of the meter, or by using GE Communicator software:

Standard RS485 Port Settings:

- **Address**: 001 to 247
- **Baud Rate**: 9600, 19200, 38400, 57600
- **Protocol**: Modbus RTU, Modbus ASCII, DNP 3.0 (THD Option only).

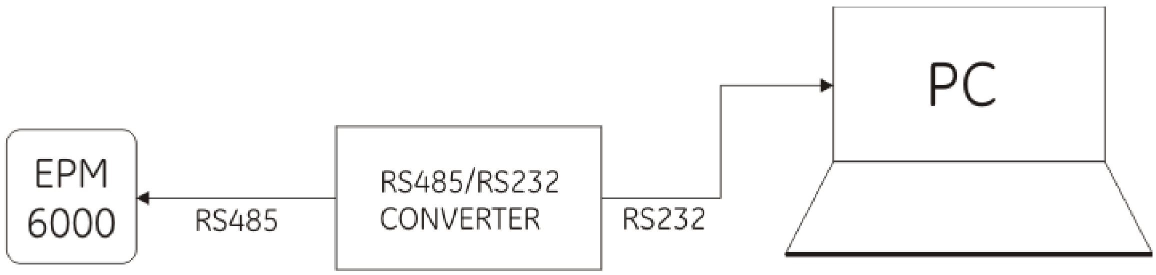


Figure 5-3: EPM 6000 Connected to PC via RS485

As shown in Figure 5-3, to connect a EPM 6000 to a PC, you need to use an RS485 to RS232 converter.

Figure 5-4 below, shows the detail of a 2-wire RS485 connection.

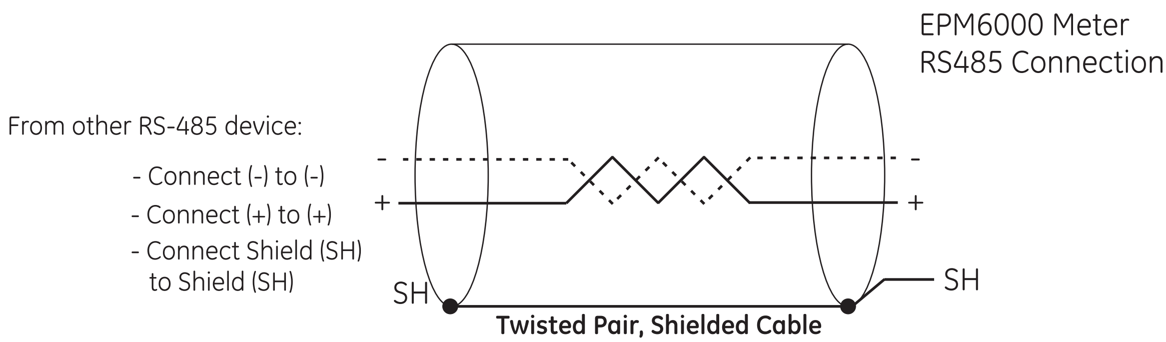


Figure 5-4: 2-wire RS485 Connection

NOTICE

For All RS485 Connections:

- Use a shielded twisted pair cable 22 AWG (0.33 mm2) or larger, grounding the shield at one end only.
- Establish point-to-point configurations for each device on a RS485 bus: connect '+' terminals to '+' terminals; connect '-' terminals to '-' terminals.
- You may connect up to 31 meters on a single bus using RS485. Before assembling the bus, each meter must be assigned a unique address: refer to the *GE Communicator Instruction Manual* for instructions.
- Protect cables from sources of electrical noise.
- Avoid both "Star" and "Tee" connections (see Figure 5-7).
- 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 (1219.20 meters).
- Connect shield to RS485 Master and individual devices as shown in Figure 5-6. You may also connect the shield to earth-ground at one point.

NOTICE

Termination Resistors (RT) may be needed on both ends for longer length transmission lines. However, since the meter has some level of termination internally, Termination Resistors may not be needed. When they are used, the value of the Termination Resistors is determined by the electrical parameters of the cable.

Figure 5-5 shows a representation of an RS485 Daisy Chain connection.

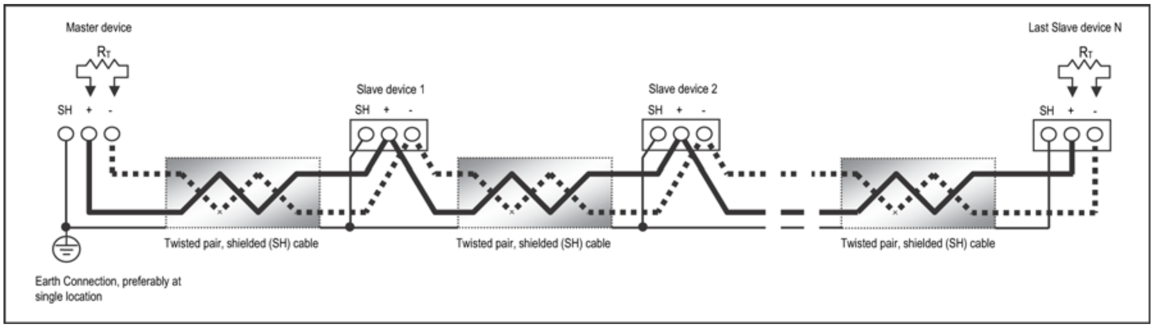


Figure 5-5: RS485 Daisy Chain Connection

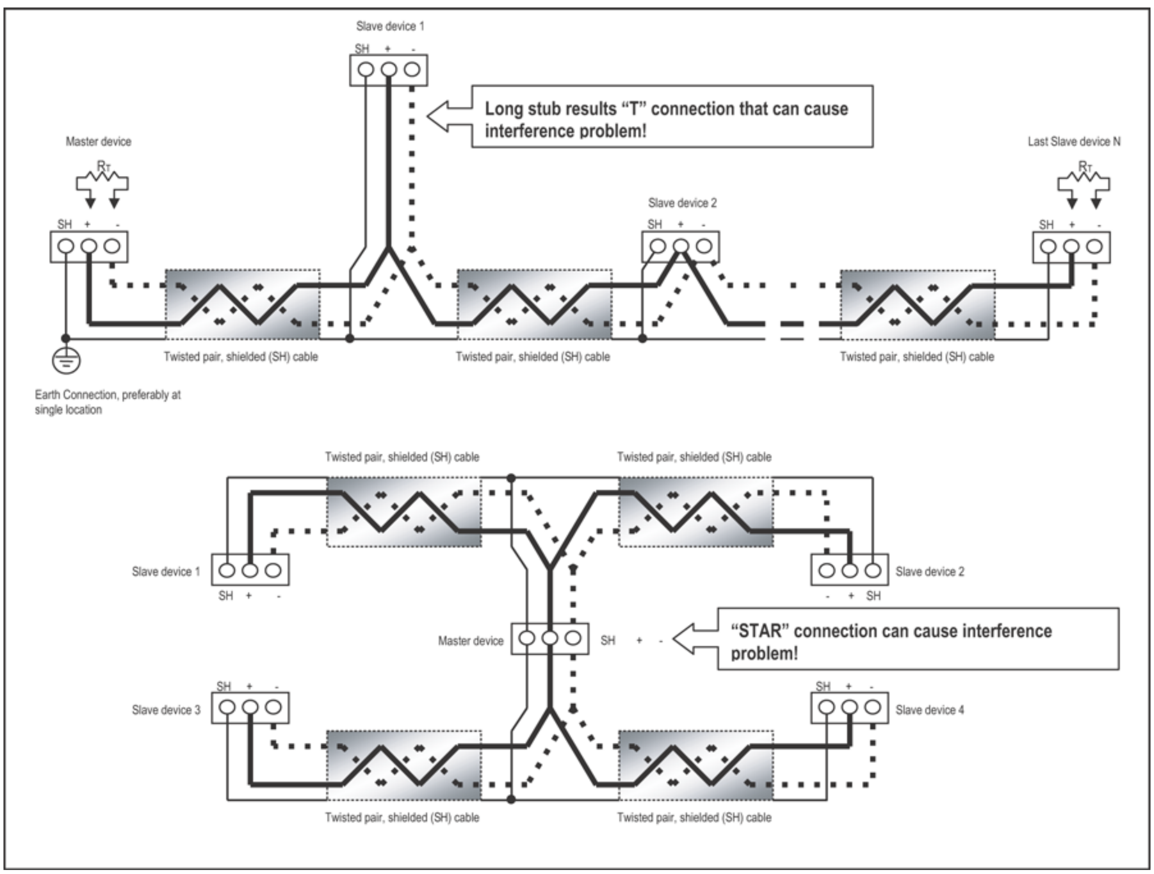


Figure 5-6: Incorrect "T" and "Star" Topologies

5.3 Configuring the Ethernet Connection (Com Option E)

The E- option gives the EPM 6000 meter a wired (RJ45) Ethernet connection, allowing it to communicate on the Local Area Network (LAN). The meter is easily configured through a host PC using Telnet connection. Once configured, you can access the meter directly through any computer on your LAN.

This chapter outlines the procedures for setting up the parameters for Ethernet communication:

- Host PC setup - Section 5.3.1
- EPM 6000 meter setup - Section 5.3.2

5.3.1 Setting up the Host PC to Communicate with the EPM 6000 meter

Consult with the network administrator before performing these steps because some of the functions may be restricted to Administrator privileges.

The Host PC could have multiple Ethernet Adapters (Network Cards) installed. Identify and configure the one that will be used for accessing the EPM 6000 meter.

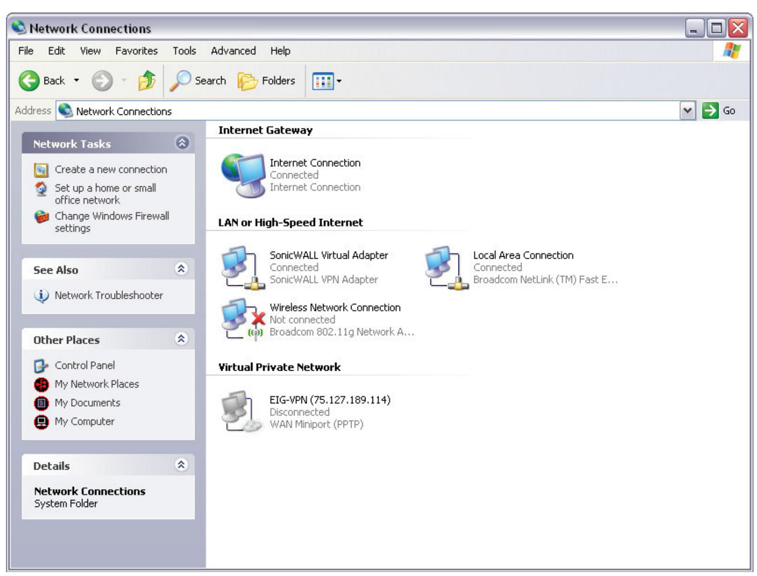
The PC's Ethernet Adapter must be set up for point-to-point communication when configuring the EPM 6000 meter's E- option. The Factory Default IP parameters programmed in the E- card are:

- IP Address: 10.0.0.1
- Subnet Mask: 255.255.255.0

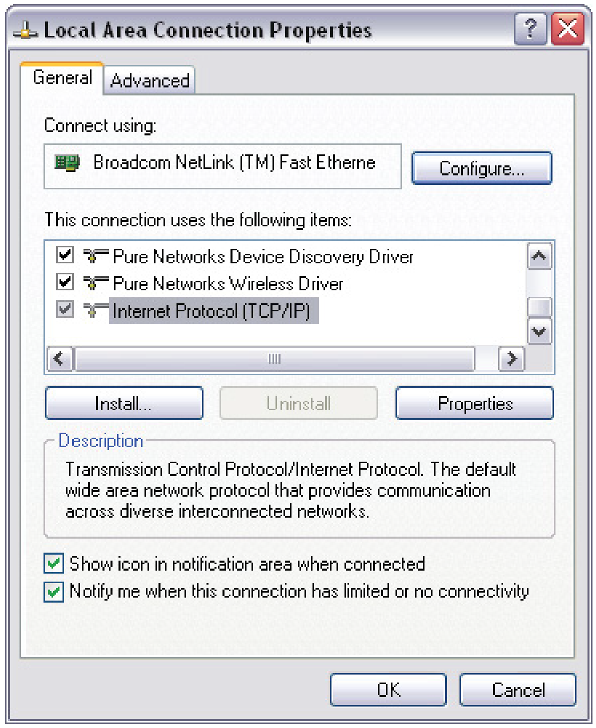
Configuring the Host PC's Ethernet Adapter

The following example shows the PC configuration settings that allow you to access the EPM 6000 meter configured with default parameters. Use the same procedure when the settings are different than the default settings.

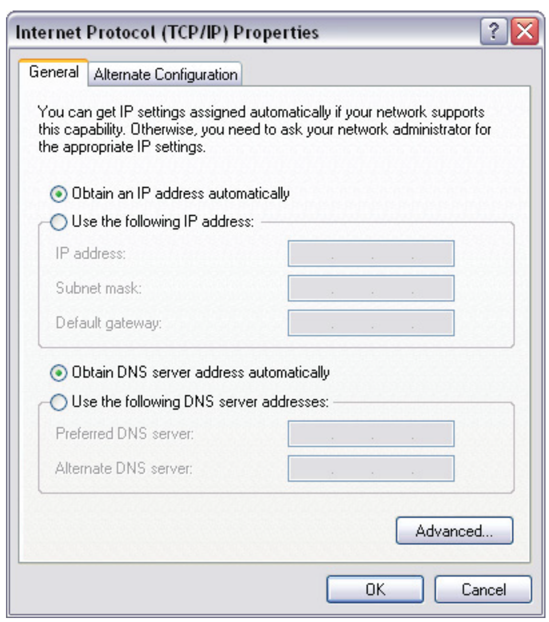
1. From the **Start** Menu, select **Control Panel > Network Connections**. You will see the window shown below:



2. Right click on the Local Area Network Connection you will use to connect to the EPM 6000 meter and select **Properties** from the drop-down menu.
3. Select **Internet Protocol [TCP/IP]** and click the **Properties** button.
   You will see the window shown below:



4. Click the **Use the Following IP Address** radio button and enter these parameters:
   IP Address: 10.0.0.2
   Subnet Mask: 255.255.255.0



5. Click the **OK** button.

You have completed the setup procedure.

5.3.2 Setting up the Ethernet Card (Option E) in the EPM 6000 meter

Below are the Factory Default settings for the EPM 6000 meter's Ethernet card. These are programmed into the meter before it is shipped out from the factory. Parameters in group **1** may need to be altered to satisfy the local Ethernet configuration requirements. **Other parameters (2, 3, 4) should not be altered**.

1)	**Network/IP Settings:**
	IP Address - 10.0.0.1
	Default Gateway - Not Set
	Netmask - 255.255.255.0
2)	**Serial & Mode Settings:**
	Protocol - Modbus/RTU, Slave(s) attached
	Serial Interface - 57600, 8, N , RS232
3)	**Modem/Configurable Pin Settings:**
	CP1 - Not Used
	CP2 - Not Used
	CP3 - Not Used
4)	**Advanced Modbus Protocol Settings:**
	Slave Addr/Unit ID Source - Modbus/TCP Header
	Modbus Serial Broadcasts - Disabled (ID=0 auto-mapped to 1)
	MB/TCP Exception Codes - Yes (Return 00AH and 00BH)
	Char, Message Timeout - 00050 msec, 05000 msec

The Ethernet card in the EPM 6000 meter can be locally or remotely configured using a Telnet connection over the network.

The configuration parameters can be changed at any time and are retained when the meter is not powered up. After the configuration has been changed and saved, the Ethernet card performs a Reset.

Only one person at a time should be logged into the network port used for setting up the meter. This eliminates the possibility of several people trying to configure the Ethernet interface simultaneously.

It is possible to reset the Ethernet card to its default values. See the procedure 5.3.3 *Resetting the Ethernet Card (E-)* on page 5–9.

Configuring the EPM 6000 Meter's Ethernet Connection on the Host Computer

Establish a Telnet connection on port 9999. Follow these steps:

1. From the Windows **Start** menu, click **Run** and type '**cmd**'.
2. Click the **OK** button to bring up the Windows' Command Prompt window.
3. In the Command Prompt window, type:
   "telnet 10.0.0.1 9999" and press the **Enter** key

Make sure there is a space between the IP address and 9999.

```
Serial Number 5415404   MAC Address 00:20:4A:3C:2C
Software Version V01.2 (000719)
Press Enter to go into Setup Mode
```

When the Telnet connection is established you will see a message similar to the example shown below.

```
Microsoft Windows XP [Version 5.1.2600]
(C) Copyright 1985-2001 Microsoft Corp.

C:\Documents and Settings\Administrator>telnet 10.0.0.1 9999
```

4. To proceed to Setup Mode press **Enter** again. You will see a screen similar to the one shown below.

```
1)  Network/IP Settings:
    IP Address - 10.0.0.1
    Default Gateway - Not Set
    Netmask - 255.255.255.0
2)  Serial & Mode Settings:
    Protocol - Modbus/RTU, Slave(s) attached
    Serial Interface - 57600, 8, N , RS232, CH1
3)  Modem/Configurable Pin Settings:
    CP1 - Not Used
    CP2 - Not Used
    CP3 - Not Used
4)  Advanced Modbus Protocol Settings:
    Slave Addr/Unit ID Source - Modbus/TCP Header
    Modbus Serial Broadcasts - Disabled (ID=0 auto-mapped to 1)
    MB/TCP Exception Codes - Yes (Return 00AH and 00BH)
    Char, Message Timeout - 00050 msec, 05000 msec

D)efault settings, S)ave, Q)uit without save
Select Command or parameter set (1..4) to change:
```

5. Change only the parameters in group 1. To do so:
   - Type number “1”.
   - Once group 1 is selected, the individual parameters display for editing. Either:
     - Enter a new parameter if a change is required.
     - Press **Enter** to proceed to the next parameter without changing the current setting.

NOTE

Settings 2, 3, and 4 must have the default values shown above.

Example: Setting device with static IP Address.

IP Address <010> 192.<000> 168.<000> .<000> .<001>

Set Gateway IP Address <N> ? Y

Gateway IP Address : <192> .<168> .<000> .<001>

Set Netmask <N for default> <Y> ? Y

6. Continue setting up parameters as needed. After finishing your modifications, make sure to press the “S” key on the keyboard. This will save the new values and perform a Reset in the Ethernet card.

NOTICE

DO NOT PRESS ‘D’ as it will overwrite any changes and save the default values.

NOTE

If the IP Address of the Ethernet card is lost, you can restore the factory default settings by pressing the Reset button on the card.

Follow the procedure in the following section.

5.3.3 Resetting the Ethernet Card (E-)

The E- card’s Reset Button is accessed from the back of the EPM 6000 meter. See the figure below for the location of the Reset Button.

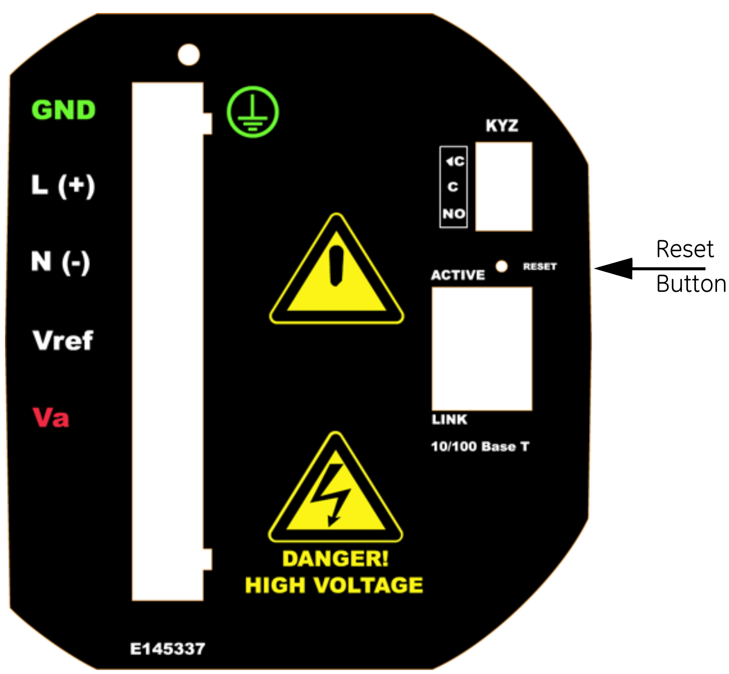


Figure 5-7: Backplate of EPM 6000 meter, showing Reset Button placement

Using an implement such as a ballpoint pen tip, press and hold the Reset button for 30 seconds. The E- card will be reset to the default settings.

EPM 6000 Power Meter

Chapter 6: Using the Meter

You can use the Elements and Buttons on the EPM 6000 meter face to view meter readings, reset and/or configure the meter, and perform related functions. You can also use the GE Communicator software to configure the meter through communication.

The following sections explain meter programming, first by using the faceplate and then with GE Communicator software.

6.1 Programming Using the Faceplate

The EPM 6000 meter can be configured and a variety of functions can be accomplished simply by using the Elements and the Buttons on the meter face. Complete Navigation Maps can be found in Appendix A of this manual.

NOTE

An EPM 6000T transducer does not have a front panel. Configuration changes use the back port and the GE Communicator software.

6.1.1 Meter Face Elements

Figure 6-1: Faceplate of EPM 6000 Meter with Elements

- **Reading Type Indicator:**
  Indicates Type of Reading
- **IrDA Communication Port:**
  Com 1 Port for Wireless Communication
- **% of Load Bar:**
  Graphic Display of Amps as % of the Load
- **Parameter Designator:**
  Indicates Reading Displayed
- **Watt-Hour Test Pulse:**
  Energy Pulse Output to Test Accuracy
- **Scale Selector:**
  Kilo or Mega multiplier of Displayed Readings

Figure 6-2: EPM 6000 Faceplate Buttons

6.1.2 Meter Face Buttons

Using **Menu, Enter, Down and Right Buttons**, perform the following functions:

- View Meter Information
- Enter Display Modes
- Configure Parameters (Password Protected)
- Perform Resets
- Perform LED Checks
- Change Settings
- View Parameter Values
- Scroll Parameter Values

The EPM 6000 has three MODES:

- **Operating Mode** (Default)
- **Reset Mode**
- **Configuration Mode**.

The MENU, ENTER, DOWN and RIGHT buttons navigate through the MODES and navigate through all the SCREENS in each mode.

In this chapter, a typical set up will be demonstrated. Other settings are possible. The complete Navigation Map for the Display Modes is in Appendix A of this manual. The meter can also be configured with software (see *GE Communicator Instruction Manual*).

6.1.3 Start Up

Upon Power Up, the meter will display a sequence of screens. The sequence includes the following screens:

- Lamp Test Screen where all LEDs are lighted
- Lamp Test Screen where all digits are lighted
- Firmware Screen showing build number
- Error Screen (if an error exists)

The EPM 6000 will then automatically Auto-Scroll the Parameter Designators on the right side of the front panel. Values are displayed for each parameter.

The **KILO or MEGA LED** lights, showing the scale for the Wh, VARh and VAh readings.

An example of a Wh reading is shown below.

Figure 6-3: Typical Wh Reading

The EPM 6000 will continue to scroll through the Parameter Designators, providing readings until one of the buttons on the front panel is pushed, causing the meter to enter one of the other MODES.

6.1.4 Main Menu

Push **MENU** from any of the Auto-Scrolling Readings. The MAIN MENU Screens appear.

The String for **Reset Mode** (rSt) appears (blinking) in the A Screen.

If you push **DOWN**, the MENU scrolls and the String for **Configuration Mode** (CFG) appears

(blinking) in the A Screen.

If you push **DOWN** again, the String for **Operating Mode** (OPr) appears (blinking) in the A Screen.

If you push **DOWN** again, the MENU scrolls back to Reset Mode (rSt).

If you push **ENTER** from the Main Menu, the meter enters the Mode that is in the A Screen and is blinking.

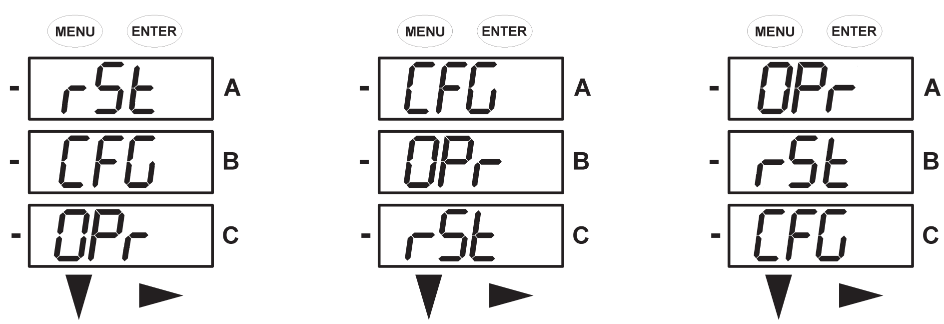
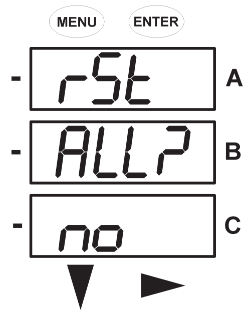


Figure 6-4: Main Menu Screens

6.1.5 Reset Mode

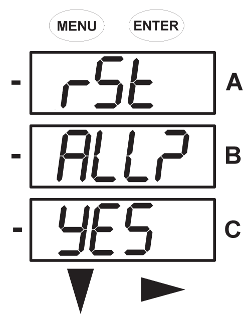
If you push **ENTER** from the Main Menu, the meter enters the Mode that is in the A Screen and is blinking. Reset Mode is the first mode to appear on the Main Menu. Push **ENTER** while (rSt) is in the A Screen and the "RESETALL? no" screen appears. **Reset ALL resets all Max and Min values.**

.



- If you push **ENTER** again, the Main Menu continues to scroll.
- The DOWN button does not change the screen.
- If you push the **RIGHT** button, the RESET All? YES screen appears.

.



- To Reset All, you must enter a 4-digit Password, **if Enabled** in the software (see section 6.4.3: Device Profile Settings).
- Push **ENTER**; the following Password screen appears.

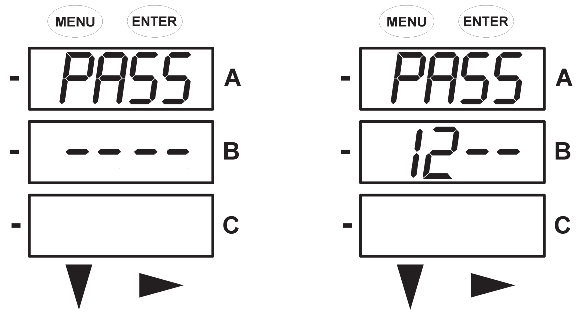
6.1.6 Enter Password (IF ENABLED IN SOFTWARE)

To enter a Password:

- **If PASSWORD is Enabled in the software** (see 6.4.3: Device Profile Settings to Enable/ Change Password), a screen appears requesting the Password. **PASS** appears in the A Screen and **4 dashes** in the B Screen. The LEFT digit is flashing.
- Use the **DOWN** button to scroll from 0 to 9 for the flashing digit. When the correct number appears for that digit, use the **RIGHT** button to move to the next digit.

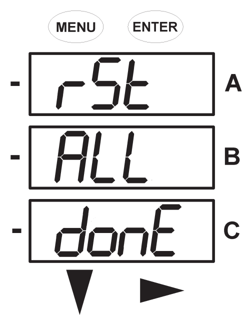
Example: On the Password screens below:

- On the left screen, four dashes appear and the left digit is flashing.
- On the right screen, 2 digits have been entered and the third digit is flashing.

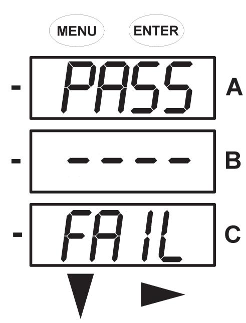


PASS or FAIL:

- When all 4 digits have been entered, push **ENTER**.
- If the **correct Password** has been entered, “rSt ALL donE” appears and the screen returns to Auto-Scroll the Parameters. (In other Modes, the screen returns to the screen to be changed. The left digit of the setting is flashing and the Program (PRG) LED flashes on the left side of the meter face.)



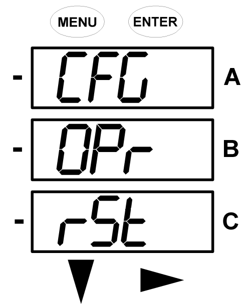
- If an **incorrect Password** has been entered, “PASS ---- FAIL” appears and the screen returns to Reset ALL? YES.



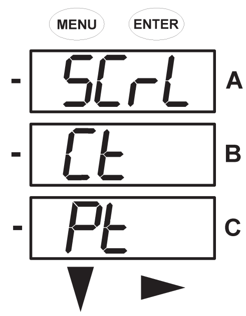
6.1.7 Configuration Mode

Navigating the Configuration Mode Menu.

1. Press the **MENU** Button from any of the auto-scrolling readings.
2. Press **DOWN** to display the Configuration Mode (**CFG**) string in the “A” screen.



3. Press **ENTER** to scroll through the configuration parameters, starting at the **SCrL Ct Pt** screen.

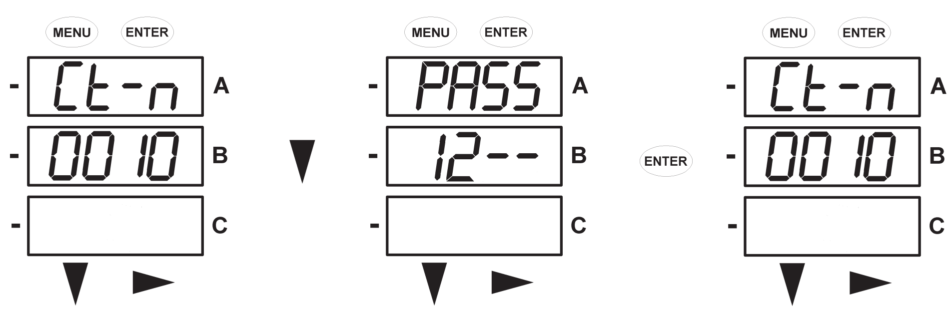


4. Push the **DOWN** Button to scroll all the parameters: scroll, CT, PT, connection (**Cnct**) and port.
   The active parameter is always flashing and displayed in the “A” screen.

Programming the Configuration Mode Screens

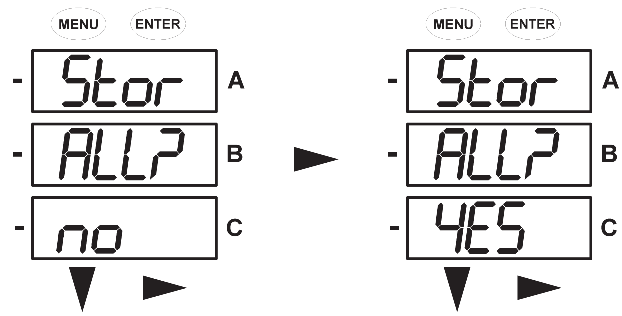
Use the following procedure to program the screen for configuration mode.

1. Press the **DOWN** or **RIGHT** button (for example, from the **Ct-n** message below) to display the password screen, if enabled in the software.
2. Use the **DOWN** and **RIGHT** buttons to enter the correct password (refer to *Reset Mode* above, for steps on password entry).
3. Once the correct password is entered, push **ENTER**.
   The **Ct-n** message will reappear, the PRG faceplate LED will flash, and the first digit of the “B” screen will also flash.



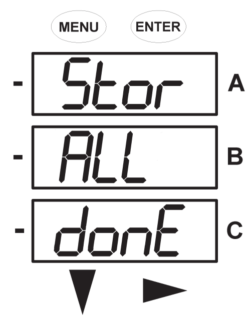
4. Use the **DOWN** button to change the first digit.
5. Use the **RIGHT** button to select and change the successive digits.

6. When the new value is entered, push **ENTER** twice.
   This will display the **Stor ALL? no** screen.
7. Use the **RIGHT** button to scroll to change the value from **no** to **YES**.



8. When the **Stor ALL? YES** message is displayed, press **ENTER** to change the setting.

The **Stor ALL donE** message will appear and the meter will reset.



6.1.8 Configuring the Scroll Feature

Use the following procedure to configure the scroll feature.

1. Press the **ENTER** button to display the **SCrL no** message.
2. Press the **RIGHT** button to change the display to **SCrL YES** as shown below.

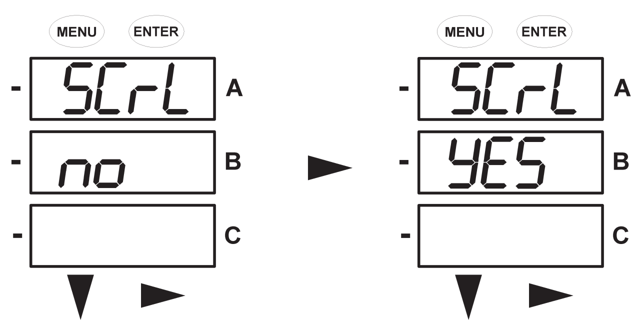


Figure 6-5: Scroll Mode Configuration

When in scroll mode, the unit scrolls each parameter for 7 seconds on and 1 second off. The meter can be configured through software to only display selected screens. In this case, it will only scroll the selected displays.

3. Push **ENTER** to select **YES** or **no**.

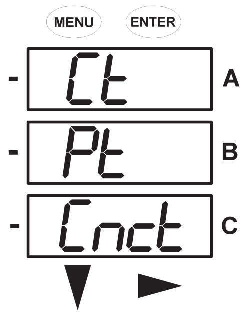
The screen scrolls to the CT parameters.

6.1.9 Configuring the CT Setting

Use the following procedure to program the CT setting.

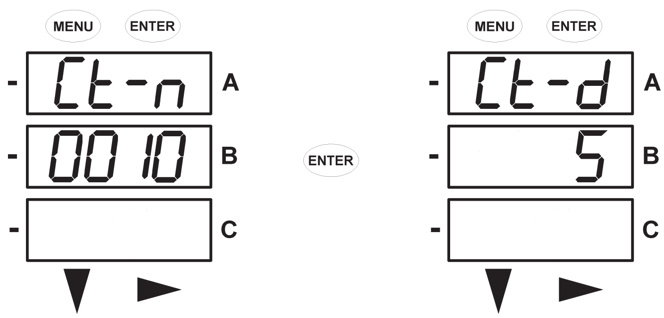
1. Push the **DOWN** Button to scroll through the configuration mode parameters.

Press **ENTER** when **Ct** is the active parameter (i.e. it is in the “A” screen and flashing).



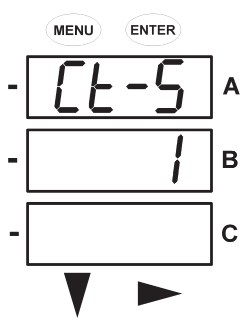
This will display the and the **Ct-n** (CT numerator) screen.

2. Press **ENTER** again to change to display the **Ct-d** (CT denominator) screen.



The **Ct-d** value is preset to a 1 or 5 A at the factory and cannot be changed.

3. Press **ENTER** again to select the to **Ct-S** (CT scaling) value.



The **Ct-S** value can be “1”, “10”, or “100”. Refer to *Programming the Configuration Mode Screens* above, for instructions on changing values.

Example settings for the **Ct-S** value are shown below:

200/5 A: set the **Ct-n** value for “200” and the **Ct-S** value for “1”
800/5 A: set the **Ct-n** value for “800” and the **Ct-S** value for “1”
2000/5 A: set the **Ct-n** value for “2000” and the **Ct-S** value for “1”.
10000/5 A: set the **Ct-n** value for “1000” and the **Ct-S** value for “10”.

NOTICE

The value for amps is a product of the Ct-n and the Ct-S values.

4. Press **ENTER** to scroll through the other **CFG** parameters.
   Pressing **DOWN** or **RIGHT** displays the password screen (see *Reset Mode* above, for details).
5. Press **MENU** to return to the main configuration menu.

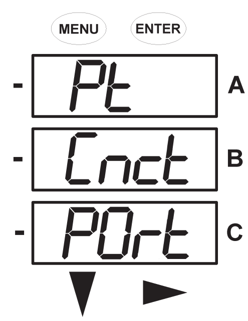
NOTICE

Ct-n and **Ct-S** are dictated by Primary Voltage.
Ct-d is secondary Voltage.

6.1.10 Configuring the PT Setting

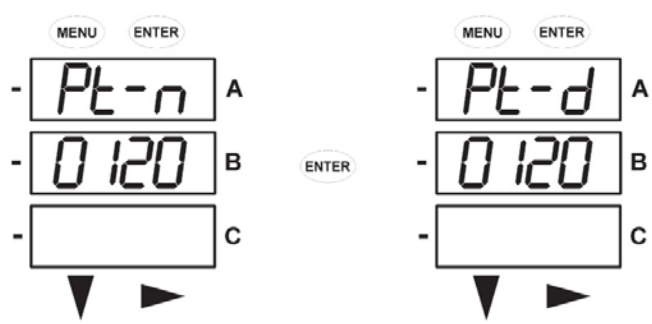
Use the following procedure to program the PT setting.

1. Push the **DOWN** Button to scroll through the configuration mode parameters.
2. Press **ENTER** when **Pt** is the "active" parameter (i.e. it is in the “A” screen and flashing) as shown below.

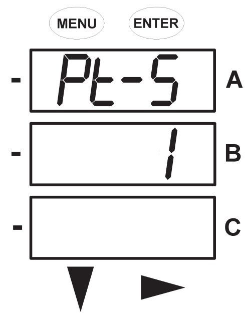


This will display the **Pt-n** (PT numerator) screen.

3. Press **ENTER** again to change to display the **Pt-d** (PT denominator) screen.



4. Press **ENTER** again to select the to **Pt-S** (PT scaling) value.



The **Pt-S** value can be "1", "10", or "100". Refer to *Programming the Configuration Mode Screens* above, for instructions on changing values.

Example settings for the **Pt-n**, **Pt-d**, and **Pt-S** values are shown below:

277/277 Volts:	**Pt-n** value is 277, Pt-d value is 277, **Pt-Multiplier** is 1
14400/120 Volts:	**Pt-n** value is 1440, Pt-d value is 120, **Pt-S** value is 10
138000/69 Volts:	**Pt-n** value is 1380, Pt-d value is 69, **Pt-S** value is 100
345000/115 Volts:	**Pt-n** value is 3450, Pt-d value is 115, **Pt-S** value is 100
345000/69 Volts:	**Pt-n** value is 345, Pt-d value is 69, **Pt-S** value is 1000

5. Press **ENTER** to scroll through the other **CFG** parameters.
6. Press **DOWN** or **RIGHT** to display the password screen (see *Reset Mode* above, for details).
7. Press **MENU** to return to the Main Configuration Menu.

NOTICE

Pt-n and **Pt-S** are dictated by primary voltage.
Pt-d is secondary voltage.

6.1.11 Configuring the Connection (Cnct) Setting

Use the following procedure to program the connection (**Cnct**) setting.

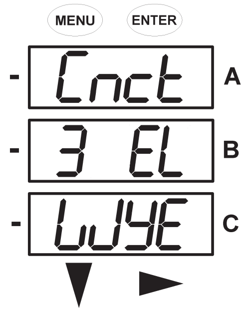
1. Push the **DOWN** Button to scroll through the Configuration Mode parameters: Scroll, CT, PT, Connection (Cnct), and Port. The "active" parameter is in the A screen and is flashing
2. Press **ENTER** when **Cnct** is the "active" parameter (i.e. it is in the "A" screen and flashing).

This will display the **Cnct** (Connection) screen. To change this setting, use the RIGHT button to scroll through the three settings. Select the setting that is right for your meter.

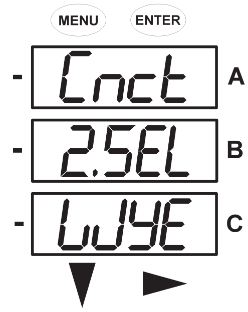
The possible Connection configurations are

- 3-element Wye (**3 EL WYE**)
- 2.5-element Wye (**2.5EL WYE**)
- 2 CT Delta (**2 Ct deL**)

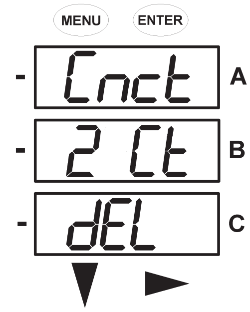
as shown below:



3-Element Wye



2.5-Element Wye



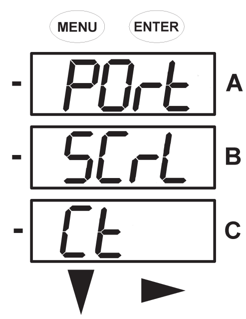
2 CT Delta

3. Press **ENTER** to scroll through the other **CFG** parameters.
4. Press **DOWN** or **RIGHT** to display the Password screen (see *Reset Mode* above for details).
5. Press **MENU** to return to the main Configuration menu.

6.1.12 Configuring the Communication Port Setting

Use the following procedure to program the communication port (**POrt**) settings.

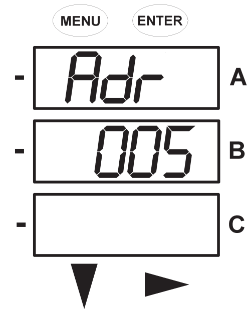
1. Push the **DOWN** Button to scroll through the configuration mode parameters.
2. Press **ENTER** when **POrt** is the active parameter (i.e. it is in the “A” screen and flashing) as shown below.



The following parameters can be configured through the **POrt** menu

- The meter **Address** (**Adr**, a 3-digit number).
- The **Baud Rate** (**bAUd**). Select from “9600”, “19.2”, “38.4”, and “57.6” for 9600, 19200, 38400, and 57600 kbps, respectively.
- The **Communications Protocol** (**Prot**). Select “rtU” for Modbus RTU, “ASCI” for Modbus ASCII, and “dnP” for the DNP 3.0 protocol.

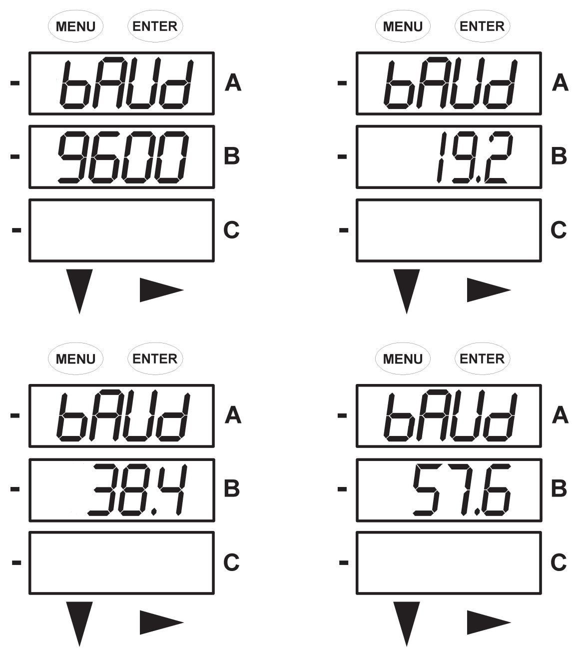
- The first **POrt** screen is **Meter Address** (**Adr**). The current address appears on the screen. Select a three-digit number for the address.



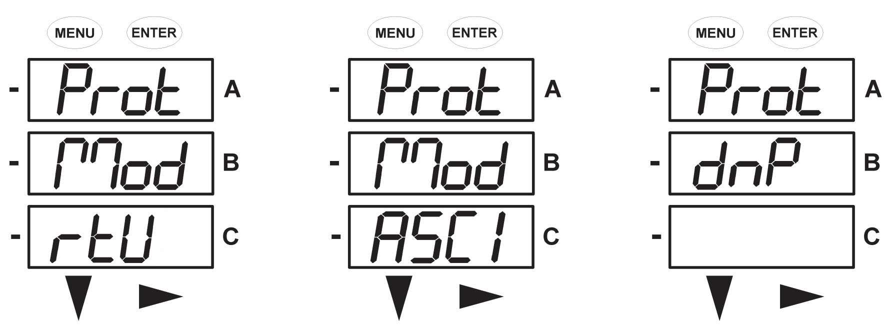
Address 005

Refer to *Programming the Configuration Mode Screens* above, for details on changing values.

- The next **POrt** screen is the baud rate (**bAUd**). The current baud rate is displayed on the “B” screen. Refer to *Programming the Configuration Mode Screens* above, for details on changing values. The possible baud rate screens are shown below.



- The final **POrt** screen is the **Communications Protocol** (**Prot**). The current protocol is displayed on the “B” screen.



Refer to *Programming the Configuration Mode Screens* above, for details on changing values. The three protocol selections are shown below.

3. Press **ENTER** to scroll through the other **CFG** parameters.
4. Press **DOWN** or **RIGHT** to display the Password screen (see *Reset Mode* above, for details).
5. Press **MENU** to return to the main Configuration menu.

6.1.13 Operating Mode

Operating mode is the EPM 6000 meter's default mode. If scrolling is enabled, the meter automatically scrolls through these parameter screens after startup. The screen changes every 7 seconds. Scrolling is suspended for 3 minutes after any button is pressed.

Push the **DOWN** button to scroll all the parameters in operating mode. The active parameter has the indicator light next to it on the right face of the meter.

Push the **RIGHT** button to view additional displays for that parameter. A table of the possible displays in the operating mode is below. Refer to *Appendix A* for a detailed navigation map of the operating mode.

Table 6–1: Operating Mode Parameter Readings

Parameter designator Available by THD and Pulse Output (Software) Option THD)		Possible Readings					THD Option Only
VOLTS L-N	0, THD	VOLTS_LN	VOLTS_LN_ MAX	VOLTS_LN_ MIN			VOLTS_LN_ THD
VOLTS L-L	0, THD	VOLTS_LL	VOLTS_LL_ MAX	VOLTS_LL_ MIN			
AMPS	0, THD	AMPS	AMPS_NEUTRAL	AMPS_MAX	AMPS_MIN		AMPS_THD
W/VAR/PF	0, THD	W_VAR_PF	W_VAR_PF _MAX_POS	W_VAR_PF _MIN_POS	W_VAR_PF _MAX_NEG	W_VAR_PF _MIN_NEG	
VA/Hz	0, THD	VA_FREQ	VA_FREQ_ MAX	VA_FREQ_ MIN			
Wh	0, THD	KWH_REC	KWH_DEL	KWH_NET	KWH_TOT		
VARh	0, THD	KVARH_ POS	KVARH_ NEG	KVARH_ NET	KVARH_TOT		
VAh	0, THD	KVAH					

NOTE

Readings or groups of readings are skipped if not applicable to the meter type or hookup, or if explicitly disabled in the programmable settings.

6.2 % of Load Bar

The 10-segment LED bargraph at the bottom of the EPM 6000 unit's display provides a graphic representation of Amps. The segments light according to the load in the %Load Segment Table below.

When the Load is over 120% of Full Load, all segments flash "On" (1.5 secs) and "Off" (0.5 secs).

Table 6–2: % Load Segments

Segments	Load ≤ % Full Load
None	No Load
1	1%
1 - 2	15%
1 - 3	30%
1 - 4	45%
1 - 5	60%
1 - 6	72%
1 - 7	84%
1 - 8	96%
1 - 9	108%
1 - 10	120%
All Blink	>120%

6.3 Watt-hour Accuracy Testing (Verification)

To be certified for revenue metering, power providers and utility companies have to verify that the billing energy meter will perform 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. Since the EPM 6000 is a traceable revenue meter, it contains a utility grade test pulse that can be used to gate an accuracy standard. This is an essential feature required of all billing grade meters.

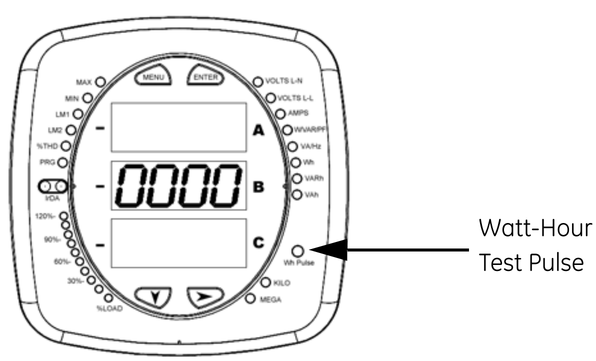


Figure 6-6: Watt-hour Test Pulse

Refer to the figure below for an example of how this test works.

Refer to Table 6-2 below for the Wh/Pulse Constant for Accuracy Testing.

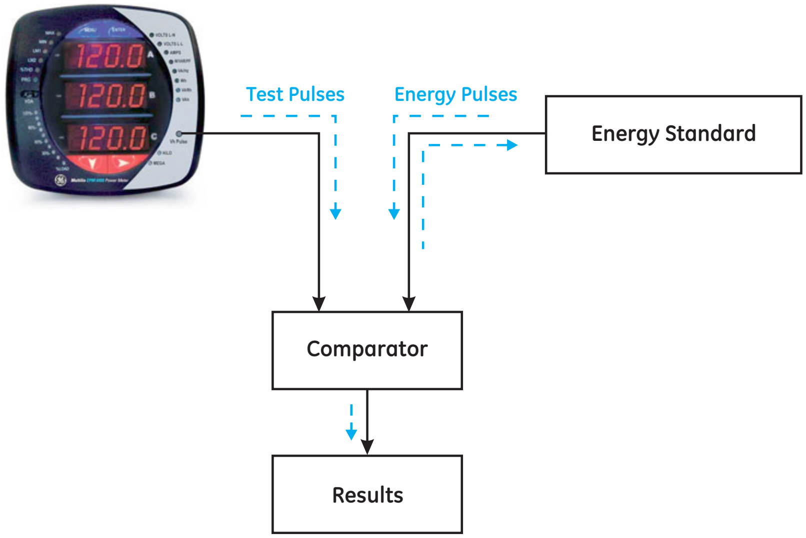


Figure 6-7: Using the Watt-Hour Test Pulse

6.3.1 Infrared & KYZ Pulse Constants for Accuracy Testing (Kh)

Table 6–3: Infrared & KYZ Pulse Constants for Accuracy Testing

Voltage Level	Class 10 Models	Class 2 Models
Below 150 V	0.2505759630	0.0501151926
Above 150 V	1.0023038521	0.2004607704

NOTICE

- Minimum pulse width is 40 ms.
- Refer to 2.2: Specifications for Wh Pulse specifications.

6.4 GE Communicator Programming Overview

Programming the EPM 6000T requires using the back communication port and software. The EPM 6000 can also be programmed this way. Once a connection is established, GE Communicator software can be used to program the meter and communicate to EPM 6000 slave devices.

Meter Connection

To provide power to the meter, use one of the wiring diagrams in Chapter 4 or attach an Aux cable to GND, L('+') and N('-').

The RS-485 cable attaches to SH, '-' and '+' as shown in 5.2 *RS-485 / KYZ Output COM 2 (Com Option S)* on page 5–2.

6.4.1 Factory Initial Default Settings

You can connect to the EPM 6000/6000T using the Factory Initial Default Settings if you are using the RS485 port (Com Option S). This feature is useful in debugging or in any situation where you do not know the meter's programmed settings and want to find them.

When the EPM 6000 is powered up, you have up to 5 seconds to poll the Name Register as shown in the example below: "How to Connect." You will be connected to the meter with the Factory Initial Default Settings.

NOTE

Factory Initial Default Settings:

- Baud Rate: 9600
- Address: 001
- Protocol: Modbus RTU

The meter continues to operate with these default settings for 5 minutes. During this time, you can access the meter's Device Profile to ascertain/change meter information. After the 5 minutes have passed, the meter reverts to the programmed Device Profile settings.

NOTE

In Normal operating mode the initial factory communication settings are:

- Baud Rate: 57,600
- Address: 001
- Protocol: Modbus RTU

6.4.2 How to Connect Using GE Communicator Software

1. Open the GE Communicator software.
2. Click the **Connect** button on the tool bar.

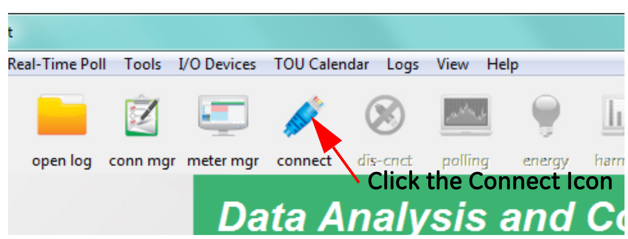


Figure 6-8: Connect Button

3. The Connect screen opens, showing the Default settings. Make sure your settings are the same as shown here. Use the pull-down windows to make changes, if necessary.

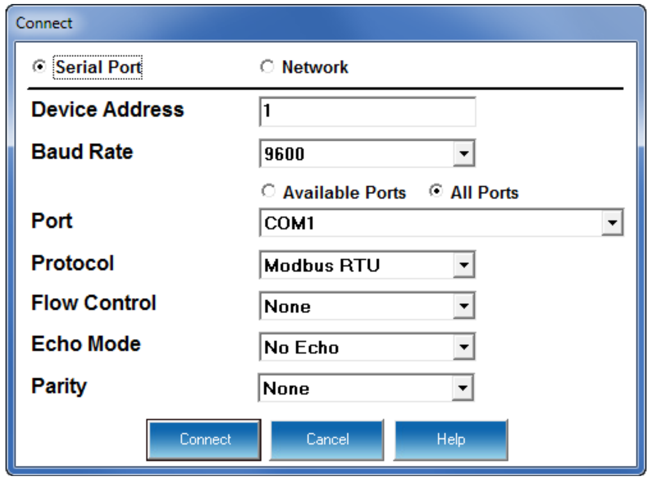


Figure 6-9: Serial Port settings

4. Click the **Connect** button on the screen.

NOTICE

If you do not connect with the Factory Initial Default Settings within 5 seconds after powering on the meter, the Device Profile reverts to the programmed Device Profile. In that case, disconnect and reconnect power before clicking the **Connect** button.

5. You will see the Device Status screen, confirming a connection. Click **OK**.

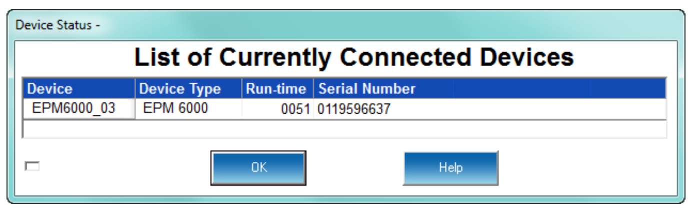
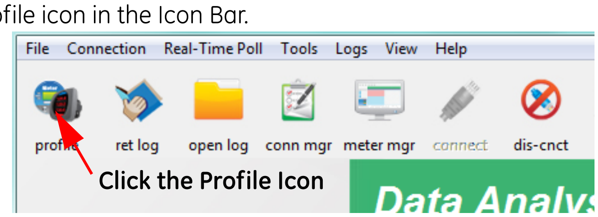
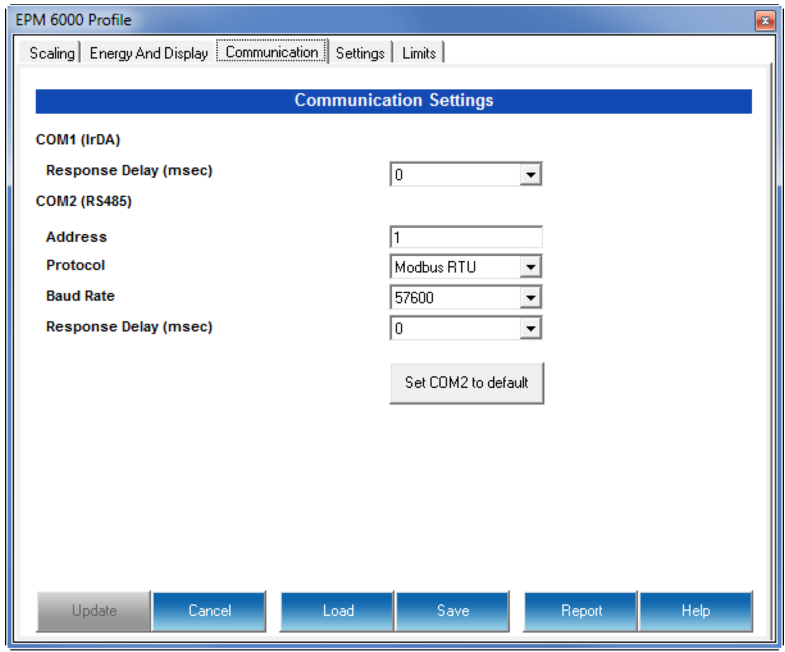


Figure 6-10: Device Status screen

6. Click the Profile icon in the Icon Bar.



7. You will see the Device Profile screen. The tabs at the top of the screen allow you to navigate between setting screens (see below).



8. Click the **Communication** tab. The Communication Settings appear. Use pull-down menus to change settings, if desired.

Communication Settings

- **COM1 (IrDA)**
  - Response Delay (0-750 msec)
- **COM2 (RS485)**
  - Address (1-247)
  - Protocol (Modbus RTU, ASCII or DNP)
  - Baud Rate (9600 to 57600)
  - Response Delay (0-750 msec)

9. When changes are complete, click the Update button to send a new profile to the meter.

10. Click Cancel to **Exit** the Profile (or)

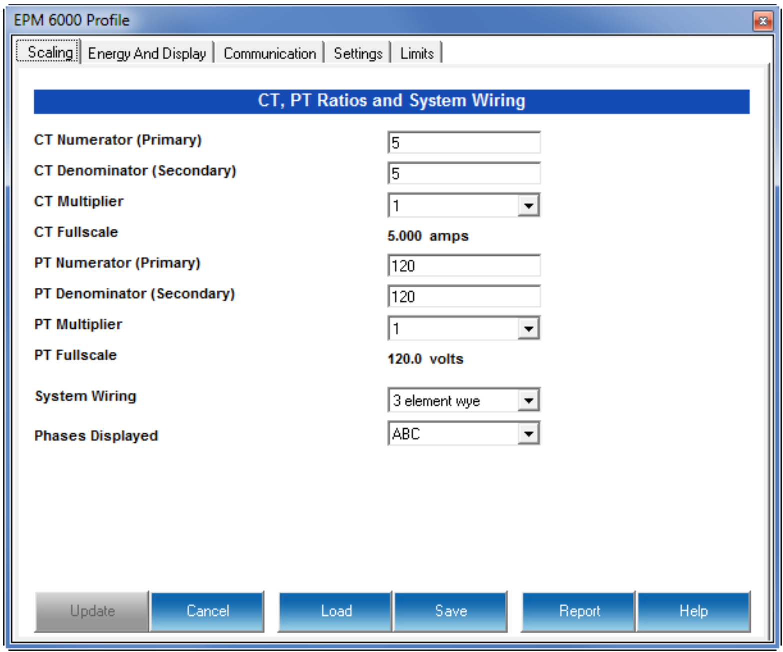
11. Click other tabs to update other aspects of the Profile (see 6.4.3 *Device Profile Settings* below).

6.4.3 Device Profile Settings


NOTE

Only the basic EPM 6000 meter Device Profile settings are explained in this manual. Refer to the *GE Communicator Instruction Manual* for detailed instructions on configuring all settings of the meter's Device Profile. You can view the manual online by clicking **Help > Contents** from the GE Communicator Main screen.

CT, PT Ratios and System Wiring



The screen fields and acceptable entries are as follows:

CT Ratios

CT Numerator (Primary): 1 - 9999

CT Denominator (Secondary): 5 or 1 Amp

NOTE

This field is display only.

CT Multiplier: 1, 10 or 100

Current Full Scale: Calculations based on selections.

PT Ratios

PT Numerator (Primary): 1 - 9999

PT Denominator (Secondary): 40 - 600

PT Multiplier: 1, 10, 100, or 1000

Voltage Full Scale: Calculations based on selections.

System Wiring

3 Element Wye; 2.5 Element Wye; 2 CT Delta

Phases Displayed

A, AB, or ABC

NOTE

Voltage Full Scale = PT Numerator x PT Multiplier

Example:

A 14400/120 PT would be entered as:

PT Num: 1440

PT Denom: 120

Multiplier: 10

This example would display a 14.40kV.

Example CT Settings:

200/5 Amps: Set the Ct-n value for 200, Ct-Multiplier value for 1.

800/5 Amps: Set the Ct-n value for 800, Ct-Multiplier value for 1.

2,000/5 Amps: Set the Ct-n value for 2000, Ct-Multiplier value for 1.

10,000/5 Amps: Set the Ct-n value for 1000, Ct-Multiplier value for 10.

Example PT Settings:

277/277 Volts Pt-n value is 277, Pt-d value is 277, Pt-Multiplier is 1.

14,400/120 Volts: Pt-n value is 1440, Pt-d value is 120, Pt-Multiplier value is 10.

138,000/69 Volts: Pt-n value is 1380, Pt-d value is 69, Pt-Multipier value is 100.

345,000/115 Volts: Pt-n value is 3470, Pt-d value is 115, Pt-Multiplier value is 100

345,000/69 Volts: Pt-n value is 345, Pt-d value is 69, Pt-Multiplier value is 1000.

NOTE

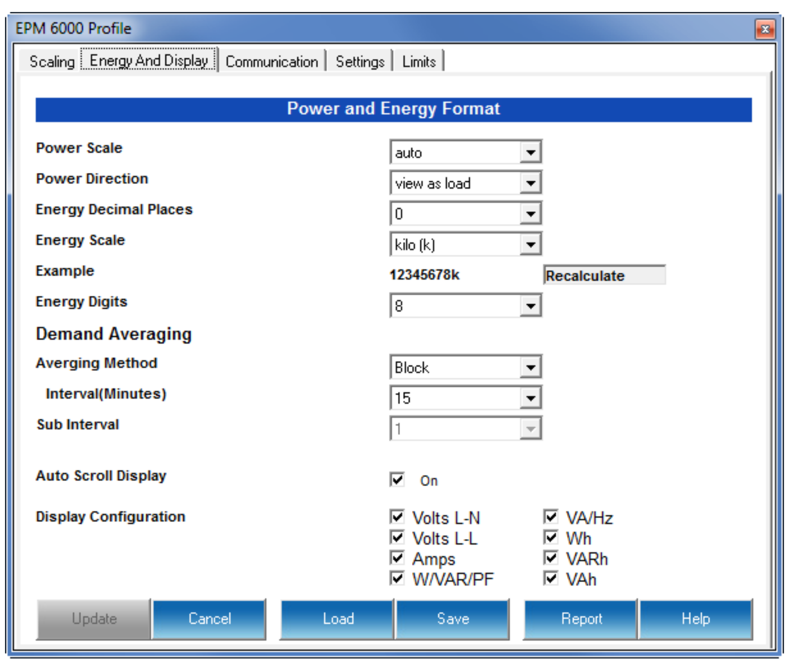
Settings are the same for Wye and Delta configurations.

ENERGY AND DISPLAY

The settings on this screen determine the display configuration of the meter's faceplate.

NOTE

For an EPM 6000T transducer, the Display Configuration setting does not apply as there is no display.



The screen fields and acceptable entries are as follows:

Power and Energy Format

Power Scale: Unit, kilo (k), Mega (M), or auto.

Energy Digits: 5, 6, 7, or 8

Energy Decimal Places: 0-6

Energy Scale: Unit, kilo (k), or Mega (M)

For Example: a reading for Digits: 8; Decimals: 3; Scale: k would be formatted: 00123.456k

Power Direction: View as Load or View as Generator

Demand Averaging

Averaging Method: Block or Rolling

Interval (Minutes): 5, 15, 30, or 60

Sub Interval (if Rolling is selected): 1-4

Auto Scroll

Click to set On or Off.

Display Configuration:

Click Values to be displayed.

NOTE

You MUST select at least ONE.

NOTE

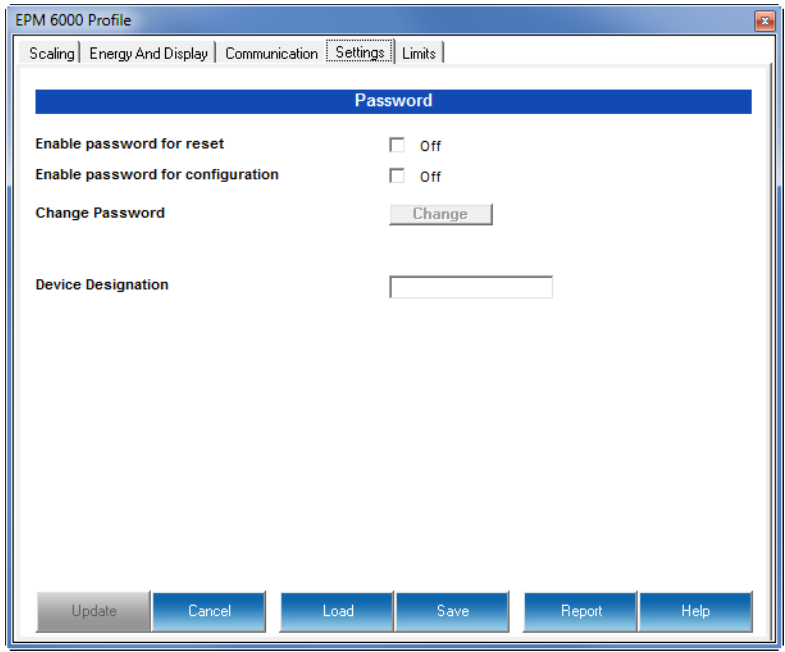
If incorrect values are entered on this screen the following message appears: **WARNING: Current, CT, PT and Energy Settings will cause invalid energy accumulator values**.

Change the settings until the message disappears.

NOTE

If you are changing the energy digits, decimal places, or energy scale, we recommend you first reset the Energy Accumulators, in order to prevent erroneous counts. See the *GE Communicator Instruction Manual* for instructions on resetting the EPM 6000 meter Energy Accumulators.

SETTINGS



The screen fields are as follows:

Password

NOTE

The meter is shipped with Password Disabled. There is NO DEFAULT PASSWORD.

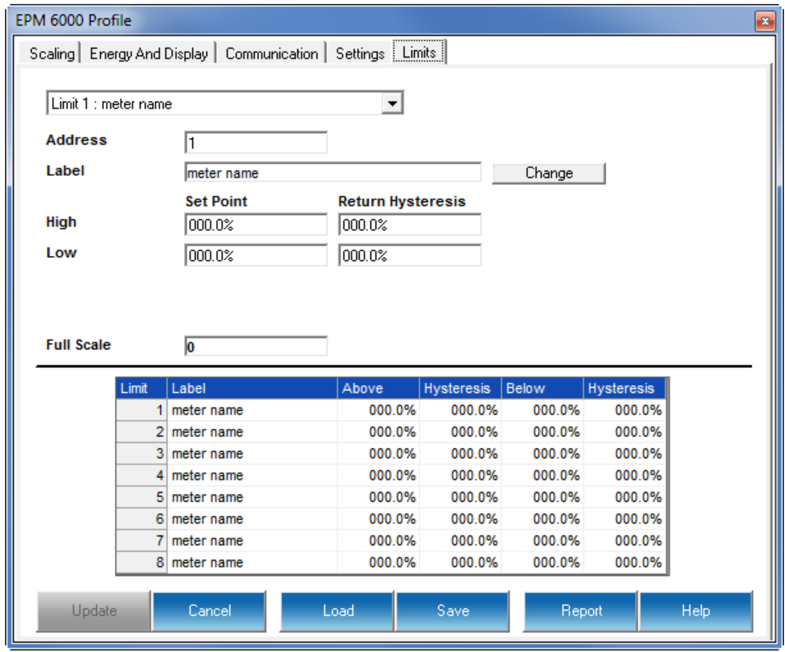
Enable Password for Reset: click to Enable.

Enable Password for Configuration: click to Enable.

Change Password: click to Change.

Device Designation: optional user-assigned label.

LIMITS (THD Option only)



Limits are transition points used to divide acceptable and unacceptable measurements. When a value goes above or below the limit, an out-of-limit condition occurs. Once they are configured, you can view the out-of-Limits (or Alarm) conditions in the Limits Log or Limits Polling screen. You can also use Limits to trigger relays. See the GE Communicator Instruction Manual for details.

For up to 8 Limits, set:

Address: Modbus Address (1 based)

Label: Your designation for the limit

High Set Point: % of Full Scale

Example: 100% of 120VFS = 120V; 90% of 120V FS = 108V

Return Hysteresis: Point to go back in Limit

Example: High Set Point = 110% (Out of Limit at 132V);Return Hysteresis =

105%(Stay Out until 126V)

Low Set Point: % of Full Scale

Return Hysteresis: Point to go back in Limit.

Your settings appear in the Table at the bottom of the screen

NOTE

If Return Hysteresis is > High Set Point, the Limit is Disabled.

NOTICE

When you have finished making changes to the Device Profile, click **Update Device** to send the new Profile settings to the meter.

NOTE

Refer to the GE Communicator Instruction Manual for additional instructions on configuring the EPM 6000 transducer/meter settings.

EPM 6000 Power Meter

Appendix A: EPM 6000 Navigation Maps

A.1 Introduction

The EPM 6000 meter can be configured and a variety of functions performed using the BUTTONS on the meter face.

- An Overview of programming using the Elements and Buttons on the meter face can be found in 6.1 *Programming Using the Faceplate* on page 6–1.
- An overview of programming using software can be found in 6.4 *GE Communicator Programming Overview* on page 6–16 (see also the *GE Communicator Instruction Manual*).

A.2 Navigation Maps (Sheets 1 to 4)

The EPM 6000 Navigation Maps begin on the next page.

They show in detail how to move from one screen to another and from one Display Mode to another using the buttons on the face of the meter. All Display Modes will automatically return to Operating Mode after 10 minutes with no user activity.

A.2.1 EPM 6000 Navigation Map Titles:

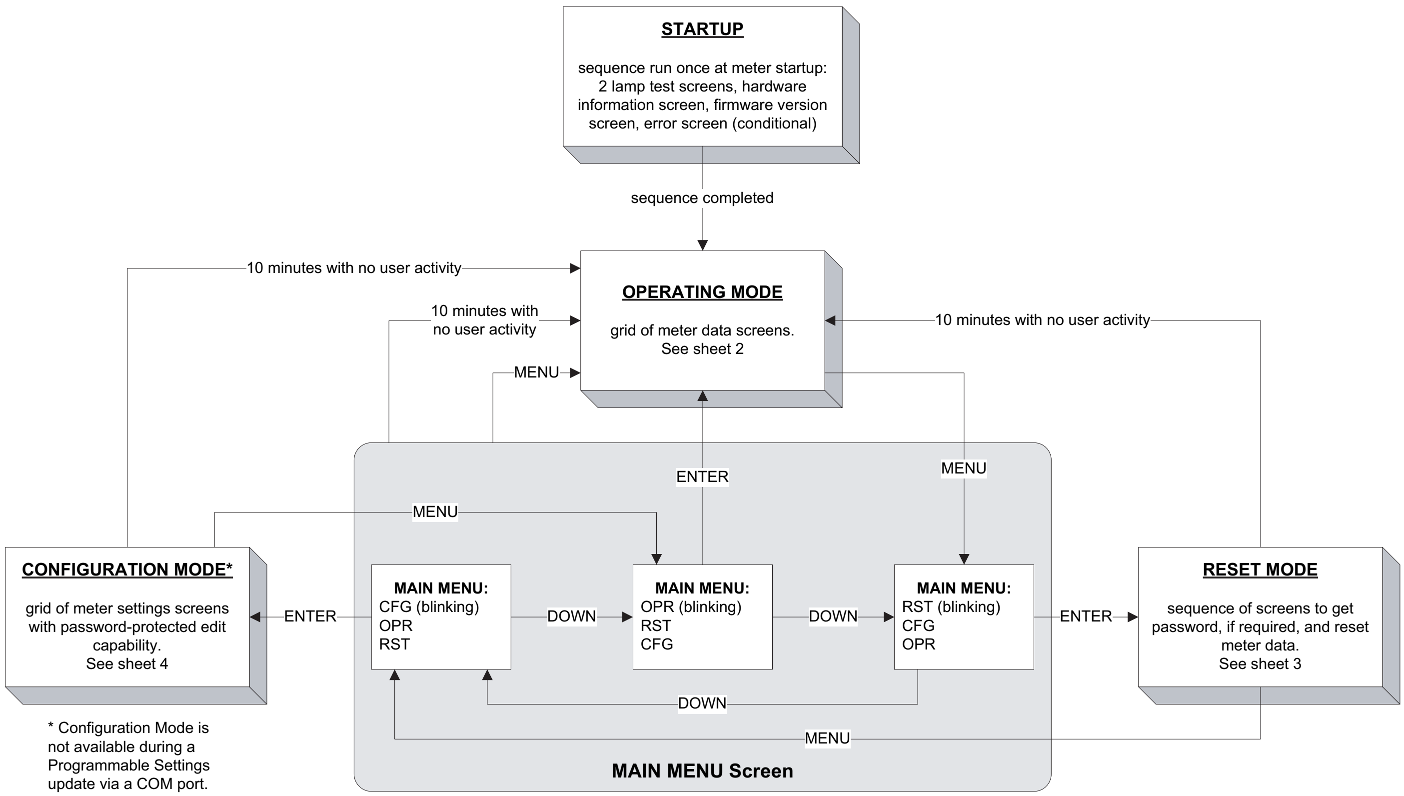
Main Menu Screens (Sheet 1)

Operating Mode Screens (Sheet 2)

Reset Mode Screens (Sheet 3)

Configuration Mode Screens (Sheet 4)

Figure A-1: Main Menu Screens (Sheet 1)



MAIN MENU screen scrolls through 3 choices, showing all 3 at once. The top choice is always the "active" one, which is indicated by blinking the legend.

BUTTONS

MENU	Returns to previous menu from any screen in any mode
ENTER	Indicates acceptance of the current screen and advances to the next one
DOWN, RIGHT	Navigation and edit buttons
Navigation:	No digits or legends are blinking. On a menu, down advances to the next menu selection, right does nothing. In a grid of screens, down advances to the next row, right advances to the next column. Rows, columns, and menus all navigate circularly.
Editing:	A digit or legend is blinking to indicate that it is eligible for change. When a digit is blinking, down increases the digit value, right moves to the next digit. When a legend is blinking, either button advances to the next choice legend.

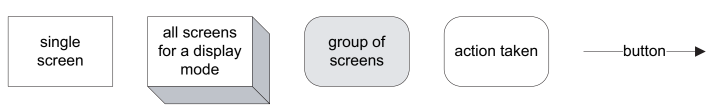


Figure A-2: Operating Mode Screens (Sheet 2)

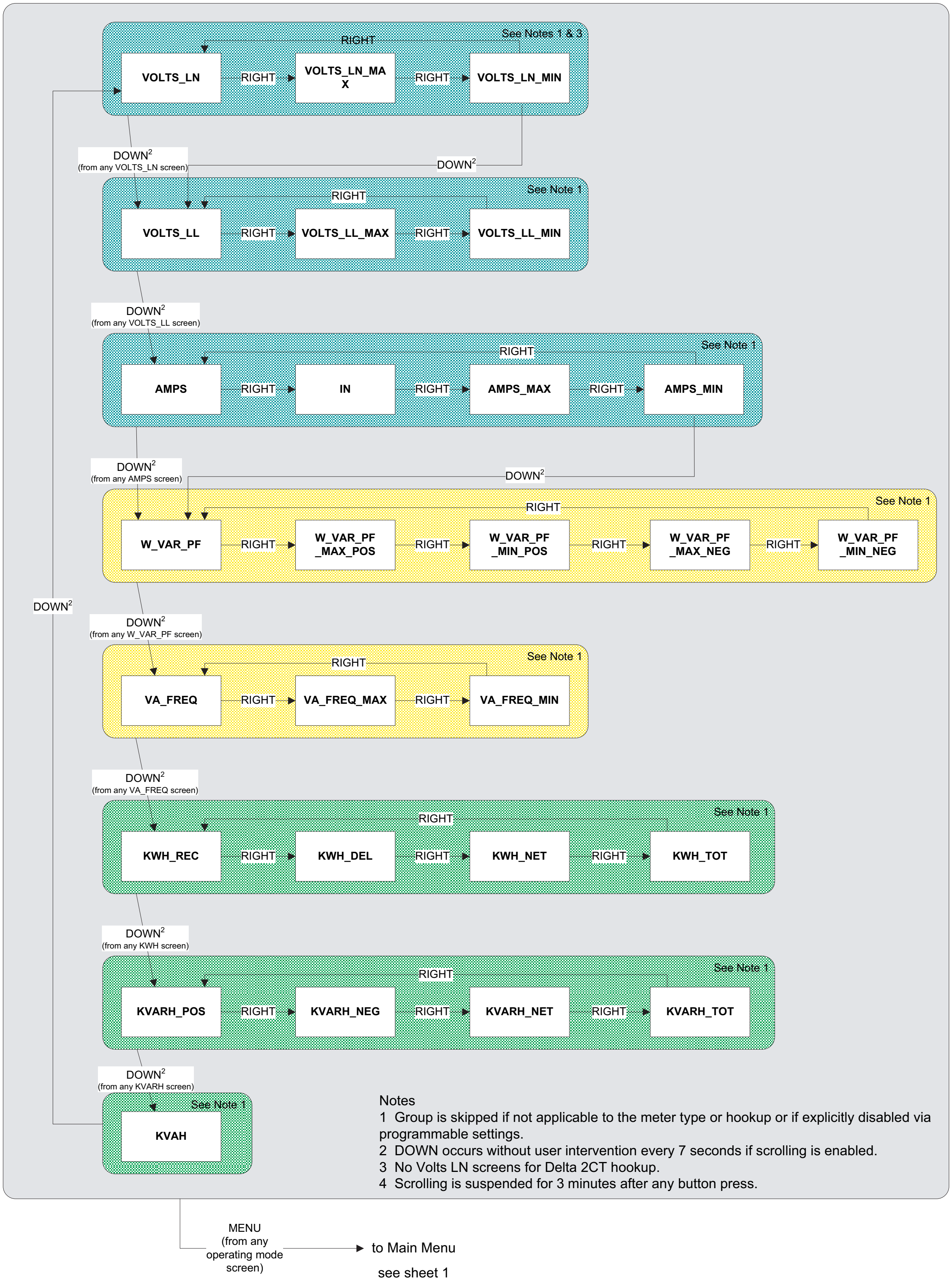


Figure A-3: Reset Mode Screens (Sheet 3)

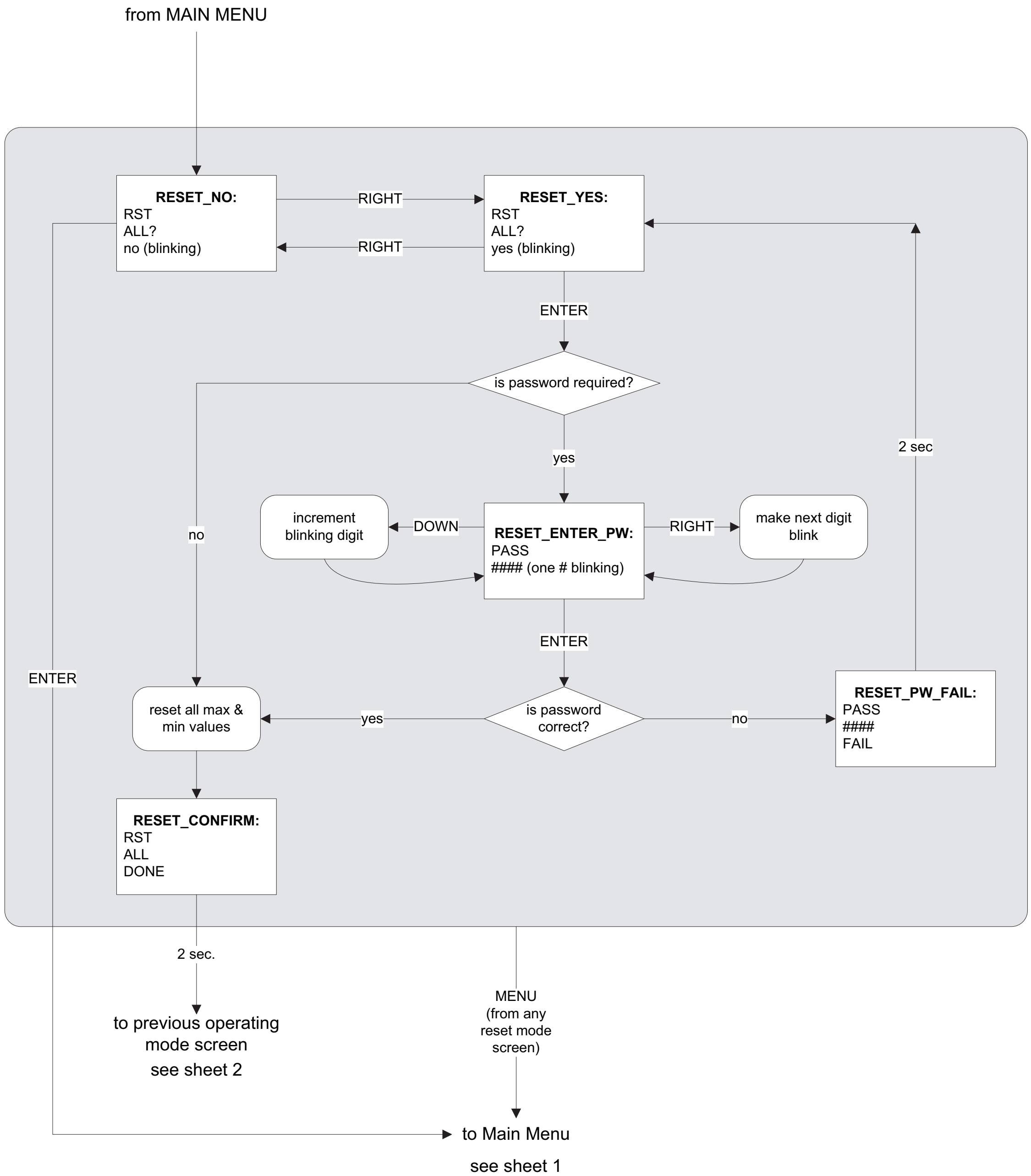
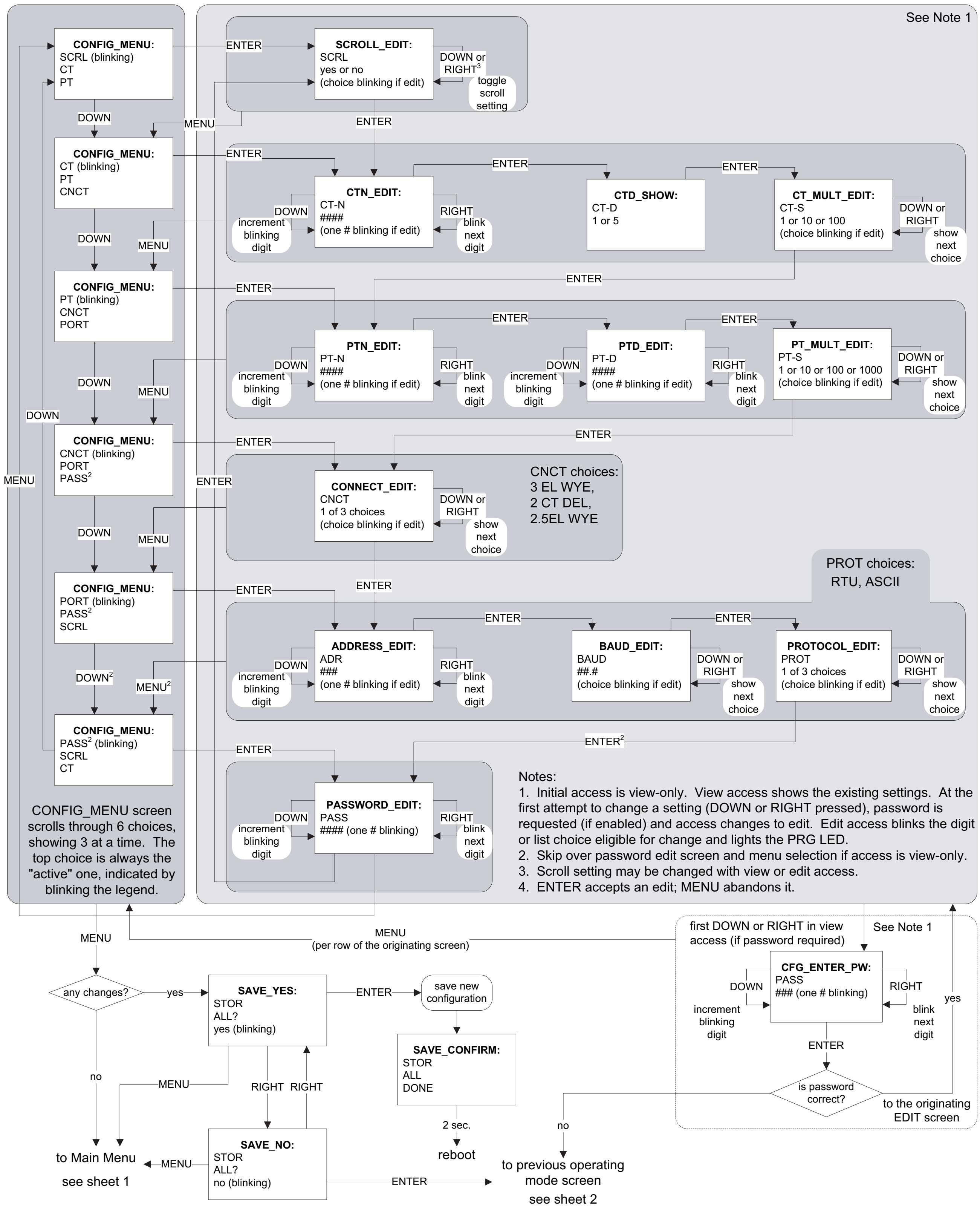


Figure A-4: Configuration Mode Screens (Sheet 4)



EPM 6000 Power Meter

Appendix B: Modbus Mapping for EPM 6000

B.1 Introduction

The Modbus Map for the EPM 6000 Meter gives details and information about the possible readings of the meter and about the programming of the meter. The EPM 6000 can be programmed using the buttons on the face plate of the meter (6.1 *Programming Using the Faceplate* on page 6–1). The meter can also be programmed using software (6.4 *GE Communicator Programming Overview* on page 6–16). For further details see the *GE Communicator Instruction Manual*.

B.2 Modbus Register Map Sections

The EPM 6000 Modbus Register Map includes the following sections:

Fixed Data Section, Registers 1- 47, details the Meter's Fixed Information described in Section 7.2.

Meter Data Section, Registers 1000 - 5003, details the Meter's Readings, including Primary Readings, Energy Block, Demand Block, Maximum and Minimum Blocks, THD Block, Phase Angle Block and Status Block. Operating Mode readings are described in Section 7.3.4.

Commands Section, Registers 20000 - 26011, details the Meter's Resets Block, Programming Block, Other Commands Block and Encryption Block.

Programmable Settings Section, Registers 30000 - 30067, details the Meter's Basic Setups.

Secondary Readings Section, Registers 40001 - 40100, details the Meter's Secondary Readings Setups.

B.3 Data Formats

ASCII: ASCII characters packed 2 per register in high, low order and without any termination charcters.

> **Example**: "EPM6000" would be 4 registers containing 0x5378, 0x6172, 0x6B31, 0x3030.

SINT16/UINT16:16-bit signed/unsigned integer.

SINT32/UINT32:32-bit signed/unsigned integer spanning 2 registers. The lower-addressed register is the high order half.

FLOAT:32-bit IEEE floating point number spanning 2 registers. The lower-addressed register is the high order half (i.e., contains the exponent).

B.4 Floating Point Values

Floating Point Values are represented in the following format:

Register	0																1															
Byte	0								1								0								1							
Bit	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0
Meaning	s	e	e	e	e	e	e	e	e	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m
	sign	exponent								mantissa																						

The formula to interpret a Floating Point Value is: $-1^{sign} \times 2^{exponent-127} \times 1.mantissa$ = 0x0C4E11DB9

$-1^{sign} \times 2^{137-127} \times 1.11000010001110111001$

$-1 \times 2^{10} \times 1.75871956$

-1800.929

Register	0x0C4E1																0x01DB9															
Byte	0x0C4								0x0E1								0x01D								0x0B9							
Bit	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0
	1	1	0	0	0	1	0	0	1	1	1	0	0	0	0	1	0	0	0	1	1	1	0	1	1	0	1	1	1	0	0	1
Meaning	s	e	e	e	e	e	e	e	e	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m
	sign	exponent								mantissa																						
	1	0x089 = 137								0b11000010001110110111001																						

Formula Explanation

C4E11DB9 (hex) 11000100 11100001 00011101 10111001 (binary)

The sign of the Mantissa (and therefore the number) is 1, which represents a negative value.

The Exponent is 10001001 (binary) or 137 decimal.

The Exponent is a value in excess of 127, so the Exponent value is 10.

The Mantissa is 11000010001110110111001 binary.

With the implied leading 1, the Mantissa is (1).C23B72 (hex).

The Floating Point Representation is therefore -1.75871956 x 2^{10}

Decimal equivalent: -1800.929

NOTE

Exponent = the whole number before the decimal point

Mantissa = the positive fraction after the decimal point

B.5 Modbus Register Map

Table B–1: Modbus Register Map (Sheet 1 of 8)

Hex	Decimal	Description[1]	Format	Range[6]	Units or Resolution	Comments	# Reg
Fixed Data Section							
Identification Block						read-only	
0000 - 0007	1 - 8	Meter Name	ASCII	16 char	none		8
0008 - 000F	9 - 16	Meter Serial Number	ASCII	16 char	none		8
0010 - 0010	17 - 17	Meter Type	UINT16	bit-mapped	-------t -----vvv	t = transducer model (1=yes, 0=no), vvv = THD and Pulse Output (Software) Option 0 or THD	1
0011 - 0012	18 - 19	Firmware Version	ASCII	4 char	none		2
0013 - 0013	20 - 20	Map Version	UINT16	0 to 65535	none		1
0014 - 0014	21 - 21	Meter Configuration	UINT16	bit-mapped	-------- --ffffff	ffffff = calibration frequency (50 or 60)	1
0015 - 0015	22 - 22	ASIC Version	UINT16	0-65535	none		1
0016 - 0026	23 - 39	Reserved					17
0027 - 002E	40 - 47	GE Part Number	ASCII	16 char	none		8
						Block Size:	47
Meter Data Section[2]							
Primary Readings Block, 6 cycles (IEEE Floating Point)						read-only	
0383 - 0384	900 - 901	Watts, 3-Ph total	FLOAT	-9999 M to +9999 M	watts		2
0385 - 0386	902 - 903	VARs, 3-Ph total	FLOAT	-9999 M to +9999 M	VARs		2
0387 - 0388	904 - 905	VAs, 3-Ph total	FLOAT	-9999 M to +9999 M	VAs		2
						Block Size:	6
Primary Readings Block, 60 cycles (IEEE Floating Point)						read-only	
03E7 - 03E8	1000 - 1001	Volts A-N	FLOAT	0 to 9999 M	volts		2
03E9 - 03EA	1002 - 1003	Volts B-N	FLOAT	0 to 9999 M	volts		2
03EB - 03EC	1004 - 1005	Volts C-N	FLOAT	0 to 9999 M	volts		2
03ED - 03EE	1006 - 1007	Volts A-B	FLOAT	0 to 9999 M	volts		2
03EF - 03F0	1008 - 1009	Volts B-C	FLOAT	0 to 9999 M	volts		2
03F1 - 03F2	1010 - 1011	Volts C-A	FLOAT	0 to 9999 M	volts		2
03F3 - 03F4	1012 - 1013	Amps A	FLOAT	0 to 9999 M	amps		2

Table B–1: Modbus Register Map (Sheet 2 of 8)

Hex	Decimal	Description[1]	Format	Range[6]	Units or Resolution	Comments	# Reg
03F5 - 03F6	1014 - 1015	Amps B	FLOAT	0 to 9999 M	amps		2
03F7 - 03F8	1016 - 1017	Amps C	FLOAT	0 to 9999 M	amps		2
03F9 - 03FA	1018 - 1019	Watts, 3-Ph total	FLOAT	-9999 M to +9999 M	watts		2
03FB - 03FC	1020 - 1021	VARs, 3-Ph total	FLOAT	-9999 M to +9999 M	VARs		2
03FD - 03FE	1022 - 1023	VAs, 3-Ph total	FLOAT	-9999 M to +9999 M	VAs		2
03FF - 0400	1024 - 1025	Power Factor, 3-Ph total	FLOAT	-1.00 to +1.00	none		2
0401 - 0402	1026 - 1027	Frequency	FLOAT	0 to 65.00	Hz		2
0403 - 0404	1028 - 1029	Neutral Current	FLOAT	0 to 9999 M	amps		2
						Block Size:	30
Primary Energy Block						**read-only**	
044B - 044C	1100 - 1101	W-hours, Received	SINT32	0 to 99999999 or 0 to -99999999	Wh per energy format	* Wh received & delivered always have opposite signs	2
044D - 044E	1102 - 1103	W-hours, Delivered	SINT32	0 to 99999999 or 0 to -99999999	Wh per energy format	* Wh received is positive for "view as load", delivered is positive for "view as generator"	2
044F - 0450	1104 - 1105	W-hours, Net	SINT32	-99999999 to 99999999	Wh per energy format		2
0451 - 0452	1106 - 1107	W-hours, Total	SINT32	0 to 99999999	Wh per energy format	* 5 to 8 digits	2
0453 - 0454	1108 - 1109	VAR-hours, Positive	SINT32	0 to 99999999	VARh per energy format	* decimal point implied, per energy format	2
0455 - 0456	1110 - 1111	VAR-hours, Negative	SINT32	0 to -99999999	VARh per energy format	* resolution of digit before decimal point = units, kilo, or mega, per energy format	2
0457 - 0458	1112 - 1113	VAR-hours, Net	SINT32	-99999999 to 99999999	VARh per energy format		2
0459 - 045A	1114 - 1115	VAR-hours, Total	SINT32	0 to 99999999	VARh per energy format		2
045B - 045C	1116 - 1117	VA-hours, Total	SINT32	0 to 99999999	VAh per energy format	* see note 10	2
						Block Size:	18
Primary Demand Block (IEEE Floating Point)						**read-only**	
07CF - 07D0	2000 - 2001	Amps A, Average	FLOAT	0 to 9999 M	amps		2
07D1 - 07D2	2002 - 2003	Amps B, Average	FLOAT	0 to 9999 M	amps		2
07D3 - 07D4	2004 - 2005	Amps C, Average	FLOAT	0 to 9999 M	amps		2
07D5 - 07D6	2006 - 2007	Positive Watts, 3-Ph, Average	FLOAT	-9999 M to +9999 M	watts		2
07D7 - 07D8	2008 - 2009	Positive VARs, 3-Ph, Average	FLOAT	-9999 M to +9999 M	VARs		2
07D9 - 07DA	2010 - 2011	Negative Watts, 3-Ph, Average	FLOAT	-9999 M to +9999 M	watts		2
07DB - 07DC	2012 - 2013	Negative VARs, 3-Ph, Average	FLOAT	-9999 M to +9999 M	VARs		2
07DD - 07DE	2014 - 2015	VAs, 3-Ph, Average	FLOAT	-9999 M to +9999 M	VAs		2
07DF - 07E0	2016 - 2017	Positive PF, 3-Ph, Average	FLOAT	-1.00 to +1.00	none		2
07E1 - 07E2	2018 - 2019	Negative PF, 3-PF, Average	FLOAT	-1.00 to +1.00	none		2
						Block Size:	20
Primary Minimum Block (IEEE Floating Point)						**read-only**	
0BB7 - 0BB8	3000 - 3001	Volts A-N, Minimum	FLOAT	0 to 9999 M	volts		2
0BB9 - 0BBA	3002 - 3003	Volts B-N, Minimum	FLOAT	0 to 9999 M	volts		2
0BBB - 0BBC	3004 - 3005	Volts C-N, Minimum	FLOAT	0 to 9999 M	volts		2
0BBD - 0BBE	3006 - 3007	Volts A-B, Minimum	FLOAT	0 to 9999 M	volts		2

Table B–1: Modbus Register Map (Sheet 3 of 8)

Hex	Decimal	Description[1]	Format	Range[6]	Units or Resolution	Comments	# Reg
0BBF - 0BC0	3008 - 3009	Volts B-C, Minimum	FLOAT	0 to 9999 M	volts		2
0BC1 - 0BC2	3010 - 3011	Volts C-A, Minimum	FLOAT	0 to 9999 M	volts		2
0BC3 - 0BC4	3012 - 3013	Amps A, Minimum Avg Demand	FLOAT	0 to 9999 M	amps		2
0BC5 - 0BC6	3014 - 3015	Amps B, Minimum Avg Demand	FLOAT	0 to 9999 M	amps		2
0BC7 - 0BC8	3016 - 3017	Amps C, Minimum Avg Demand	FLOAT	0 to 9999 M	amps		2
0BC9 - 0BCA	3018 - 3019	Positive Watts, 3-Ph, Minimum Avg Demand	FLOAT	0 to +9999 M	watts		2
0BCB - 0BCC	3020 - 3021	Positive VARs, 3-Ph, Minimum Avg Demand	FLOAT	0 to +9999 M	VARs		2
0BCD - 0BCE	3022 - 3023	Negative Watts, 3-Ph, Minimum Avg Demand	FLOAT	0 to +9999 M	watts		2
0BCF - 0BD0	3024 - 3025	Negative VARs, 3-Ph, Minimum Avg Demand	FLOAT	0 to +9999 M	VARs		2
0BD1 - 0BD2	3026 - 3027	VAs, 3-Ph, Minimum Avg Demand	FLOAT	-9999 M to +9999 M	VAs		2
0BD3 - 0BD4	3028 - 3029	Positive Power Factor, 3-Ph, Minimum Avg Demand	FLOAT	-1.00 to +1.00	none		2
0BD5 - 0BD6	3030 - 3031	Negative Power Factor, 3-Ph, Minimum Avg Demand	FLOAT	-1.00 to +1.00	none		2
0BD7 - 0BD8	3032 - 3033	Frequency, Minimum	FLOAT	0 to 65.00	Hz		2
						Block Size:	34
Primary Maximum Block (IEEE Floating Point)						read-only	
0C1B - 0C1C	3100 - 3101	Volts A-N, Maximum	FLOAT	0 to 9999 M	volts		2
0C1D - 0C1E	3102 - 3103	Volts B-N, Maximum	FLOAT	0 to 9999 M	volts		2
0C1F - 0C20	3104 - 3105	Volts C-N, Maximum	FLOAT	0 to 9999 M	volts		2
0C21 - 0C22	3106 - 3107	Volts A-B, Maximum	FLOAT	0 to 9999 M	volts		2
0C23 - 0C24	3108 - 3109	Volts B-C, Maximum	FLOAT	0 to 9999 M	volts		2
0C25 - 0C26	3110 - 3111	Volts C-A, Maximum	FLOAT	0 to 9999 M	volts		2
0C27 - 0C28	3112 - 3113	Amps A, Maximum Avg Demand	FLOAT	0 to 9999 M	amps		2
0C29 - 0C2A	3114 - 3115	Amps B, Maximum Avg Demand	FLOAT	0 to 9999 M	amps		2
0C2B - 0C2C	3116 - 3117	Amps C, Maximum Avg Demand	FLOAT	0 to 9999 M	amps		2
0C2D - 0C2E	3118 - 3119	Positive Watts, 3-Ph, Maximum Avg Demand	FLOAT	0 to +9999 M	watts		2
0C2F - 0C30	3120 - 3121	Positive VARs, 3-Ph, Maximum Avg Demand	FLOAT	0 to +9999 M	VARs		2
0C31 - 0C32	3122 - 3123	Negative Watts, 3-Ph, Maximum Avg Demand	FLOAT	0 to +9999 M	watts		2
0C33 - 0C34	3124 - 3125	Negative VARs, 3-Ph, Maximum Avg Demand	FLOAT	0 to +9999 M	VARs		2
0C35 - 0C36	3126 - 3127	VAs, 3-Ph, Maximum Avg Demand	FLOAT	-9999 M to +9999 M	VAs		2
0C37 - 0C38	3128 - 3129	Positive Power Factor, 3-Ph, Maximum Avg Demand	FLOAT	-1.00 to +1.00	none		2
0C39 - 0C3A	3130 - 3131	Negative Power Factor, 3-Ph, Maximum Avg Demand	FLOAT	-1.00 to +1.00	none		2
0C3B - 0C3C	3132 - 3133	Frequency, Maximum	FLOAT	0 to 65.00	Hz		2
						Block Size:	34

Table B–1: Modbus Register Map (Sheet 4 of 8)

Hex	Decimal	Description[1]	Format	Range[6]	Units or Resolution	Comments	# Reg
THD Block[7, 13]						read-only	
0F9F - 0F9F	4000 - 4000	Volts A-N, %THD	UINT16	0 to 9999, or 65535	0.1%		1
0FA0 - 0FA0	4001 - 4001	Volts B-N, %THD	UINT16	0 to 9999, or 65535	0.1%		1
0FA1 - 0FA1	4002 - 4002	Volts C-N, %THD	UINT16	0 to 9999, or 65535	0.1%		1
0FA2 - 0FA2	4003 - 4003	Amps A, %THD	UINT16	0 to 9999, or 65535	0.1%		1
0FA3 - 0FA3	4004 - 4004	Amps B, %THD	UINT16	0 to 9999, or 65535	0.1%		1
0FA4 - 0FA4	4005 - 4005	Amps C, %THD	UINT16	0 to 9999, or 65535	0.1%		1
0FA5 - 0FA5	4006 - 4006	Phase A Current 0th harmonic magnitude	UINT16	0 to 65535	none		1
0FA6 - 0FA6	4007 - 4007	Phase A Current 1st harmonic magnitude	UINT16	0 to 65535	none		1
0FA7 - 0FA7	4008 - 4008	Phase A Current 2nd harmonic magnitude	UINT16	0 to 65535	none		1
0FA8 - 0FA8	4009 - 4009	Phase A Current 3rd harmonic magnitude	UINT16	0 to 65535	none		1
0FA9 - 0FA9	4010 - 4010	Phase A Current 4th harmonic magnitude	UINT16	0 to 65535	none		1
0FAA - 0FAA	4011 - 4011	Phase A Current 5th harmonic magnitude	UINT16	0 to 65535	none		1
0FAB - 0FAB	4012 - 4012	Phase A Current 6th harmonic magnitude	UINT16	0 to 65535	none		1
0FAC - 0FAC	4013 - 4013	Phase A Current 7th harmonic magnitude	UINT16	0 to 65535	none		1
0FAD - 0FAD	4014 - 4014	Phase A Voltage 0th harmonic magnitude	UINT16	0 to 65535	none		1
0FAE - 0FAE	4015 - 4015	Phase A Voltage 1st harmonic magnitude	UINT16	0 to 65535	none		1
0FAF - 0FAF	4016 - 4016	Phase A Voltage 2nd harmonic magnitude	UINT16	0 to 65535	none		1
0FB0 - 0FB0	4017 - 4017	Phase A Voltage 3rd harmonic magnitude	UINT16	0 to 65535	none		1
0FB1 - 0FB8	4018 - 4025	Phase B Current	same as Phase A Current 0th to 7th harmonic magnitudes				8
0FB9 - 0FBC	4026 - 4029	Phase B Voltage	same as Phase A Voltage 0th to 3rd harmonic magnitudes				4
0FBD - 0FC4	4030 - 4037	Phase C Current	same as Phase A Current 0th to 7th harmonic magnitudes				8
0FC5 - 0FC8	4038 - 4041	Phase C Voltage	same as Phase A Voltage 0th to 3rd harmonic magnitudes				4
						Block Size:	42
Phase Angle Block[14]						read-only	
1003 - 1003	4100 - 4100	Phase A Current	SINT16	-1800 to +1800	0.1 degree		1
1004 - 1004	4101 - 4101	Phase B Current	SINT16	-1800 to +1800	0.1 degree		1
1005 - 1005	4102 - 4102	Phase C Current	SINT16	-1800 to +1800	0.1 degree		1
1006 - 1006	4103 - 4103	Angle, Volts A-B	SINT16	-1800 to +1800	0.1 degree		1
1007 - 1007	4104 - 4104	Angle, Volts B-C	SINT16	-1800 to +1800	0.1 degree		1
1008 - 1008	4105 - 4105	Angle, Volts C-A	SINT16	-1800 to +1800	0.1 degree		1
						Block Size:	6
Status Block						read-only	
1387 - 1387	5000 - 5000	Meter Status	UINT16	bit-mapped	--exnpch ssssssss	exnpch = EEPROM block OK flags (e=energy, x=max, n=min, p=programmable settings, c=calibration, h=header), ssssssss = state (1=Run, 2=Limp, 10=Prog Set Update via buttons, 11=Prog Set Update via IrDA, 12=Prog Set Update via COM2)	1

Table B–1: Modbus Register Map (Sheet 5 of 8)

Hex	Decimal	Description[1]	Format	Range[6]	Units or Resolution	Comments	# Reg
1388 - 1388	5001 - 5001	Limits Status[7]	UINT16	bit-mapped	87654321 87654321	high byte is setpt 1, 0=in, 1=out low byte is setpt 2, 0=in, 1=out	1
1389 - 138A	5002 - 5003	Time Since Reset	UINT32	0 to 4294967294	4 msec	wraps around after max count	2
						Block Size:	4
Commands Section[4]							
Resets Block[9]						**write-only**	
4E1F - 4E1F	20000 - 20000	Reset Max/Min Blocks	UINT16	password[5]			1
4E20 - 4E20	20001 - 20001	Reset Energy Accumulators	UINT16	password[5]			1
						Block Size:	2
Meter Programming Block						**read/conditional write**	
55EF - 55EF	22000 - 22000	Initiate Programmable Settings Update	UINT16	password[5]		meter enters PS update mode	1
55F0 - 55F0	22001 - 22001	Terminate Programmable Settings Update[3]	UINT16	any value		meter leaves PS update mode via reset	1
55F1 - 55F1	22002 - 22002	Calculate Programmable Settings Checksum[3]	UINT16			meter calculates checksum on RAM copy of PS block	1
55F2 - 55F2	22003 - 22003	Programmable Settings Checksum[3]	UINT16			read/write checksum register; PS block saved in EEPROM on write[8]	1
55F3 - 55F3	22004 - 22004	Write New Password[3]	UINT16	0000 to 9999		write-only register; always reads zero	1
59D7 - 59D7	23000 - 23000	Initiate Meter Firmware Reprogramming	UINT16	password[5]			1
						Block Size:	6
Other Commands Block						**read/write**	
61A7 - 61A7	25000 - 25000	Force Meter Restart	UINT16	password[5]		causes a watchdog reset, always reads 0	1
						Block Size:	1
Encryption Block						**read/write**	
658F - 659A	26000 - 26011	Perform a Secure Operation	UINT16			encrypted command to read password or change meter type	12
						Block Size:	12
Programmable Settings Section (See note 15)							
Basic Setups Block						**write only in PS update mode**	
752F - 752F	30000 - 30000	CT multiplier & denominator	UINT16	bit-mapped	dddddddd mmmmmmmm	high byte is denominator (1 or 5, read-only), low byte is multiplier (1, 10, or 100)	1
7530 - 7530	30001 - 30001	CT numerator	UINT16	1 to 9999	none		1
7531 - 7531	30002 - 30002	PT numerator	UINT16	1 to 9999	none		1
7532 - 7532	30003 - 30003	PT denominator	UINT16	1 to 9999	none		1

Table B–1: Modbus Register Map (Sheet 6 of 8)

Hex	Decimal	Description[1]	Format	Range[6]	Units or Resolution	Comments	# Reg
7533 - 7533	30004 - 30004	PT multiplier & hookup	UINT16	bit-mapped	mmmmmmmm MMMMhhhh	MMMMmmmmmmmm is PT multiplier (1, 10, 100, 1000), hhhh is hookup enumeration (0 = 3 element wye[9S], 1 = delta 2 CTs[5S], 3 = 2.5 element wye[6S])	1
7534 - 7534	30005 - 30005	Averaging Method	UINT16	bit-mapped	--iiiiii b----sss	iiiiii = interval (5,15,30,60) b = 0-block or 1-rolling sss = # subintervals (1,2,3,4)	1
7535 - 7535	30006 - 30006	Power & Energy Format	UINT16	bit-mapped	pppp--nn -eee-ddd	pppp = power scale (0-unit, 3-kilo, 6-mega, 8-auto) nn = number of energy digits (5-8 --> 0-3) eee = energy scale (0-unit, 3-kilo, 6-mega) ddd = energy digits after decimal point (0-6) See note 10.	1
7536 - 7536	30007 - 30007	Operating Mode Screen Enables	UINT16	bit-mapped	00000000 eeeeeeee	eeeeeeee = op mode screen rows on(1) or off(0), rows top to bottom are bits low order to high order	1
7537 - 753D	30008 - 30014	Reserved					7
753E - 753E	30015 - 30015	User Settings Flags	UINT16	bit-mapped	---g--nn srp--wf-	g = enable alternate full scale bargraph current (1=on, 0=off) nn = number of phases for voltage & current screens (3=ABC, 2=AB, 1=A, 0=ABC) s = scroll (1=on, 0=off) r = password for reset in use (1=on, 0=off) p = password for configuration in use (1=on, 0=off) w = pwr dir (0-view as load, 1-view as generator) f = flip power factor sign (1=yes, 0=no)	1
753F - 753F	30016 - 30016	Full Scale Current (for load % bargraph)	UINT16	0 to 9999	none	If non-zero and user settings bit g is set, this value replaces CT numerator in the full scale current calculation.	1
7540 - 7547	30017 - 30024	Meter Designation	ASCII	16 char	none		8
7548 - 7548	30025 - 30025	COM1 setup	UINT16	bit-mapped	----dddd -0100110	dddd = reply delay (* 50 msec) ppp = protocol (1-Modbus RTU, 2-Modbus ASCII, 3-DNP) bbb = baud rate (1-9600, 2-19200, 4-38400, 6-57600)	1
7549 - 7549	30026 - 30026	COM2 setup	UINT16	bit-mapped	----dddd -ppp-bbb		1
754A - 754A	30027 - 30027	COM2 address	UINT16	1 to 247	none		1
754B - 754B	30028 - 30028	Limit #1 Identifier	UINT16	0 to 65535		use Modbus address as the identifier (See notes 7, 11,	1
754C - 754C	30029 - 30029	Limit #1 Out High Setpoint	SINT16	-200.0 to +200.0	0.1% of full scale	Setpoint for the "above" limit (LM1), see notes 11-12.	1

Table B–1: Modbus Register Map (Sheet 7 of 8)

Hex	Decimal	Description[1]	Format	Range[6]	Units or Resolution	Comments	# Reg
754D - 754D	30030 - 30030	Limit #1 In High Threshold	SINT16	-200.0 to +200.0	0.1% of full scale	Threshold at which "above" limit clears; normally less than or equal to the "above" setpoint; see notes 11-12.	1
754E - 754E	30031 - 30031	Limit #1 Out Low Setpoint	SINT16	-200.0 to +200.0	0.1% of full scale	Setpoint for the "below" limit (LM2), see notes 11-12.	1
754F - 754F	30032 - 30032	Limit #1 In Low Threshold	SINT16	-200.0 to +200.0	0.1% of full scale	Threshold at which "below" limit clears; normally greater than or equal to the "below" setpoint; see notes 11-12.	1
7550 - 7554	30033 - 30037	Limit #2	SINT16	same as Limit #1	same as Limit #1	same as Limit #1	5
7555 - 7559	30038 - 30042	Limit #3	SINT16				5
755A - 755E	30043 - 30047	Limit #4	SINT16				5
755F - 7563	30048 - 30052	Limit #5	SINT16				5
7564 - 7568	30053 - 30057	Limit #6	SINT16				5
7569 - 756D	30058 - 30062	Limit #7	SINT16				5
756E - 7572	30063 - 30067	Limit #8	SINT16				5
						Block Size:	68
12-Bit Readings Section							
12-Bit Block						**read-only except as noted**	
9C40 - 9C40	40001 - 40001	System Sanity Indicator	UINT16	0 or 1	none	0 indicates proper meter operation	1
9C41 - 9C41	40002 - 40002	Volts A-N	UINT16	2047 to 4095	volts	2047= 0, 4095= +150	1
9C42 - 9C42	40003 - 40003	Volts B-N	UINT16	2047 to 4095	volts	volts = 150 * (register - 2047) / 2047	1
9C43 - 9C43	40004 - 40004	Volts C-N	UINT16	2047 to 4095	volts		1
9C44 - 9C44	40005 - 40005	Amps A	UINT16	0 to 4095	amps	0= -10, 2047= 0, 4095= +10	1
9C45 - 9C45	40006 - 40006	Amps B	UINT16	0 to 4095	amps	amps = 10 * (register - 2047) / 2047	1
9C46 - 9C46	40007 - 40007	Amps C	UINT16	0 to 4095	amps		1
9C47 - 9C47	40008 - 40008	Watts, 3-Ph total	UINT16	0 to 4095	watts	0= -3000, 2047= 0, 4095= +3000	1
9C48 - 9C48	40009 - 40009	VARs, 3-Ph total	UINT16	0 to 4095	VARs	watts, VARs, VAs =	1
9C49 - 9C49	40010 - 40010	VAs, 3-Ph total	UINT16	2047 to 4095	VAs	3000 * (register - 2047) /	1
9C4A - 9C4A	40011 - 40011	Power Factor, 3-Ph total	UINT16	1047 to 3047	none	1047= -1, 2047= 0, 3047= +1 pf = (register - 2047) / 1000	1
9C4B - 9C4B	40012 - 40012	Frequency	UINT16	0 to 2730	Hz	0= 45 or less, 2047= 60, 2730=65 or more freq = 45 + ((register / 4095) * 30)	1
9C4C - 9C4C	40013 - 40013	Volts A-B	UINT16	2047 to 4095	volts	2047= 0, 4095= +300	1
9C4D - 9C4D	40014 - 40014	Volts B-C	UINT16	2047 to 4095	volts	volts = 300 * (register - 2047) / 2047	1
9C4E - 9C4E	40015 - 40015	Volts C-A	UINT16	2047 to 4095	volts		1
9C4F - 9C4F	40016 - 40016	CT numerator	UINT16	1 to 9999	none	CT = numerator * multiplier / denominator	1
9C50 - 9C50	40017 - 40017	CT multiplier	UINT16	1, 10, 100	none		1
9C51 - 9C51	40018 - 40018	CT denominator	UINT16	1 or 5	none		1
9C52 - 9C52	40019 - 40019	PT numerator	UINT16	1 to 9999	none	PT = numerator * multiplier / denominator	1
9C53 - 9C53	40020 - 40020	PT multiplier	UINT16	1, 10, 100	none		1
9C54 - 9C54	40021 - 40021	PT denominator	UINT16	1 to 9999	none		1
9C55 - 9C56	40022 - 40023	W-hours, Positive	UINT32	0 to 99999999	Wh per energy format	* 5 to 8 digits	2
9C57 - 9C58	40024 - 40025	W-hours, Negative	UINT32	0 to 99999999	Wh per energy format	* decimal point implied, per energy format	2

Table B–1: Modbus Register Map (Sheet 8 of 8)

Hex	Decimal	Description[1]	Format	Range[6]	Units or Resolution	Comments	# Reg
9C59 - 9C5A	40026 - 40027	VAR-hours, Positive	UINT32	0 to 99999999	VARh per energy format	* resolution of digit before decimal point = units, kilo, or mega, per energy format	2
9C5B - 9C5C	40028 - 40029	VAR-hours, Negative	UINT32	0 to 99999999	VARh per energy format		2
9C5D - 9C5E	40030 - 40031	VA-hours	UINT32	0 to 99999999	VAh per energy format	* see note 10	2
9C5F - 9C5F	40032 - 40032	Neutral Current	UINT16	0 to 4095	amps	see Amps A/B/C above	1
9C60 - 9CA2	40033 - 40099	Reserved	N/A	N/A	none		67
9CA3 - 9CA3	40100 - 40100	Reset Energy Accumulators	UINT16	password[5]		write-only register; always reads as 0	1
						Block Size:	100

Data Formats

ASCII	ASCII characters packed 2 per register in high, low order and without any termination characters.
SINT16 / UINT16	16-bit signed / unsigned integer.
SINT32 / UINT32	32-bit signed / unsigned integer spanning 2 registers. The lower-addressed register is the high order half.
FLOAT	32-bit IEEE floating point number spanning 2 registers. The lower-addressed register is the high order half (i.e., contains

Notes

1. All registers not explicitly listed in the table read as 0. Writes to these registers will be accepted but won't actually change the register
2. Meter Data Section items read as 0 until first readings are available or if the meter is not in operating mode. Writes to these registers will be accepted but won't actually change the register.
3. Register valid only in programmable settings update mode. In other modes these registers read as 0 and return an illegal data address
4. Meter command registers always read as 0. They may be written only when the meter is in a suitable mode. The registers return an illegal data address exception if a write is attempted in an incorrect mode.
5. If the password is incorrect, a valid response is returned but the command is not executed. Use 5555 for the password if passwords are disabled in the programmable settings.
6. M denotes a 1,000,000 multiplier.
7. Not applicable to EPM 6000, THD and Pulse Output (Software) Option 0
8. Writing this register causes data to be saved permanently in EEPROM. If there is an error while saving, a slave device failure exception is returned and programmable settings mode automatically terminates via reset.
9. Reset commands make no sense if the meter state is LIMP. An illegal function exception will be returned.
10. Energy registers should be reset after a format change.
11. Entities to be monitored against limits are identified by Modbus address. Entities occupying multiple Modbus registers, such as floating point values, are identified by the lower register address. If any of the 8 limits is unused, set its identifier to zero. If the indicated Modbus register is not used or is a non-sensical entity for limits, it will behave as an unused limit.
12. There are 2 setpoints per limit, one above and one below the expected range of values. LM1 is the "too high" limit, LM2 is "too low". The entity goes "out of limit" on LM1 when its value is greater than the setpoint. It remains "out of limit" until the value drops below the in threshold. LM2 works similarly, in the opposite direction. If limits in only one direction are of interest, set the in threshold on the "wrong" side of the setpoint. Limits are specified as % of full scale, where full scale is automatically set appropriately for the entity being

    current FS = CT numerator *
    voltage FS = PT numerator *
    power FS = CT numerator *
    frequency FS = 60 (or 50)
    power FS = 1.0
    percentage FS = 100.0
    angle FS = 180.0

13. THD not available shows 65535 (=0xFFFF) in all THD and harmonic magnitude registers for the channel when the THD and Pulse Output (Software) Option =THD. THD may be unavailable due to low V or I amplitude, or delta hookup (V only).

14 All 3 voltage angles are measured for Wye and Delta hookups. For 2.5 Element, Vac is measured and Vab & Vbc are calculated. If a voltage phase is missing, the two voltage angles in which it participates are set to zero. A and C phase current angles are measured for all hookups. B phase current angle is measured for Wye and is zero for other hookups. If a voltage phase is missing, its current angle is zero.

15 If any register in the programmable settings section is set to a value other than the acceptable value then the meter will stay in LIMP mode. Please read the comments section or the range for each register in programmable settings section for acceptable .

16 If the THD and Pulse Output (Software) Option is THD and protocol (ppp) is set to 3 (DNP) then meter will use the MODBUS RTU protocol as DNP is supported by THD and Pulse Output (Software) Option THD.

EPM 6000 Power Meter

Appendix C: DNP Mapping for EPM 6000

C.1 Introduction

The DNP Map for the EPM 6000 Meter shows the client-server relationship in the EPM 6000's use of DNP Protocol.

C.2 DNP Mapping (DNP-1 to DNP-2)

The EPM 6000 DNP Point Map follows.

Binary Output States, Control Relay Outputs, Binary Counters (Primary) and **Analog Inputs** are described on Page 1.

Internal Indication is described on Page 2.

Object	Point	Var	Description	Format	Range	Multiplier	Units	Comments
Binary Output States								Read via Class 0 only
10	0	2	Reset Energy Counters	BYTE	Always 1	N/A	none	
10	1	2	Change to Modbus RTU Protocol	BYTE	Always 1	N/A	none	
Control Relay Outputs								
12	0	1	Reset Energy Counters	N/A	N/A	N/A	none	Responds to Function 5 (Direct Operate), Qualifier Code 17x or 28x, Control Code 3, Count 0, On 0 msec,
12	1	1	Change to Modbus RTU Protocol	N/A	N/A	N/A	none	Responds to Function 6 (Direct Operate - No Ack), Qualifier Code 17x, Control Code 3, Count 0, On 0 msec,

Object	Point	Var	Description	Format	Range	Multiplier	Units	Comments
Binary Counters (Primary)								Read via Class 0 only
20	0	4	W-hours, Positive	UINT32	0 to 99999999	multiplier = $10^{(n-d)}$, where n and d are derived from the energy format. n = 0, 3, or 6 per energy format scale and d = number of decimal places.	W hr	example:
20	1	4	W-hours, Negative	UINT32	0 to 99999999		W hr	energy format = 7.2K and W-hours counter = 1234567
20	2	4	VAR-hours, Positive	UINT32	0 to 99999999		VAR hr	n=3 (K scale), d=2 (2 digits after decimal point), multiplier = $10^{(3-2)} = 10^1 = 10$, so energy is 1234567 * 10 Whrs, or 12345.67 KWhrs
20	3	4	VAR-hours, Negative	UINT32	0 to 99999999		VAR hr	
20	4	4	VA-hours, Total	UINT32	0 to 99999999		VA hr	
Analog Inputs (Secondary)								Read via Class 0 only
30	0	5	Meter Health	SINT16	0 or 1	N/A	none	0 = OK
30	1	5	Volts A-N	SINT16	0 to 32767	(150 / 32768)	V	Values above 150V secondary read 32767.
30	2	5	Volts B-N	SINT16	0 to 32767	(150 / 32768)	V	
30	3	5	Volts C-N	SINT16	0 to 32767	(150 / 32768)	V	
30	4	5	Volts A-B	SINT16	0 to 32767	(300 / 32768)	V	Values above 300V secondary read 32767.
30	5	5	Volts B-C	SINT16	0 to 32767	(300 / 32768)	V	
30	6	5	Volts C-A	SINT16	0 to 32767	(300 / 32768)	V	
30	7	5	Amps A	SINT16	0 to 32767	(10 / 32768)	A	Values above 10A secondary read 32767.
30	8	5	Amps B	SINT16	0 to 32767	(10 / 32768)	A	
30	9	5	Amps C	SINT16	0 to 32767	(10 / 32768)	A	
30	10	5	Watts, 3-Ph total	SINT16	-32768 to +32767	(4500 / 32768)	W	
30	11	5	VARs, 3-Ph total	SINT16	-32768 to +32767	(4500 / 32768)	VAR	
30	12	5	VAs, 3-Ph total	SINT16	0 to +32767	(4500 / 32768)	VA	
30	13	5	Power Factor, 3-Ph total	SINT16	-1000 to +1000	0.001	none	
30	14	5	Frequency	SINT16	0 to 9999	0.01	Hz	
30	15	5	Positive Watts, 3-Ph, Maximum Avg Demand	SINT16	-32768 to +32767	(4500 / 32768)	W	
30	16	5	Positive VARs, 3-Ph, Maximum Avg Demand	SINT16	-32768 to +32767	(4500 / 32768)	VAR	
30	17	5	Negative Watts, 3-Ph, Maximum Avg Demand	SINT16	-32768 to +32767	(4500 / 32768)	W	
30	18	5	Negative VARs, 3-Ph, Maximum Avg Demand	SINT16	-32768 to +32767	(4500 / 32768)	VAR	
30	19	5	VAs, 3-Ph, Maximum Avg Demand	SINT16	-32768 to +32767	(4500 / 32768)	VA	
30	20	5	Angle, Phase A Current	SINT16	-1800 to +1800	0.1	degree	
30	21	5	Angle, Phase B Current	SINT16	-1800 to +1800	0.1	degree	
30	22	5	Angle, Phase C Current	SINT16	-1800 to +1800	0.1	degree	
30	23	5	Angle, Volts A-B	SINT16	-1800 to +1800	0.1	degree	
30	24	5	Angle, Volts B-C	SINT16	-1800 to +1800	0.1	degree	
30	25	5	Angle, Volts C-A	SINT16	-1800 to +1800	0.1	degree	
30	26	5	CT numerator	SINT16	1 to 9999	N/A	none	CT ratio =
30	27	5	CT multiplier	SINT16	1, 10, or 100	N/A	none	(numerator * multiplier) / denominator

Object	Point	Var	Description	Format	Range	Multiplier	Units	Comments
30	28	5	CT denominator	SINT16	1 or 5	N/A	none	
30	29	5	PT numerator	SINT16	1 to 9999	N/A	none	PT ratio =
30	30	5	PT multiplier	SINT16	1, 10, or 100	N/A	none	(numerator * multiplier) / denominator
30	31	5	PT denominator	SINT16	1 to 9999	N/A	none	
30	32	5	Neutral Current	SINT16	0 to 32767	(10 / 32768)	A	For 1A model, multiplier is (2 / 32768) and values above 2A secondary read 32767.
Internal Indication								
80	0	1	Device Restart Bit	N/A	N/A	N/A	none	Clear via Function 2 (Write), Qualifier Code 0.

EPM 6000 Power Meter

Appendix D: DNP 3.0 Protocol Assignments for EPM 6000

D.1 DNP Implementation

PHYSICAL LAYER

The EPM 6000 meter is capable of using RS-485 as the physical layer. This is accomplished by connecting a PC to the EPM 6000 with the RS-485 connection on the back face of the meter.

RS-485

RS-485 provides multi-drop network communication capabilities. Multiple meters may be placed on the same bus, allowing for a Master device to communicate with any of the other devices. Appropriate network configuration and termination should be evaluated for each installation to insure optimal performance.

Communication Parameters

EPM 6000 meters communicate in DNP 3.0 using the following communication settings:

- 8 Data Bits
- No Parity
- 1 Stop Bit

Baud Rates

EPM 6000 meters are programmable to use several standard baud rates, including:

- 9600 Baud
- 19200 Baud
- 38400 Baud
- 57600 Baud

D.2 Data Link Layer

The Data Link Layer as implemented on EPM 6000 meters is subject to the following considerations:

Control Field

The Control Byte contains several bits and a Function Code. Specific notes follow.

Control Bits

Communication directed to the meter should be Primary Master messages (DIR = 1, PRM = 1). Response will be primary Non-Master messages (DIR = 0, PRM = 1). Acknowledgment will be Secondary Non-Master messages (DIR = 0, PRM = 0).

Function Codes

EPM 6000 meters support all of the Function Codes for DNP 3.0. Specific notes follow.

Reset of Data Link (Function 0)

Before confirmed communication with a master device, the Data Link Layer must be reset. This is necessary after a meter has been restarted, either by applying power to the meter or reprogramming the meter. The meter must receive a RESET command before confirmed communication may take place. Unconfirmed communication is always possible and does not require a RESET.

User Data (Function 3)

After receiving a request for USER DATA, the meter will generate a Data Link CONFIRMATION, signaling the reception of that request, before the actual request is processed. If a response is required, it will also be sent as UNCONFIRMED USER DATA.

Unconfirmed User Data (Function 4)

After receiving a request for UNCONFIRMED USER DATA, if a response is required, it will be sent as UNCONFIRMED USER DATA.

Address

DNP 3.0 allows for addresses from 0 - 65534 (0x0000 - 0xFFFE) for individual device identification, with the address 65535 (0xFFFF) defined as an all stations address. EPM 6000 meters' addresses are programmable from 0 - 247 (0x0000 - 0x00F7), and will recognize address 65535 (0xFFFF) as the all stations address.

D.3 Transport Layer

The Transport Layer as implemented on EPM 6000 meters is subject to the following considerations:

Transport Header

Multiple-frame messages are not allowed for EPM 6000 meters. Each Transport Header should indicate it is both the first frame (FIR = 1) as well as the final frame (FIN = 1).

D.4 Application Layer

The Application Layer contains a header (Request or Response Header, depending on direction) and data. Specific notes follow.

Application Headers

Application Headers contain the Application Control Field and the Function Code.

Application Control Field

Multiple-fragment messages are not allowed for EPM 6000 meters. Each Application Header should indicate it is both the first fragment (FIR = 1) as well as the final fragment (FIN = 1). Application-Level confirmation is not used for EPM 6000 meters.

Function Codes

The following Function codes are implemented on EPM 6000 meters.

Read (Function 1)

Objects supporting the READ function are:

- Binary Outputs (Object 10)
- Counters (Object 20)
- Analog Inputs (Object 30)
- Class (Object 60)

These Objects can be read via a Class 0 request.

Write (Function 2)

Objects supporting the WRITE function are:

- Internal Indications (Object 80)

Direct Operate (Function 5)

Objects supporting the DIRECT OPERATE function are:

- Control Relay Output Block (Object 12) - see Section D.4.1.2 for details

Direct Operate - No Acknowledgment (Function 6)

Objects supporting the DIRECT OPERATE - NO ACKNOWLEDGMENT function are:

- Change to MODBUS RTU Protocol

Response (Function 129)

Application responses from EPM 6000 meters use the RESPONSE function.

Application Data

Application Data contains information about the Object and Variation, as well as the Qualifier and Range.

D.4.1 Object and Variation

The following Objects and Variations are supported on EPM 6000 meters:

- Binary Output Status (Object 10, Variation 2) †
- Control Relay Output Block (Object 12, Variation 1)

- 32-Bit Binary Counter Without Flag (Object 20, Variation 5) †
- 16-Bit Analog Input Without Flag (Object 30, Variation 4) †
- Class 0 Data (Object 60, Variation 1) †
- Internal Indications (Object 80, Variation 1)

† READ requests for Variation 0 will be honored with the above Variations.

Binary Output Status (Obj. 10, Var. 2)

Binary Output Status supports the following functions:

Read (Function 1)

A READ request for Variation 0 will be responded to with Variation 2.

Binary Output Status is used to communicate the following data measured by EPM 6000 meters:

Energy Reset State

Change to MODBUS RTU Protocol State

Energy Reset State (Point 0)

EPM 6000 meters accumulate power generated or consumed over time as Hour Readings, which measure positive VA Hours and positive and negative W Hours and VAR Hours. These readings may be reset usinga Control Relay Output Block object (Obj. 12). This Binary Output Status point reports whether the Energy Readings are in the process of being reset, or if they are accumulating. Normally, readings are being accumulated and the state of this point is read as '0'. If the readings are in the process of being reset, the state of this point is read as '1'.

Change to Modbus RTU Protocol State (Point 1)

EPM 6000 meters are capable of changing from DNP Protocol to Modbus RTU Protocol. This enables the user to update the Device Profile of the meter. This does not change the Protocol setting. A meter reset brings you back to DNP. Status reading of "1" equals Open, or de-energized. A reading of "0" equals Closed, or energized.

Control Relay Output Block (Obj. 12, Var. 1)

Control Relay Output Block supports the following functions:

Direct Operate (Function 5)

Direct Operate - No Acknowledgment (Function 6)

Control Relay Output Blocks are used for the following purposes:

Energy Reset

Change to MODBUS RTU Protocol

Energy Reset (Point 0)

EPM 6000 meters accumulate power generated or consumed over time as Hour Readings, which measure positive VA Hours and positive and negative W Hours and VAR Hours. These readings may be reset using Point 0.

Change to Modbus RTU Protocol (Point 1)

Refer to the previous section for the Change to Modbus Protocol information.

Use of the DIRECT OPERATE (Function 5) function will operate only with the settings of Pulsed ON (Code = 1 of Control Code Field) once (Count = 0x01) for ON 1 millisecond and OFF 0 milliseconds.

32-Bit Binary Counter Without Flag (Obj. 20, Var. 5)

Counters support the following functions:

Read (Function 1)

A READ request for Variation 0 is responded to with Variation 5.

Counters are used to communicate the following data measured by Shark® 100

meters:

Hour Readings

Hour Readings (Points 0 - 4)

Point	Readings	Unit
0	+W hour	Wh
1	-W hour	Wh
2	+VAR hour	VARh
3	-VAR hour	VARh
4	+VA hour	VAh

NOTE

These readings may be cleared by using the Control Relay Output Block (see previous section).

16-Bit Analog Input Without Flag (Obj. 30, Var. 4)

Analog Inputs support the following functions:

Read (Function 1)

A READ request for Variation 0 is responded to with Variation 4.

Analog Inputs are used to communicate the following data measured by EPM 6000 meters:

- Health Check
- Phase-to-Neutral Voltage
- Phase-to-Phase Voltage
- Phase Current
- Total Power
- Three Phase Total VAs
- Three Phase Power Factor Total
- Frequency
- Three Phase +Watts Max Avg Demand
- Three Phase + VARs Max Avg Demand
- Three Phase -Watts Max Avg Demand
- Three Phase -VARs Max Avg Demand
- Three Phase VAs Max Avg Demand

- Angle, Phase Power
- Angle, Phase-to-Phase Voltage
- CT Numerator, Multiplier, Denominator
- PT Numerator, Multiplier, Denominator

Health Check (Point 0)

The Health Check point is used to indicate problems detected by the EPM 6000 Power Meter. A value of zero (0x0000) indicates the meter does not detect a problem. Nonzero values indicate a detected anomaly.

Phase-to-Neutral Voltage (Points 1 - 3)

Point	Reading
1	Phase AN Voltage
2	Phase BN Voltage
3	Phase CN Voltage

These points are formatted as 2's complement fractions. They represent a fraction of a 150V Secondary input. Inputs of above 150V Secondary are pinned at 150V Secondary.

Phase-to-Phase Voltage (Points 4 - 6)

Point	Reading
4	Phase AB Voltage
5	Phase BC Voltage
6	Phase CA Voltage

These points are formatted as 2's complement fractions. They represent a fraction of a 300V Secondary input. Inputs of above 300 V Secondary are pinned at 300V Secondary.

Phase Current (Points 7 - 9)

Point	Reading
7	Phase A Current
8	Phase B Current
9	Phase C Current

These points are formatted as 2's complement fractions. They represent a fraction of a 10A Secondary input. Inputs of above 10A Secondary are pinned at 10A Secondary.

Total Power (Points 10 - 11)

Point	Reading
10	Total Watt
11	Total VAR

These points are formatted as 2's complement fractions. They represent a fraction of 4500W Secondary in normal operation, or 3000W Secondary in Open Delta operation. Inputs above/below +/-4500 or +/-3000W Secondary are pinned at +/-4500 or +/- 3000W Secondary, respectively.

Total VA (Point 12)

Point	Reading
12	Total VA

This point is formatted as a 2's complement fraction. It represents a fraction of 4500W Secondary in normal operation, or 3000W Secondary in Open Delta operation. Inputs above/below +/-4500 or +/-3000W Secondary are pinned at +/-4500 or +/-3000W Secondary, respectively.

Power Factor (Point 13)

Point	Reading
13	Power Total Factor

This point is formatted as a 2's complement integer. It represents Power Factors from -1.000 (0x0FC18) to +1.000 (0x003E8). In Open Delta operation, Total Power Factor (Point 13) is always zero.

Frequency (Point 14)

Point	Reading
14	Frequency

This point is formatted as a 2's complement fraction. It represents the Frequency as measured on Phase A Voltage in units of cHz (centiHertz, 1/100 Hz). Inputs below 45.00 Hz are pinned at 0 (0x0000); inputs above 75.00 Hz are pinned at 9999 (0x270F).

Maximum Demands of Total Power (Points 15 - 19)

Point	Reading
15	Maximum Positive Demand Total Watts
16	Maximum Positive Demand Total VARs
17	Maximum Negative Demand Total Watts
18	Maximum Negative Demand Total VARs
19	Maximum Average Demand Total VAs

These points are formatted as 2's complement fractions. They represent a fraction of 4500W Secondary in normal operation, or 3000W Secondary in Open Delta operation. Inputs above/below +/-4500 or +/-3000W Secondary are pinned at +/-4500 or +/-3000W Secondary, respectively.

Phase Angle (Points 20 - 25)

Point	Reading
20	Phase A Current Angle
21	Phase B Current Angle
22	Phase C Current Angle
23	Volts A-B Angle
24	Volts B-C Angle
25	Volts C-A Angle

These points are formatted as 2's complement integers. They represent angles from -180.00 (0x0F8F8) to +180.00 (0x00708).

CT & PT Ratios (Points 26 - 31)

Point	Reading
26	CT Ratio Numerator
27	CT Ratio Multiplier
28	CT Ratio Denominator
29	PT Ratio Numerator
30	PT Ratio Multiplier
31	PT Ratio Denominator

These points are formatted as 2's complement integers. They can be used to convert from units in terms of the Secondary of a CT or PT into units in terms of the Primary of a CT or PT. The ratio of Numerator divided by Denominator is the ratio of Primary to Secondary.

EPM 6000 meters typically use full scales relating primary current to 5 A and primary voltage to 120 V. However, these Full scales can range from mAs to thousands of kAs, and from mVs, to thousands of kVs. Following are example settings:

CT Example Settings

200 amps: Set the Ct-n value for 200 and the Ct-S value for 1.

800 amps: Set the Ct-n value for 800 and the Ct-S value for 1.

2,000 amps: Set the Ct-n value for 2000 and the Ct-S value for 1.

10,000 amps:Set the Ct-n value for 1000 and the Ct-S value for 10.

NOTE

CT Denominator is fixed at 5 for 5 A units; CT Denominator is fixed at 1 for 1 A units.

PT Example Settings

277 volts (Reads 277 volts): Pt-n value is 277, Pt-d value is 277, Pt-S value is 1.

120 volts (Reads 14,400 volts): Pt-n value is 1440, Pt-d value is 120, Pt-S value is 10.

69 volts (Reads 138,000 volts): Pt-n value is 1380, Pt-d value is 69, Pt-S value is 100.

115 volts (Reads 347,000 volts): Pt-n value is 3470, Pt-d value is 115, Pt-S value is 100.

69 volts (Reads 347,000 volts): Pt-n value is 347, Pt-d value is 69, Pt-S value is 1000.

Class 0 Data (Obj. 60, Var. 1)

Class 0 Data supports the following functions:

Read (Function 1)

A request for Class 0 Data from a Shark® 100 meter returns three Object Headers. Specifically, it returns 16-Bit Analog Input Without Flags (Object 30, Variation 4), Points 0 - 31, followed by 32-Bit Counters Without Flags (Object 20, Variation 5), Points 0 - 4, followed by Binary Output Status (Object 10, Variation 2), Points 0 - 1. (There is NO Object 1.)

A request for Object 60, Variation 0 is treated as a request for Class 0 Data.

Internal Indications (Obj. 80, Var. 1)

Internal Indications support the following functions:

Write (Function 2)

Internal Indications may be indexed by Qualifier Code 0.

Device Restart (Point 0)

This bit is set whenever the meter resets. The polling device may clear this bit by Writing (Function 2) to Object 80, Point 0.

GE
Grid Solutions

EPM 6000 Power Meter

Appendix E: Manual Revision History

E.1 Release Notes

Table E–1: Release Dates

MANUAL	GE PART NO.	RELEASE DATE
GEK-113637	1601-0215-A1	January 2005
GEK-113637A	1601-0215-A7	August 2015
GEK-113637B	1601-0215-A8	October 2017

Table E–2: Major Updates for 1601-0038-A8 (Sheet 1 of 2)

SECT (A7)	SECT (A8)	DESCRIPTION
Title	Title	Manual part number to 1601-0215-A8.
Cover	Cover	Updated branding to Grid Solutions.
1.2	1.2	Updated Figure 1-2.
2.1	2.1	Added UL note.
2.1.1	2.1.1	Updated Universal Voltage Inputs description. Updated CT Pass Through description.
2.2	2.2	Environmental Specifications, Faceplate rating updated.
2.3	2.3	Added REACH and RoHS Compliance.
4.1.1	4.1.1	Added mention of Com Option S difference.
D.4	D.4	Updated description of Read (Function 1). Added Section D.4.1.2 reference to Direct Operate (Function 5) description.

Table E–2: Major Updates for 1601-0038-A8 (Sheet 2 of 2)

SECT (A7)	SECT (A8)	DESCRIPTION
D.4.1	D.4.1	Corrected input range for Phase-to-Phase Voltage (Points 4-6).

Table E–3: Major Updates for 1601-0038-A7

SECT (A6)	SECT (A7)	DESCRIPTION
Title	Title	Manual part number to 1601-0215-A7.
Cover	Cover	Updated title, picture, format, and front matter.
Ch2	Ch2	Updated Order Codes Updated dimensions in Specifications section. Updated Approval and Compliance information.
Ch3	Ch3	Updated Dimensions in drawings.
Ch4	Ch4	Updated Wiring Diagrams.
Ch7	Ch6	Combined Chapters 6 and 7.
App B	App B	Updated Navigation Maps.
App D	App D	Added content to section D4.1, page D-5 onward.
N/A	N/A	Minor corrections throughout.